

**RADIOGRAPHY, ULTRASONOGRAPHY AND LAPAROSCOPY FOR
THE DIAGNOSIS OF INTRA-ABDOMINAL DISORDERS IN DOGS**

**PRAMOD U
(15-MVP-017)**

THESIS

Submitted in partial fulfilment of the requirement for the degree of

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DECLARATION

I hereby declare that this thesis entitled “**Radiography, ultrasonography and laparoscopy for the diagnosis of intra-abdominal disorders in dogs**” is a bonafide record of research done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title of any other University or Society.

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EXTERNAL EXAMINER

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Introduction

1. INTRODUCTION

Dogs have been domesticated by man since time immemorial. Since then he has gained the status of “man’s best friend and guardian”. He has gained access from the backyard to his master’s bed room. Ever since, the variety of diseases seen in dogs has breached all concepts of veterinary medicine. The changes in environment, climatic conditions and life style of his master combined with uncontrolled inbreeding, unscientific breeding for creating newer breeds, altered feeding and indiscriminate use of common drugs, have all contributed for more and more complicated diseases reported in dogs. The increased number of cancer patients is a direct effect of these changes.

Intra-abdominal disorders are one of the most commonly presented canine cases in any veterinary hospital. More than any other domestic animals, dogs were presented with many types of abdominal diseases (Ljunggren, 1964). Most of the abdominal disorders involving any of the organs/systems in the abdominal cavity are presented with non-specific symptoms like vomiting, anorexia, weight loss, lethargy, diarrhoea, anaemia, abnormal urination, abdominal pain etc. Therefore their early diagnosis is a challenge. Moreover, the failure from the part of owners to detect subtle changes in behaviour of dogs lead to late presentation of these animals to a veterinary practitioner, usually in an advanced state. The time available for the veterinarian to diagnose the condition will be therefore limited. This fact magnifies the importance of a quick diagnosis and accurate therapy.

History, clinical signs, physical examination, haematology and serum biochemistry will help to arrive at a tentative diagnosis to start with an initial treatment protocol. But usually it is difficult to accurately diagnose a specific abdominal disorder because of improper and distorted history, subtle and non-specific clinical signs and equivocal serum biochemistry and haematology. In this context the use of modern diagnostic methodologies gains relevance. Usage of radiography, ultrasonography and diagnostic laparoscopy have gained much popularity over the years. However diagnostic laparoscopy is still in nascent stage of development in our country. More specialised diagnostic techniques like,

computed tomography (CT), magnetic resonance imaging (MRI), nuclear scintigraphy etc. are not very popular in veterinary field because of their exorbitant cost involved.

Articles are available from various researchers reporting satisfactory results of radiography and ultrasonography in different conditions (Nyland *et al.*, 1995, Manczur *et al.*, 1998 and Smith, 2006). None of the tools will give a fool proof diagnosis in any case. Some will be good in some particular case and not useful in some other cases. False positive and false negative findings are also very common. More over each of these techniques have its own demerits. Radiation is the major disadvantage of radiography. According to Mannion (2006) and Gomaa *et al.* (2012) the interpretation of sonographic images depends on the experience of sonographer. Diagnostic laparoscopy is commonly used in human medicine (Almeida *et al.* 1995, Boyd and Nord 2000). But its use is limited in veterinary field, eventhough it could be used for direct visualisation of organs and for selective, specific and multiple biopsies (Wildt and Lawler, 1985 and Twedt, 2011).

The usage of different diagnostic modalities will complement each other and help to get a correct picture of the disorder, when they are used in combination judiciously. Detailed analysis of available literature on the use of radiography, ultrasonography and laparoscopy revealed that there is a dearth of available studies on comprehensive comparative study on their usage in abdominal disorders of dogs.

Hence the present study, “Radiography, ultrasonography and laparoscopy for the diagnosis of intra-abdominal disorders in dogs”, was undertaken with an objective, to evaluate the use of radiography, ultrasonography and laparoscopy for the diagnosis of various intra-abdominal disorders in dogs and to suggest most suitable diagnostic test for specific disorders.

Review of Literature

2. REVIEW OF LITERATURE

3.6 INCIDENCE OF ABDOMINAL DISORDERS IN DOGS

Ljunggren (1964) opined that more than any other domestic animals, dogs were presented with many types of abdominal disease. It was extremely important to quickly determine if surgery was indicated and in some cases of misdiagnosis, surgery might be a fatal mistake.

Patnaik *et al.* (1980) reported that the incidence of hepatic carcinomas in dogs were 0.05 to 0.13 per cent and bile duct carcinomas were the second most common type of hepatic carcinoma.

Ward *et al.* (1994) stated that out of all other species, dogs were more affected with haemangiosarcoma with a prevalence of 0.3 per cent to 2.0 per cent.

Cullen and Popp (2002) reported that cholangiocarcinomas were rare in domestic species and comprises only 0.36 per cent of all canine neoplasms.

Hendrick (2002) reported that fibromas though rarely seen in large animals, could be seen in dogs.

Schultheiss (2004) reported that nonvisceral hemangiosarcomas were found less frequently compared to visceral hemangiosarcomas in dogs.

Hall and German (2010) observed that the most common type of intussusception reported in small animals were ileo-colic. Mid jejunal and double intussusceptions were also reported.

Scherk and Center (2010) reported that the incidence of primary hepatobiliary neoplasia were less than 1.5per cent of all canine cancers.

Simpson (2010) stated that gastritis was the common intra abdominal disorder in dogs.

Schlafer and Foster (2016) opined that pyometra was a common condition in dogs, compared to its less common nature in sow, ewe, camelids, mare and queen.

2.2 CAUSES AND ORGANS OR SYSTEMS AFFECTED IN INTRA ABDOMINAL DISORDERS.

According to Ljunggren (1964) diseases causing acute abdominal signs could be related to digestive system, urinary system, liver, pancreas, spleen, reproductive system and peritoneum.

Kumar and Tayal (1994) opined that the most common reason for any kind of gastro-intestinal foreign body in dogs was their greedy feeding nature.

Ward *et al.* (1994) reported there were primary dermal and hypodermal variants of haemangiosarcoma which accounts for 14 per cent of total cases in dogs. Stage III haemangiosarcoma was primary tumor with deeper muscle involvement.

Walters (2000b) opined that in small animals abdominal discomfort might be associated with a variety of disorders *viz*, gastrointestinal, hepatic, splenic or urogenital. Such affections would normally be associated with pain.

Webster and Cooper (2009) opined that because of the high blood flow to the liver, due to its dual supply (systemic and portal) and its role in detoxification of the body, liver was sensitive to other systemic disorders. Therefore there would be hepatic changes in gastrointestinal disorders, vascular disorders, systemic infection, muscle injury and paraneoplastic conditions.

Hall and German (2010) were of the opinion that intestinal obstruction as an abdominal disorder could be intra luminal (foreign bodies), extra luminal (intussusception) or sometimes intra mural (intestinal neoplasia, haematoma, granuloma or a stricture)

Radlinsky (2013) listed the causes of gastric outflow obstruction as, pyloric abnormalities, disorders of gastric motility or extrinsic masses. Pyloric stenosis was the benign muscular hypertrophy of the pylorus. The cause for pyloric stenosis was unknown, however, excessive gastrin secretion or neurogenic dysfunction could be an exciting cause.

Vegad (2015) opined that the causes of intussusception were intestinal hypermotility due to irritation, foreign body, neoplasm, parasites and granulomas.

Valli *et al.* (2016) stated that congestive splenomegaly in dogs was due to many reasons like, barbiturate anaesthesia, circulatory disturbances, splenic

volvulus, acute haemolytic anaemia or infectious diseases like babesiosis or trypanosomiasis.

2.3 AGE

Ng and Mills (1985) and Ward *et al.* (1994) reported that the median age of presentation of haemangiosarcoma in their study on affected dogs was 9.1 years and nine years respectively.

Johnson *et al.* (1989) in a study of 100 cases of splenomegaly observed that splenic torsion was generally seen in young dogs and barring this all other cases of splenic disorders were seen in older dogs.

Cullen and Popp (2002) reported that 65 per cent of cholangiocarcinomas were seen in dogs more than 10 years of age.

Schultheiss (2004) reported that hemangiosarcomas, both nonvisceral and visceral were found rarely in young animals.

Smith (2006) reviewed that there was an increased incidence of pyometra in nulliparous female dogs, especially in those of more than four years of age, as per findings of different studies.

Hall and German (2010) observed that in small animals intussusception cases were usually seen in young animals than in adults.

Scherk and Center (2010) reported that incidence of hepatobiliary neoplasia in dogs were more common in the age ranging from 10-12 years.

Simpson (2010) stated that cases of foreign body ingestion and gastric outflow obstruction were most commonly seen in young dogs.

Radlinsky (2013) observed that animals of any age might be affected with pyloric stenosis. However, it was mostly found in young animals.

2.4 SEX

Patnaik *et al.* (1980) reported in their study on 110 primary hepatic neoplasms in dogs, that more number of females were affected with bile duct carcinoma.

Ward *et al.* (1994) could not find any sex predilection for haemangiosarcoma in a study on 25 affected dogs.

Cullen and Popp (2002) reviewed that cholangiocarcinomas were more common in females than males.

Scherk and Center (2010) observed that female dogs were more prone to biliary carcinomas, and male dogs to hepatocellular carcinomas.

Radlinsky (2013) was of the opinion that pyloric stenosis were more commonly seen in males than females.

2.5 BREED

Patnaik *et al.* (1980) reported that there was no breed predilection for incidence of bile duct carcinoma in dogs.

Ng and Mills (1985) reported that German shepherd dog was the common breed affected with haemangiosarcoma.

Hendrick (2002) opined that Rhodesian ridge backs, Doberman pinschers and boxers were predisposed to fibromas.

Radlinsky (2013) reported that most prevalent breeds of dogs in which pyloric stenosis was seen were brachycephalic breeds.

2.6 DIAGNOSIS

Kraft (1986) opined that hepatic diseases generally provide non-specific clinical symptoms and therefore there was a need to investigate them further. Laboratory tests could sometimes suggest presence or absence of liver diseases.

Johnson *et al.* (1989) in a study of splenomegaly in 100 dogs could diagnose the condition by palpation in 79 dogs and by radiography in 80 dogs. They further opined that it was difficult to differentially diagnose neoplastic and non neoplastic splenic disorders with accuracy. Even at the time of surgery, from the gross appearance of spleen it could not be differentiated. An aspiration cytology or frozen section biopsy was required for this.

According to Simpson (2010) imaging diagnostic tool of choice for cases with vomiting and abdominal pain was abdominal radiography. A combination of

ultrasonography and endoscopy was more effective to detect obstructive inflammatory and neoplastic gastro-intestinal disorders.

Radlinsky (2013) opined that in conditions of gastric outflow disorders, radiography and ultrasonography could not differentiate the reason for obstruction like inflammation, hypertrophy and neoplasia.

2.7 HISTORY AND CLINICAL SIGNS IN ABDOMINAL DISORDERS

Patnaik *et al.* (1980) reported anorexia, ascites, lethargy, dyspnoea and hepatomegaly as common clinical signs in a study on bile duct carcinoma in dogs.

Ng and Mills (1985) observed that the common clinical signs showed by dogs with haemangiosarcoma in their study were, weakness and lethargy, anorexia, depression and weight loss.

Johnson *et al.* (1989) opined that anorexia, vomiting and weakness were some clinical signs exhibited by dogs with splenic disorders.

Stanton and Bright (1989) observed that dogs with gastro-intestinal perforation were not usually presented in an acutely collapsed state.

Monroe (2000) stated that anorexia as a clinical sign which could be due to systemic diseases like inflammatory, degenerative, endocrine, metabolic, neoplastic or toxic disorders affecting different organ systems. He opined that in order to confirm reason for anorexia, other diagnostic methods like radiography, ultrasonography or endoscopy might be needed.

According to Walters (2000a) pain was a general sign of acute abdominal affections which could be from the abdominal viscera, parietal peritoneum, or from extra-abdominal sites. It was suggested that visceral pain was secondary to other pathological changes like, inflammation, ischemia, distention, or rupture of abdominal organs. Pain would be manifested by signs like guarding the abdomen when touched or palpated. It was also observed that other clinical signs of acute abdomen were abdominal distention, praying posture, restlessness, vomiting, diarrhea, and collapse.

Nichols (2001) explained that polyurea and polydipsia were having diagnostic importance and there were many reasons. Some specific differential

diagnosis could be renal failure, hyperadrenocorticism, hypoadrenocorticism, hypokalemia, hypercalcemia, pyelonephritis, hepatic failure and pyometra.

Cullen and Popp (2002) reviewed that clinical signs of cholangiocarcinomas were nonspecific and included, lethargy, anorexia, vomiting, weight loss and dyspnoea. They reported that ascites was a less common sign.

Hinton *et al.* (2002) enlisted clinical signs in 15 dogs with gastro-duodenal perforation. They could observe lethargy, anorexia, weight loss, vomiting, melena and hematemesis. Other signs were dehydration, shock, polyurea and polydipsia.

Brown (2003) reported vomiting, anorexia, depression and abdominal tenderness in cases of small intestinal obstruction in dogs. When the obstruction was complete and located proximally, they noted frequent projectile vomiting and in case of partial or distal obstruction, there was less profuse and sporadic vomiting.

Fransson and Ragle (2003) stated that clinical signs of pyometra in dogs were not only limited to those signs related to genital tract, but there might also be other general signs like anorexia, vomiting, polydipsia, polyuria, lethargy, and vulvar discharge. They further observed that signs were more severe in dogs with closed pyometra.

Smith (2006) observed that female dogs with pyometra might be presented with a history of inappetence, depression, polydipsia, and lethargy, with or without vaginal discharge.

Chaudhary *et al.* (2008) studied 200 cases of suspected hepatopathies and observed varying range of presenting signs like nausea/vomiting, anaemia, jaundice, fever, polyurea, muscle tremors, ascites, constipation, weakness and anorexia. They further opined that most of those signs were nonspecific and vague and might even be related to neurologic or gastro intestinal tract involvement, necessitating other diagnostic tests to confirm hepatic involvement.

Jawre (2008) observed that lower intestinal obstructions were showing less acute symptoms. The loss of fluid and electrolytes were less in those cases. Obvious distension was less evident because the length of intestine was enough to accommodate and contain intestinal distension.

Webster and Cooper (2009) stated that clinical signs of liver diseases were not usually specific to that system. They noted signs related to gastro-intestinal disorders (anorexia, vomiting, diarrhoea and weight loss), urinary disorders (polyurea, polydipsia and dysurea) and central nervous system defects (lethargy and depression).

Elwood *et al.* (2010) opined that vomiting was an important clinical sign exhibited by dogs with various intra abdominal disorders including neoplasms like gastro intestinal disorders, non gastro intestinal disorders, other systemic diseases and nervous system related disorders. They suggested that in most of the clinical conditions with vomiting as a clinical sign, the manifestations of the disease and that of vomiting could not be completely differentiated.

Foley (2010) stated that intraluminal and extraluminal obstruction of colon could lead to tenesmus.

Hall and German (2010) explained that cardinal signs of small intestinal diseases was diarrhoea. They enumerated other signs as vomiting, weight loss, haematemesis, melena, altered appetite, abdominal distension and flatus, dehydration, ascites, oedema, shock etc.

Shulman (2010) opined that weakness and lethargy were nonspecific signs and could be attributed to a multiple reasons. The reason could be hepatic, renal, gastro-intestinal or related to pancreatic diseases. He told that any chronic systemic disorder could lead to cachexia with anorexia, weight loss and weakness.

Simpson (2010) could infer that changes in hydration status, body temperature, rate of respiration, perfusion rate and mucosal pallor were observed in gastric outflow obstruction, gastric ulceration and perforation. He was of the opinion that vomiting after 8-10 hours of feeding was due to delayed gastric emptying on account of outflow obstruction or gastric outflow obstruction due to defective gastric propulsion and that requires further investigation to distinguish between the two. He further explained that in pyloric stenosis the vomiting usually was projectile and there would be abdominal distension, weight loss, melena, abdominal discomfort, bloating and anorexia.

Singh *et al.* (2010) stated that in truly anorectic animals clinical signs would be related to the underlying cause and could be manifested in many ways. If there was an underlying systemic disease, depression, weight loss, fever (in acute infections), vomiting, diarrhoea, cough, dyspnea and organomegaly might be present along with anorexia. They could summarise that anorexia in dogs was not limited to liver and gastro-intestinal tract related disorders.

Twedt (2010) reviewed that vomiting of partially digested food more than six to eight hours after feeding would be mainly due to gastric outflow obstruction or gastric hypomotility disorder. He further stated that vomiting fresh blood, bright red blood or digested blood usually suggested gastro-intestinal erosions due to foreign body, neoplasia or gastro-intestinal ulceration.

Webster (2010) explained that early clinical signs of hepatic diseases like vomiting, anorexia, polyurea, polydypsia and lethargy were non-specific and were difficult to differentiate.

Khan *et al.* (2011) noted history of vomiting, anorexia, tenesmus and lack of defaecation for six days in a dog with ileo-colic intussusception.

Kim *et al.* (2012) reported a history of abdominal discomfort, intermittent vomiting and melena for five days in a case of double intussusception in a dog.

Prathaban *et al.* (2013) observed anorexia, vomiting, depression, diarrhoea and intermittent rectal prolapse in a non-descript pup with double intussusception.

Radlinsky (2013) reported intermittent or delayed vomiting as the most common sign in cases of gastric outflow obstruction in dogs. Severe dehydration, weight loss, anorexia and depression, were other signs.

Elhiblu *et al.* (2015) studied 140 cases of dogs with hepatic insufficiency and observed that they were showing various clinical signs like inappetence, polyuria, polydypsia, abdominal distension, weight loss, anaemia and jaundice.

Ravikumar *et al.* (2015) reported a history of vomiting, dysentery and inappetence for five days in a Labrador Retriever with intussusception.

Schlafer and Foster (2016) reported that clinical signs usually seen in case of pyometra were depression, anorexia, vomiting, polyuria and polydypsia. They

opined that the extragenital clinical signs shown by an animal with pyometra was due to severe toxemia and intermittent bacteremia.

2.8 EXAMINATION OF ABDOMEN IN DOGS

Trigo *et al.* (1982) and Cullen and Popp (2002) could confirm hepatomegaly by palpation in their study in dogs with cholangio cellular carcinoma.

Ng and Mills (1985) observed abdominal distension and abdominal pain in dogs with haemangiosarcoma in their study.

Johnson *et al.* (1989) opined that abdominal distension was a finding in dogs with splenic disorders.

Hinton *et al.* (2002) could observe abdominal pain and abdominal distension in dogs with gastro-duodenal perforation.

MacPhail (2002) opined that one could get a large mass of bundled intestines in case of linear foreign body of gastro-intestinal tract. The abdominal palpation could be painful.

Fransson and Ragle (2003) and Smith (2006) reported that dogs with closed pyometra frequently had abdominal distension.

Simpson (2010) noted that in gastric dilation/ gastric dilation volvulus or delayed gastric emptying, abdominal distension was detected and abdominal pain was noticed in cases of gastric outflow obstruction, gastric ulceration and perforation.

Khan *et al.* (2011) could palpate a firm, painful mass in the mid-caudal abdomen of a dog with ileo-colic intussusception. The animal was exhibiting mild discomfort while palpating the abdomen.

Nath *et al.* (2011) observed that dogs with gastro-intestinal tract foreign body obstruction, exhibited pain on abdominal palpation.

Kim *et al.* (2012) could notice a relatively mobile tender mass in the left mid-abdominal region which had multiple direction mobility, in a dog with double intussusception

Prathaban *et al.* (2013) could identify a sausage shaped intra-abdominal mass on abdominal palpation in a non descript pup with double intussusception.

Radlinsky (2013) reported nonspecific findings during physical examination of gastric outflow obstruction in dogs. Abdominal pain was a common finding in linear foreign bodies when the foreign body had caused bunching of the intestines. In foreign body obstruction, peristaltic activity could be auscultated or there would be no sound at all due to ileus.

Ravikumar *et al.* (2015) could palpate a relatively mobile soft mass along caudal abdomen in a Labrador Retriever with intussusception.

2.9 PHYSIOLOGICAL PARAMETERS IN DOGS WITH ABDOMINAL DISORDERS

Ng and Mills (1985) observed pale mucous membrane, dyspnoea, abnormal pulmonary rales, arrhythmia and fever in dogs with haemangiosarcoma in their study.

Smith (2006) opined that bitches with pyometra typically were afebrile.

Pretzer (2008) stated that in some cases fever might be noticed during closed pyometra in dogs, but when they had toxemia, then the animals were found to be hypothermic.

Kim *et al.* (2012) observed that a Shih-Tsu with double intussusception was showing mild depression during physical examination.

Prathaban *et al.* (2013) reported a normal body temperature and hyperpnoea with severe dehydration and emaciation in a pup with double intussusception.

Ravikumar *et al.* (2015) observed increased body temperature and normal respiratory rate, heart rate and capillary refill time in a dog with intussusception.

2.10 HAEMATOLOGICAL PARAMETERS IN DOGS WITH ABDOMINAL DISORDERS

Oksanen (1978) reported anaemia in most of the cases of haemangiosarcoma. He opined that the cause could be non-specific tumour effects, large quantities of blood in the tumor and haemorrhages into adjacent tissue or within the haemangiosarcoma.

Patnaik *et al.* (1980) reported that anaemia was less common in dogs with bile duct carcinoma. They observed that 75 per cent of their cases were showing leukocytosis with neutrophilia.

Ng and Mills (1985) observed anaemia in eight out of ten cases of haemangiosarcoma in dogs with reduced VPRC and haemoglobin level. Leukocytosis was seen in four cases with neutrophilia and it was suggestive of systemic stress. Lower levels of platelets were seen in almost all cases. They opined that anaemia and reduced platelet count could be due to sequestration or haemorrhage into the tumour sinuses or body cavities. There were chances of disseminated intravascular coagulation and this could lead to consumption of platelets and cause thrombocytopenia.

Rasmussen (2003) reported leukocytes, neutrophilia, reduced platelet count and coagulopathies in severe cases of gastric perforation and peritonitis.

Johnson *et al.* (1989) opined that anaemia, due to bleeding into peritoneum after rupture of spleen or secondary to splenic neoplasms, could be sign in case of splenic disorders exhibited as splenomegaly.

Walters (2000b) reported that while interpreting initial haematological parameters in small animals with abdominal discomfort, VPRC < 20 suggest haemorrhage or neoplasia and that more than 60 indicated dehydration or neoplasia. It was also suggested that a neutropenia could indicate sepsis and thrombocytopenia could be due to disseminated intravascular coagulation, sepsis, severe inflammation, severe blood loss or neoplasia.

Benjamin (2001) explained that neutrophilic leukocytosis were usually seen in cases of localised inflammatory response (like pyometra) rather than generalised ones.

Hinton *et al.* (2002) reported inflammatory or stress leukograms with leukocytosis, lymphopenia and neutropenia and increased band cells in most of the dogs with gastro-duodenal perforation.

Fransson and Ragle (2003) observed that bitches with pyometra were having leukocytosis (Smith, 2006) with shift to left and anaemia manifested by reduced haemoglobin level and VPRC. They explained that anaemia was due to

the reduced erythrocyte production resulting from the systemic inflammatory response.

Jawre *et al.* (2006) during haematological analysis of a dog with ileo-caecal intussusception observed normal haematological values, other than an increased WBC count

Chaudhary *et al.* (2008) after their study on hepatic diseases in 200 dogs, opined that haemato-biochemical values in cases of hepatopathies were misleading.

Simpson (2010) stated that a higher value of VPRC could sometimes be seen due to haemoconcentration on account of shock seen in gastric perforation or gastric obstruction. According to him in pyloric stenosis complete blood count was normal and anaemia was there only when it was associated with ulceration and neoplasm,

Khan *et al.* (2011) noted leukocytosis, lymphopenia and reduced levels of haemoglobin, RBC and VPRC, in a dog with ileo-colic intussusception.

Kim *et al.* (2012) reported a mild leukocytosis in an otherwise normal blood picture, during haematological analysis of a dog diagnosed with a double intussusception.

Radlinsky (2013) observed nonspecific haematological values in animals with benign gastric outlet obstruction.

Ravikumar *et al.* (2015) noticed moderate leukocytosis and neutrophilia during a complete blood count in a dog with ileo-caecal intussusception

2.11 SERUM BIOCHEMISTRY IN DOGS WITH ABDOMINAL DISORDERS

Patnaik *et al.* (1980) reported that an increase in alkaline phosphatase was seen in 75 per cent and an increase in alanine transaminase was seen in 25 per cent of dogs with bile duct carcinoma. Total protein was within normal range in all the animals.

Hinton *et al.* (2002) reported hypoproteinemia as a common finding during serum analysis of 14 dogs with gastro-duodenal perforation.

Fransson and Ragle (2003) reviewed serum biochemistry of bitches with pyometra and revealed normal or decreased levels of ALT, hyperglobulinemia (due to inflammation), hypoalbuminemia (because of an acute phase reaction), increased ALP and sometimes increased creatinine levels.

Jawre *et al.* (2006) observed normal serum biochemical values except for an increased serum ALP level, in a dog with ileo-caecal intussusception.

Smith (2006) observed that azotemia with hyperproteinemia and hyperglobulinemia was seen in female dogs with pyometra.

Singh *et al.* (2010) studied 61 cases of anorexia in dogs and suggested that an increase in serum ALT levels were relatively specific for liver disease. Total proteins in blood plasma below the normal range reflect low albumin concentration, and might indicate any liver disease.

Webster (2010) observed that serum values like ALT, AST, ALP and GGT lack specificity and thus interpretations were affected. Owing to the regenerative capacity of liver the prognosis of hepatic disease could not be ascertained even though there was a substantial hepatobiliary injury.

Radlinsky (2013) observed nonspecific biochemical values in animals with benign gastric outlet obstruction. They stated that only occasionally azotemia and mild hypoalbuminemia were seen in young emaciated dogs

Ravikumar *et al.* (2015) noticed hypoproteinemia (45 g/L) and hypoalbuminemia (18 g/L) during serum biochemical examination in a dog with ileo-caeco-colic intussusception.

2.12 RADIOGRAPHY IN DOGS

Thornton (1962) observed that the margins of the various abdominal organs would fade away when there was large quantity of fluid in the abdomen. The entire abdomen would have a homogenous, ground glass appearance. He further reported that when there was a collection of exudates or transudates in the abdomen, irrespective of cause, all had a similar radiographic appearance of ascites. Therefore other procedures were necessary to differentiate the condition causing fluid collection. He explained that in case of a liver mass the stomach was

displaced upwards and on careful observation the mass would be continuous with the liver shadow. He was of the opinion that when a mass was identified between the urinary bladder and colon in a radiograph, uterus should be considered due to its anatomical location in that area.

Ljunggren (1964) suggested that when a single segment was dilated with gas it might suggest ileus and/or obstruction. A Barium meal could be employed when one or more segments of the intestine were dilated. He explained the appearance of radiographs in case of an intestinal linear foreign body. The portion of the intestine distal to it would be pushed up on the foreign body by peristaltic waves. Intestine would be filled with gas and appear to be collected in the middle of the abdomen. He explained the radiographic signs of pyometra as fluid-filled uterine horns in the caudal abdomen and on lateral radiograph their merging into the enlarged neck of the uterus which was observed between rectum and urinary bladder. He studied radiographs of peritonitis and revealed that they were characterized by unsharp contours and blurring of borders of visceral structures. He was of the opinion that during a Barium meal, canine stomach usually emptied in three to five hours and barium reached the colon by about 12 hours.

Root (1974) was of the opinion that in diffuse liver enlargement, the lateral radiograph of abdomen shows rounded caudo-ventral tip of the liver shadow, its extension caudally beyond the costal arch. In focal hepatomegaly normal liver outline were distorted and that part would be continuous with the liver in at least one projection. He further opined that rounding of the borders of spleen was a radiographic sign of diffuse splenomegaly, however, the body and tail of the spleen were highly mobile and because of this fact it was difficult to radiographically appreciate focal splenomegaly. He inferred that there would usually be craniodorsal displacement of the small intestine in case of uterine enlargements.

Nyland and Ackerman (1978) suggested that pneumocolon radiography could be used to see luminal or mural masses of colon. They explained that to perform pneumocolon radiography air, at the rate of 1-3 ml/Kg body weight should be introduced per rectally.

According to Ackerman (1981), a 30 to 40 day post-conception uterus and a pyometra would be radiographically similar in size and shape and differentiation was difficult during this time. It was reported that it was difficult to radiographically see the normal non-gravid uterus, because it would be having a small diameter and its opacity would be similar to adjacent intestinal loops. Uterus might be visible as a tubular or convoluted soft tissue structure in the caudal ventral abdomen, when it becomes larger.

Hinton *et al.* (2002) and Rasmussen (2003) observed free peritoneal gas, decreased abdominal detail, loss of serosal details and peritoneal debris in dogs with gastric perforation on lateral survey radiograph.

MacPhail (2002) observed that plicated or bunched intestinal radiographic pattern, often considered classic were not always evident. Most of the times, obstruction would be partial and therefore abnormal distension of intestinal loops were rare.

Bischoff (2003) reviewed that for better perception, two orthogonal views of radiographs should be taken unless and until the animal was compromised, like due to some trauma of spinal cord. The radiograph should be evaluated systematically and checked for basic Roentgen signs (changes in size, shape, margination, opacity, number, location etc).

Patsikas *et al.* (2003) and Kim *et al.* (2012) were of the opinion that survey and contrast radiographic studies might be diagnostic for intussusception, but were often non specific.

Jawre *et al.* (2008) demonstrated gas filled dilated intestines with a mass anterior to it, in a case of intussusception in a Bull Mastiff.

Pretzer (2008) was of the opinion that though radiography could be used to diagnose pyometra in female dogs, it could be frequently inconclusive. They explained that the radio-opacity of normal nonpregnant and early pregnant uterus was similar to radiographic characteristics of pyometra, mucometra, and uterine torsion.

Hammond (2009) stated that mild distension of uterine body might be difficult to appreciate radiographically. They might be lost amongst the loops of

intestine. The uterine body were generally visible between descending colon and bladder neck.

Thrall *et al.* (2009) opined that radiographs of neoplasms were having different shades of soft tissue opacity based on the consistency of the mass. The displacement of adjacent organs or structures could be used to identify the location and origin of the mass.

Simpson (2010) opined that in case of delayed gastric emptying radiography should be performed by employing contrast agents and it should be checked whether food/fluid was retained in the stomach for more than 8 hrs and sometimes it could even be 12-16 hrs after feeding.

Kim *et al* (2012) could find areas of reduced serosal detail along the left mid abdomen with an increase in tissue opacity, in the abdominal radiograph of a case of double intussusception in a dog.

Radlinsky (2013) opined that survey abdominal radiographs sometimes revealed distended stomach, usually with fluid and could be used to differentiate any extrinsic causes of pyloric obstruction and pyloric wall thickening. Delayed gastric emptying, thickening of pyloric wall, and filling defect in the pylorus could be assessed by a contrast study.

Finck *et al.* (2014) recommended that in diagnosis of mechanical obstruction using abdominal radiographs in dogs, instead of simply using intestinal ratios as cut-off values for upper threshold, a flowchart approach based on probabilities of obstruction could be used. He concluded that dogs with $SI \text{ max}/L5 \leq 1.4$, $SI \text{ max}/SI \text{ min} \leq 2$ and $SI \text{ max}/SI \text{ ave} \leq 1.3$ would not be mechanically obstructed. Dogs with $SI \text{ max}/L5 \geq 2.4$, $SI \text{ max}/SI \text{ min} \geq 3.4$ and $SI \text{ max}/SI \text{ ave} \geq 1.9$, with or without segmental dilation, were most likely obstructed. Dogs with ratios falling between these values were to be further investigated with other diagnostic tools.

Kumar and Srikala (2014) reported that radiographically the entire abdomen would have a homogenous, ground glass appearance in case of ascites.

2.13 ULTRASONOGRAPHY IN DOGS

Nyland *et al.* (1981) reported abnormal echogenicity in the area of gallbladder and porta hepatis during the ultrasonic examination of the liver of a dog with bile-duct carcinoma.

Pennink *et al.* (1990) observed fluid-filled stomach and pyloric wall thickening between 8.0 and 9.0 mm, during ultrasonography of a case of hypertrophic pyloric stenosis in a bulldog. The pyloric thickening was localised and circumferentially symmetrical and there was reduced gastric motility.

Tidwell and Penninck (1992) observed that based on physical properties and interaction with the ultrasound beam ultrasonographic patterns of foreign bodies vary. Those which transmit the beam were usually observed with some accuracy and those which attenuate the sound beam produce acoustic shadowing. This had to be differentiated from gas pattern in intestine. They further opined that activity of gastro-intestinal segments could be analysed using ultrasonography and if increased it could signify mechanical obstruction or irritation.

Nyland *et al.* (1995) reported that because of the uniform parenchymal appearance of liver sonograms, ultrasonography was best suited for hepatic evaluation, especially identification of focal lesions. However, in case of diffuse hepatic diseases, diagnosis with ultrasonography was difficult and a tissue core biopsy might be needed. They noted that it was not possible to differentiate primary and metastatic lesions, neither was it possible to ascertain the tumor type by ultrasonography alone. They further reported that focal or multifocal hypoechoic or mixed lesions with parenchymal changes were more common in hepatic carcinomas compared to hyperechoic lesions.

Manczur *et al.* (1998) suggested that ultrasonography was a rapid method for diagnosing intestinal obstruction. However, they reported that it could lead to false positive (in 6 per cent cases) and false negative (in 15 per cent) results.

During abdominal ultrasound, Hinton *et al.* (2002) could find peritoneal fluid in five out of eight dogs with gastro-duodenal perforation. Based on intramural gas shadowing along the wall of duodenum in ultrasound, they could diagnose gastro-duodenal perforation in one dog.

MacPhail (2002) stated that linear foreign body in the intestine appeared as hyperechoic line with plicated intestinal segments on ultrasonography.

Patsikas *et al.* (2003) observed a target-like image with concentric rings in the transverse view ultrasonography of all cases in a study of 19 dogs with intussusception. The center was hyperechoic (mesenteric fat and compressed intussusceptum) in all except one, in which it was anechoic because of the accumulated fluid seen in the lumen of intussusceptum. The shape of the hyperechoic center was circular, G shaped, reverse G shaped or semilunar, or no shape. They could identify more than five well-differentiated hyperechoic and hypoechoic concentric rings or poorly differentiated rings. They reported multiple hyperechoic and hypoechoic parallel lines in the longitudinal view. They also got a false-positive case in that particular study.

Rasmussen (2003) explained that in cases of gastric perforation ultrasonography would show only non specific changes in the peritoneum to suggest peritonitis. It would be difficult to study the details of wall and confirm perforation because of gas in the peritoneum.

Thiel *et al.* (2003) reported that it was difficult to differentiate benign and malignant diseases in dogs using ultrasonography.

Bigliardi *et al.* (2004) opined that a high definition equipment and well-trained experienced sonographers could make a sufficiently good diagnosis in cystic hyperplasia-pyometra complex using ultrasound scan.

Mannion (2006) opined that when the architecture of liver was undisturbed and there was only minute variation in texture and echogenicity it would be very difficult to identify abnormalities. He suggested that the experience of sonographer was very important in these cases.

Smith (2006) demonstrated a fluid filled structure with variable thickness of the uterine wall along with proliferative changes in canine pyometra during ultrasonographic examination. They suggested that ultrasonography and radiology were the best diagnostic tools for canine pyometra.

Anjou (2008) reported a poorly defined structure with irregular hypoechoic and anechoic cavitations in the longitudinal sonogram of liver of a dog with biliary carcinoma.

Kramer and Anjou (2008) observed that a soft tissue tumor could be solid, cystic or with mixed lesions. The echogenicity of most soft tissue tumors would be mixed, and echotexture could be homogenous or non homogenous and could be anechoic to highly hyperechoic. In their opinion the margins could be demarcated in some cases. The Doppler result could be mixed. In some cases of malignant tumors it could be hypervascular and in some cases it could be poorly perfused or necrotic.

Hammond (2009) stated that when uterine horns were mildly dilated it could be seen as with similar diameter as the small intestines. In order to differentiate them, it was recommended to observe the absence of peristalsis, lack of wall layering and if possible the uterine horn should be traced caudally for bifurcation.

Schwarz (2009) observed that generalised hypoechogenicity of liver could be due to diffuse enlargement. Vessels of liver could be having a hyperechoic wall with greater contrast to surrounding parenchyma. The differential diagnosis could be lymphoma, congestion or acute hepatitis.

Kealy *et al.* (2011) observed generalized hypoechoic appearance of hepatic parenchyma in cases of hepatic congestion or lymphoma. They opined that it was difficult to appreciate diffuse parenchymal hepatic diseases as their appearance were non-specific and a biopsy was necessary for diagnosis.

Gomaa *et al.* (2012) observed fluid-filled loops and hyperechoic structures casting an acoustic shadow distally, in a sonographic study on dogs with gastrointestinal foreign bodies. They suggested that ultrasonographic observation of peristaltic activity was an important indicator of obstruction. They observed that in acute stage of mechanical ileus there was generalized increase in intestinal motility. Motility was found decreased during chronic stages of mechanical ileus. They could observe hyperechoic free gas shadowing in right cranial abdomen with reverberation artefact during ultrasonography, of dogs with gastrointestinal

perforations. They were of the opinion that interpretation of sonographic images depended on the sonographer and his experience. The findings should be interpreted in collaboration with history, symptoms and radiographic observations.

Kim *et al.* (2012) reported three distinct rings as a three circle sign in a case of double intussusception (ileo-ileo-colic intussusception) in a Shih-Tsu dog. However, they could not detect these signs at the time of initial ultrasonography, but could only identify during retrospective evaluation. They concluded that the double intussusception showed only standard ultrasonographic signs and symptoms of intussusception and was indistinguishable from classical intussusception preoperatively. At the time of laparotomy only, it could be detected.

Radlinsky (2013) opined that ultrasonography sometimes revealed distended stomach, usually with fluid and pyloric wall thickening in pyloric stenosis.

Kumar and Srikala (2014), while performing abdominal ultrasonography of a dog with ascites, reported that visceral organs were floating in anechoic abdominal fluid.

Elhiblu *et al.* (2015) observed that there was a diffuse increase in echogenicity of liver as compared to that of spleen (“bright liver”) and rounding of the liver margins in liver cirrhosis.

2.14 DIAGNOSTIC LAPAROSCOPY IN DOGS

2.16.1 Laparoscopy for Abdominal Disorders

Wildt and Lawler (1985) suggested that for directly observing abdominal organs of the dogs, laparoscopy could be used.

Almeida *et al.* (1995) suggested use of diagnostic laparoscopy in humans as a procedure to look directly at the contents of a patient's abdomen or pelvis, including the ovaries, uterus, small bowel, large bowel, liver and gall bladder.

According to Boyd and Nord (2000) diagnostic laparoscopy in humans could be employed to detect a problem that was not diagnosed using non invasive

tests. They also opined that for staging intra-abdominal malignancies in humans, diagnostic laparoscopy was the highly accurate method.

Maiti *et al.* (2006) studied the use of diagnostic laparoscopy in canine intraperitoneal disorders involving gastro-intestinal and reproductive organs. They also collected biopsy of the diseased viscera for different pathological affections.

In a study on radiographic, ultrasonographic and laparoscopic diagnosis of urogenital disorders in male dogs, Tumariya (2007) concluded that laparoscopy was very effective in direct visualization of abdominal and pelvic organs of urogenital system and the size, colour, external texture and peripheral blood circulation of organs were easily studied. However it was not possible to visualize their internal contents

Monnet *et al.* (2008) described two approaches for laparoscopy. The right lateral approach and a ventral approach. They suggested putting primary port caudal to umbilicus in ventral approach.

Raghuvir (2008) opined that diagnostic laparoscopy had a steep learning curve and expertise to perform the procedure. It was reported that laparoscopy could aid in early decision making to undertake a surgical intervention. He could successfully diagnose a case of cholangiocellular carcinoma in a dog, which was confirmed by histopathology.

Twedt (2011) opined that diagnostic laparoscopy was one of the only available methods for performing repeated direct examination of abdominal organs.

Moore and Ragni (2012) opined that diagnostic laparoscopy being a minimally invasive procedure was extremely safe compared to exploratory laparotomy. The diagnostic quality was enhanced because of the magnification of the telescope and the fact that it could be used to get a precise biopsy specimen.

Patel *et al.* (2014) explained that positioning was one of the primary principles of laparoscopy and it includes, patient positioning, surgical team positioning, tower positioning and instrument table positioning. It was further suggested that gravity was one of the best assistants for laparoscopic procedure as it helps to retract organs by tilting the animal on the table. They reported that

laparoscopy was a useful diagnostic test in veterinary practice and was useful in taking biopsy. For nonsurgical liver disease laparoscopy could be used to take biopsies from selected multiple sites as it gives excellent visual control to take correct samples.

2.16.2 Port placement

Monnet *et al.* (2008) opined that the disadvantage of Hasson technique was that it would need a larger incision and there was risk of subcutaneous emphysema.

Freeman (2009) stated that two 5.0 mm ports should be inserted to the abdomen so that two sets of grasping forceps could be employed for tracing and exploring the intestine in a “hand-over-hand” manner. It was explained that the use of laparoscopic biopsy cup forceps to collect tissue biopsy samples from any solid organ with minimal hemorrhage.

Rawlings (2011) described the procedure for performing Hasson technique in dogs. They suggested making a 1.5 to 2cm skin and subcutaneous ventral midline incision 2cm caudal to the umbilicus for this. Traction sutures could be used to lift the abdominal muscles to let the organs fall away from the abdominal wall, before passing the trocar-cannula.

Patel *et al.* (2014) introduced a second port either in the midline or lateral to midline depending upon the organ for taking biopsy of affected area. They passed auxiliary biopsy or grasping forceps under telescope guidance.

2.17 GROSS APPEARANCE

Oksanen (1978) defined that haemangiosarcoma might occur singly in an organ or as multiple growth, which could be miliary to 30 cm in diameter. Smaller masses would be pale grey and the larger ones were dark red. They could be soft. The larger masses were with haemorrhages and areas of necrosis. There could be massive haemorrhages in to the peritoneal cavity.

Patnaik *et al.* (1980) reported that in 49 per cent of dogs with bile duct carcinoma, the tumor was massive affecting entire lobes. In other cases it was

nodular or diffuse. Most commonly affected lobe was left lateral lobe. Metastasis was seen in lymph nodes, lungs, peritoneum, spleen, pancreas, kidneys and adrenals. They could not find metastatic lesions on gastro-intestinal tract.

Cullen and Pop (2002) observed that cholangiocarcinoma of liver were multilobulated and massive in size. Also it was noted that the tumor might either scatter throughout the lobes or entire lobes were affected. Tumor could protrude from capsule and have an umbilicated appearance. It was opined that the main feature of cholangiocarcinoma was the texture of the mass which was firm due to abundance of connective tissue and that differs from hepatocellular carcinoma which were soft and friable.

Hendrick (2002) explained that fibromas were oval or round benign fibrocyte neoplasms. They could affect intradermal and subcutaneous tissues. Their texture could be firm and rubbery, and the cut surface could be grey or white.

MacPhail (2002) opined that the site of foreign body obstruction should be assessed for viability by checking the colour, thickness, arterial pulsation and progressive peristalsis. He further opined that in case of linear foreign body, perforations were difficult to be identified because of the presence of mesenteric fat. Extensive manipulation could lead to iatrogenic perforation.

Jawre (2008) could identify dilated colon and invaginated loops of ileum in caecum during diagnostic laparoscopy in a case of ileo-caecal intussusception in a Bull mastiff.

Sastry and Rao (2009) explained that the affected part of intestine would be dark-red or bluish in colour and swollen in case of intussusception. This was because of the acute passive hyperaemia, where there was sudden obstruction to the venous flow due to compression of thin walled veins. Other lesions observed by them were, peritoneal effusion and intestinal wall oedema. In intestinal obstruction, it was observed that distension at the site of obstruction, hard contents, which compress the mucosa causing necrosis, erosions, stenosis and if prolonged, rupture. They further stated that thickening of stomach wall was common in all cases of gastritis.

Mohan (2010) described that in humans, the circular layer of muscularis in pyloric sphincter would be grossly affected in case of pyloric stenosis. There would be hypertrophy and hyperplasia. Fibrosis at the affected area could be noticed as thickening.

Kim *et al.* (2012) confirmed a double intussusception on exploratory laparotomy. They observed that an ileo-ileal intussusception had progressed and intussuscepted into the colon through the ileo-colic orifice to form a double intussusception.

Radlinsky (2013) told that in case of intestinal obstruction there could be ischemic necrosis of the bowel wall due to strangulation and thrombosis of vasculature. The colour could be blue to black compared to normal pink to red. The proximal segment would be dilated with some ischemic areas.

Vegad (2015) stated that in intussusception the segment of the affected intestine would be enlarged and thickened. Gross appearance of the affected segment would be red or black, due to congested vessels in that area and due to minute haemorrhages. Ultimately the segments would become swollen and distended.

Schlafer and Foster (2016) reported that the uterus might be only slightly enlarged with mild endometrial hyperplasia and inflammation in less advanced case of pyometra. In closed conditions the contents would become dehydrated and the inspissated material could be found in the lumen of uterine horns as soft materials. Distension could sometimes mimic that of midpregnancy. Dark serosa, prominent vessels, friable uterine wall, inflammation of peritoneal serosa and mesometrium and thick and viscid exudates were all characters of pyometra which might or might not be present.

Valli *et al.* (2016) described the gross appearance of splenomegaly and opined that there were two types, one was congested and another was non congested splenomegaly. In congested or “bloody” splenomegaly, spleen would be dark red to bluish black and when cut, blood would ooze out. Whereas in non congested or “meaty” splenomegaly there was no oozing of blood, and it would be firmer with varying shades of colour.

2.18 LINE OF TREATMENT

Ward *et al.* (1994) reported that in contrary to the treatment for stage I haemangiosarcoma, prognosis of stage III was guarded and there was risk of failure. It required an extensive surgical excision and adjuvant chemotherapy and radiotherapy.

According to Hendrick (2002) fibromas were benign with a slow growth rate. It could be surgically treated by removing the entire mass based on its extent.

MacPhail (2002) considered linear foreign body as a surgical emergency. Sometimes multiple enterotomy might be required for segmental removal of linear foreign body to prevent iatrogenic perforation.

Schultheiss (2004) reported that non visceral hemangiosarcomas affecting subcutaneous tissues and muscles had a poor prognosis. Tumors of muscle could not be excised completely and even if it was done, it could lead to death.

Smith (2006) opined that complete ovariectomy should be considered in case of a closed-cervix pyometra. He cautioned that medical management of closed pyometra could result in uterine rupture, seepage of uterine contents into the abdomen and could be life-threatening.

Kim *et al.* (2012) could easily reduce the ileo-ileal segment intussuscepted into the colon in a case of double intussusception, during laparotomy. They couldn't milk out the ileo-ileal intussusception. Therefore they did an enterectomy and entero-anastomosis.

Radlinsky (2013) suggested that Y-U pyloroplasty could be used to correct pyloric stenosis. He had opined that the viability of affected bowel segment should be assessed during intestinal surgery by checking the wall for its colour, texture, peristalsis, pulsation and capillary bleeding. Normal appearance of wall was not a confirmation for better healing. Therefore, when there was a doubt, the doubtful portion should be resected.

Materials and Methods

3. MATERIALS AND METHODS

The present study was conducted on thirteen dogs with abdominal disorders presented to the Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Pookode. Dogs, irrespective of age, sex and breed, were selected to evaluate the use of radiography, ultrasonography and laparoscopy for the diagnosis of intra-abdominal disorders, and to suggest the most suitable diagnostic tool for each case.

3.1 SCREENING AND SELECTION OF CASES

Cases suspected of canine abdominal disorders, presented to the Teaching Veterinary Clinical Complex, Pookode, were screened for the study. Among the screened cases, those having a complicated clinical presentation were subjected to radiography and ultrasonography for diagnosis of the condition. Cases which required further investigation were then subjected to laparoscopic examination. Thirteen such cases were included in this study.

3.2 HISTORY AND CLINICAL SIGNS

Dogs with history and clinical signs suggestive of an abdominal disorder, like inappetance, vomiting, abnormal defaecation, abnormal physical appearance of abdomen and pain on palpation of abdomen were selected. Age, sex, breed, owner's complaint, clinical signs noticed, degree of discomfort exhibited and duration of illness were noted before the physical examination. Detailed physical and clinical examinations of each of the twelve cases were carried out before employing the diagnostic tools.

3.3 PHYSIOLOGICAL PARAMETERS

The vital physiological parameters were recorded in all the dogs prior to other diagnostic procedures. The parameters observed were, heart rate (beats/min), rectal temperature (°F), respiratory rate (breaths/min), pulse rate

(number/min), capillary refill time (sec) and appearance of visible mucous membrane.

3.4 ABDOMINAL EXAMINATION

A detailed examination of abdomen was carried out and noted the appearance of the abdomen, findings on palpation, percussion and auscultation.

3.5 HAEMATOLOGY

3.5.1 Collection of Blood Samples

Two millilitres of blood was collected from cephalic vein in sterile vials containing K3 EDTA (CML, Biotech Ltd., Kerala) to evaluate the haematological parameters.

3.5.2 Parameters Observed

The haematological parameters observed were, haemoglobin concentration (g/dl), volume of packed red cells (VPRC - %), total leucocyte count (TLC - 10^3 cells/ μ L), differential leucocyte count (DLC - % of individual cells), platelet count (10^5 / μ L) and total erythrocyte count (TEC - 10^6 cells/ μ L).

3.5.3 Haematology Analyser

Veterinary haematological analyser (ecos Vet, Exigo, Boule Medical AB, Stockholm, Sweden), with the pre-set reference ranges for canine blood cells was used to estimate the haematological parameters.

3.6 SERUM BIOCHEMISTRY

3.6.1 Collection of Blood Samples

Four millilitres of blood was collected from all the dogs in sterile vials containing clot accelerator (CML Biotech Ltd., Kerala) to separate the serum. The tubes after clotting were centrifuged at 3000 rpm for 15 min and the serum was separated.

3.6.2 Parameters Observed

The separated serum was subjected to estimation of total protein, albumin, alanine amino transaminase, creatinine, and serum alkaline phosphatase. All the parameters were estimated on the same day of collection of blood.

3.6.3 Serum Biochemistry Analyser

Semi-automatic biochemical analyser- Master T of Hospitex Diagnostics, Italy was used to estimate serum biochemistry.

3.7 RADIOGRAPHY

All cases were subjected to survey radiography in orthogonal views, to study the morphological features - shape, size, location, number, margination and radio opacity of various abdominal organs. Contrast radiography using barium sulphate suspension or air was carried out as per the assumptions made after clinical evaluation and survey radiography.

3.7.1 Radiographic Views and Positioning

Right lateral and ventrodorsal views of the abdomen were taken in the present study. Survey radiographs were taken initially and contrast studies were carried out later, if necessary.

Animals were restrained in right lateral recumbency with fore limbs and hind limbs held parallel to the table surface and pulled in cranial and caudal directions respectively. The central beam was focussed caudal to the last rib. In case of large breeds, separate radiographs of cranial and caudal abdomen were taken to get a complete picture of the abdomen.

For ventrodorsal view, all the animals were positioned on dorsal recumbency, with fore and hind limbs pulled in cranial and caudal directions respectively.

3.7.2 Radiographic Instrumentation

Radiographs were taken using a 500 mA X-ray machine, Heliophos D of Siemens Ltd. Medical solutions division, India (Plate 1a). After exposure, image was processed with the help of a digital processing unit, Directview Vita CR, from Carestream Ltd (Plate 1b), with flexible phosphor screen GP2.

3.8 ULTRASONOGRAPHY

3.8.1 Preparation and positioning

The site required to perform ultrasonography was prepared by clipping the hair over the entire abdomen including midway up the body wall over the right and left caudal intercostal spaces. Animals were allowed to drink water before examination.

Abdominal ultrasonography was performed in dorsal and lateral recumbency. The head of the animal was oriented towards left of the examiner, when the animal was in dorsal recumbency. The point of the transducer was placed in such a way that it was directing towards the cranial side of the animal in a sagittal scan. In case of a transverse scan, the point was directed towards left side of the animal or away from the examiner. In lateral recumbency, while doing transverse scan, the point was directed towards the dorsum of the animal, away from the examiner. In occasional instances like ascites, animals were made to stand to complete the scanning procedure. No animal was sedated before scanning. The sonogram was viewed for normal and abnormal echogenicity of various abdominal organs.

3.8.2 Ultrasound scanning with selection of acoustic window

After securing the animal either in lateral or dorsal recumbency, scanning was carried out by using a sector or convex probe placed in sagittal, longitudinal or oblique manner in different regions to view various organs through acoustic windows as suggested in BSAVA (British Small Animal Veterinary Association) Manual of canine and feline ultrasonography.

3.8.3 Ultrasound Machine

Transabdominal ultrasonography was carried out using ultrasound machine Prosound α -6 of Aloka, Model IPF-1503 (Plate 1c, 1d), in B-mode with curvilinear and sector transducers. Frequency used for examination was 3 MHz to 7 MHz.

3.9 DIAGNOSTIC LAPAROSCOPY

3.9.1. Preparation and Anaesthesia

3.9.1.1 Preparation

In all the cases other than emergency cases, solid food was withheld for 12 hours and water for four hours, before diagnostic laparoscopy. In emergency conditions procedure was initiated without further fasting.

The abdomen, extending from xiphoid to the pubis and laterally on either side, was then prepared aseptically by shaving the area which was already prepared for ultrasonography. The area was thoroughly cleaned with surgical spirit.

3.9.1.2 Anaesthesia

Each case was considered as an individual entity and therefore a common anaesthetic protocol was not formulated. Anaesthesia was decided based on merits and demerits of each condition, animals' age, weight, physical and clinical status and temperament.

3.9.2 Positioning and Procedure

After anaesthesia, all animals were positioned on dorsal recumbency on the 'V' positioner of the surgical table, and secured with velcro straps.

Following positioning of the animal and draping the abdomen, a 1.5 to 2.0 centimeters midline skin and subcutaneous incision was made about 1.5 centimeters caudal to the umbilicus. Two traction sutures using No 1 silk were placed, one on each side of the incision, to lift the abdominal wall from the internal viscera. While placing traction sutures, it was ensured that enough

subcutis and muscle fascia were included in the bite. Linea alba was identified and a minilaparotomy incision was made along the linea alba using a No 11 blade. A curved mosquito forceps was inserted through the incision and rotated to ensure that the peritoneum was breached and abdominal cavity has entered. A 10 mm trocar and threaded canula were introduced through the incision in a right cranial direction to ensure minimum injury to the viscera. It was ensured that the canula was tightly fitting the minilaparotomy incision to prevent any gas leak during the procedure. The pre-placed traction sutures were used to secure the canula tight and in place.

The carbon dioxide endoflator silicone tubing was connected to the canula and carbon dioxide was insufflated to create pneumo-peritoneum. The pressure was maintained between 10 to 12 mm of Hg and initial flow rate was kept between four to six L/min. The rigid telescope connected to the xenon light source was then introduced through the canula and the abdominal cavity was examined grossly to rule out bleeding, if any. The detailed examination of the abdomen was carried out visualising each organ for abnormal visual appearance, morphological changes and gross pathological changes.

After achieving the pneumoperitoneum, additional ports were introduced as per requirement, based on the observations made after initial survey using the rigid telescope. The sites were selected in such a way as to ensure triangulation while approaching the target organ or area. The site for trocar was identified by palpating the abdominal wall externally at the same time internally visualising the indentation produced, through the rigid telescope. When the tip of canula was visible inside the abdomen, the trocar was withdrawn and canula threaded in position. A 5mm reducer was placed to introduce the 5 mm instruments.

Atraumatic graspers and forceps were introduced to grasp, manipulate, reposition, reflect and probe the organs of interest. Animals were then tilted to right lateral and left lateral positions for better visualisation. Trendelenburg and reverse Trendelenburg positions were employed in selected cases. Biopsy cup forceps were introduced in cases where a biopsy sample was required for histopathological examination.

The instruments were removed and the abdomen was deflated through the ports after thorough inspection of biopsy sites. The ports were then removed and the muscles were apposed by a simple interrupted suture with Chromic Catgut No-0. The skin incision was apposed by simple interrupted nylon sutures.

3.9.3 Laparoscopy Unit

3.9.3.1 Laparoscopic Instruments

Following laparoscopic instruments (Plate. 2b) were used in the present study.

1. Hopkins[®] II straight forward zero degree telescope- 5 mm x 29 cm, Karl Storz GmbH & Co. KG, Germany
2. Trocars and canula with automatic valve for 5mm instruments, Avalon Instrument Corporation, Coimbatore
3. Trocar and canula with automatic valve for 10mm instruments, Karl Storz GmbH & Co. KG, Germany
4. Canula reducer - 11 to 5.5 mm, Karl Storz GmbH & Co. KG, Germany
5. Endoscopic instruments, Karl Storz GmbH & Co. KG, Germany
 - i) Biopsy forceps
 - ii) Curved Kelly forceps
 - iii) Babcock grasping forceps
 - iv) Grasping forceps

3.9.3.2 Laparoscopic Equipments and Image Capture Device

Following equipments (Plate. 2a) were used in the present study.

1. Electrosurgical generator (Spark 400B Deluxe surgical diathermy) and monopolar electrocautery cable
2. Electronic carbon dioxide endoflator and silicone tubing, Karl Storz GmbH & Co. KG, Germany.
3. Xenon cold light source with fiber optic light cable with straight connector, Karl Storz GmbH & Co. KG, Germany

4. Camera control unit (CCU) telecam DX II, with camera head and adapter integrated cable, Karl Storz GmbH & Co. KG, Germany
5. 18.5” Wide TFT LCD Wipro Monitor
6. Capture IT Pro Version - 1.0 (Ambalsoft 2010) Medical image capturing and reporting software

3.10 STATISTICAL ANALYSIS

3.10.1 Diagnostic efficiency

Diagnostic efficiency of the three selected diagnostic techniques for each of the 13 cases studied was assessed by independent observers. The observers were the teaching faculty and research scholars of Department of Veterinary Surgery and Radiology, who were not involved in the study. The scoring was made on a scale of zero to three, based on a score card made separate for each of the condition encountered in the study. The per cent of observers giving a particular score for each test in each condition were then tabulated. Scores given by atleast 75 per cent or more observers for each case was then analysed. The score card is given as annexure I.

3.10.2 Perception about different diagnostic tests

The same observers were then asked to evaluate the three diagnostic techniques based on thirteen parameters. The scores given to individual technique was then statistically analysed using Friedman’s test and Wilcoxon Signed Rank to test the significance of perception scores. The score card is given as annexure II.

Plate 1
Instrumentation : Radiography and
Ultrasonography



Plate 1 a



Plate 1 b



Plate 1 d



- Plate 1 a – Seimens 500 mA X-ray unit
- Plate 1 b – Care stream digital processing unit
- Plate 1 c – Prosound α-6, Aloka
- Plate 1 d – Close up view of monitor and control panel

Plate 2
Instrumentation : Laparoscopy



Plate 2 a

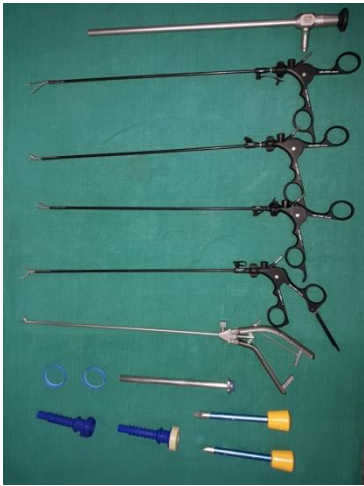


Plate 2 b

Plate 2 a – Laparoscopic tower with accessories
Plate 2 b – Laparoscopic equipments

Results

4. RESULTS

The study was conducted at the department of Veterinary Surgery and Radiology, College of Veterinary and Animal Sciences, Pookode, Wayanad, during the period from August 2016 to July 2017.

4.1. SELECTION OF CASES

Thirteen dogs with clinical manifestations of abdominal disorders presented to outpatient unit of Teaching Veterinary Clinical Complex, irrespective of age, sex or breed were selected for the study. The cases were coded for the ease of study from A1 to A13.

4.2. SIGNALMENT

Out of the thirteen animals selected for study, six were non-descript dogs, three were Rottweilers, one each were Labrador Retriever, Spitz, Pug and Labrador-Rottweiler cross. Amongst the selected dogs, five were females and eight were males. Average bodyweight of the animals under study was 19.45 Kg (Range 6.9 to 34 Kg). Animals belonged to an age group ranging from six months to ten years (Table 1).

4.3. ANAMNESIS

The details of anamnesis are given in Table 2. All the cases were presented with various complaints associated with an abdominal discomfort. All the animals, other than case A4, had undergone symptomatic treatment prior to presentation. Most common signs are briefed here.

4.3.1. Vomiting

All the cases had a history of vomiting, though in varying degrees and duration, ranging from four days to one month. In one animal (A2) blood tinged vomitus was occasionally observed. None of the animals reported any correlation between vomiting and feeding or watering at the time of history taking, except for

case A1, where vomiting was reported between four to seven hours after feeding and the contents were mainly partially digested food.

4.3.2. Anorexia

All animals showed anorexia or inappetence of varying duration (four days to one month). Five cases showed partial anorexia, five cases showed partial anorexia progressing to complete anorexia and the remaining three cases showed complete anorexia without any prior reduction in food intake.

4.3.3. Weight loss

Weight loss was noticed by the owners in nine cases.

4.3.4. Abnormal water intake and urination

Reduced water intake was reported in two cases (A6 and A9) and increased in four cases (A3, A4, A7 and A8). In rest of the animals water consumption was not found affected. Oligurea was reported in four cases (A2, A6, A10 and A11), polyurea in two cases (A7 and A8) and in the remaining cases urination was normal.

4.3.5. Abnormal defaecation

Reduced defecation was reported in six cases, out of which one case (A3) previously had diarrhoea. Two animals (A3 and A5) were showing severe tenesmus. Melena was noticed in one case (A2). All other cases were having normal defecation.

4.3.6. Dehydration

Mild to moderate dehydration was observed in five cases (A2, A3, A6, A9 and A13).

Table 1- Signalment

Case ID	Breed	Age	Sex	Body weight (kg)
A1	Rottweiler	2yr 6m	M	29
A2	Spitz	6m	M	8
A3	Non Descript	7m	M	15
A4	Non Descript	7m	M	10
A5	Rottweiler	3yr	F	34
A6	Non Descript	1yr	F	10
A7	Labrador retriever	5yr	F	31
A8	Non Descript	7yr	F	6.9
A9	Non Descript	6yr	M	16.5
A10	Non Descript	4yr	M	23
A11	Pug	4yr 6m	F	8.5
A12	Labrador-Rottweiler Cross	1yr	M	30
A13	Rottweiler	10yr	M	31

4.4. FINDINGS OF CLINICAL EVALUATION

4.4.1. Clinical Examination

Ten animals were dull and lethargic at the time of presentation; however none of the animals were recumbent at the time of presentation.

Table 2- Anamnesis

Case ID	Vomiting	Anorexia	Inappetence	Weight loss	Lethargy	Defaecation	Urination	Recumbency	Dehydration	Water intake
A1	1m	X	1m	Y	1m	Reduced with tenesmus	N	X	X	N
A2	1w	3d	1w	X	X	Melena	Reduced	X	Mild	N
A3	1w	X	2w	Y	3d	Diarrhoea for 10-15d	N	X	Mild	Increased
A4	4d	4d	X	X	X	Reduced to nil	N	X	X	Increased
A5	1w	X	1w	X	X	Reduced to nil with tenesmus	N	X	X	N
A6	1w	1w	X	Y	5d	Reduced	Reduced	X	Moderate	Reduced
A7	4d	1w	X	X	3d	Normal	Increased	X	X	Increased
A8	1w	4d	1w	Y	3d	Normal	Increased	X	X	Increased
A9	2w	1w	2w	Y	2w	Diarrhoea for 10 days. Since last week no defaecation	N	X	Mild	Reduced
A10	5d	2d	2w	Y	2w	Normal	Reduced	X	X	N
A11	2w	X	2w	Y	1w	Reduced	Reduced	X	X	N
A12	1m	X	2w	Y	1w	Normal	N	X	X	N
A13	1w	1w	2w	Y	1w	Diarrhoea for 1w	N	X	Mild	N

d- days

w- weeks

Y- present

X – absent

N – normal

4.4.2. Physiological Parameters

On clinical examination, respiratory rate of all the animals under the study were found to be within normal range, with four animals towards the lower value and one towards the higher value. Heart rates of three animals were just below the normal range with pulse rates within the lower limit of normal range. In one animal it was just above the normal range. Elevated (≥ 3 sec) capillary refill time (CRT) was reported in six animals. Visible mucous membrane was found to be congested in five animals, pale in six dogs and pale-roseate in rest of the animals. Temperature of all the cases were within normal range and only in one case (A7), it was towards the higher end of the range (Table 3).

Table 3 – Physiological Parameters on the day of presentation (Mean \pm SE)

Case ID	HR (/min)	PR (/min)	RR (/min)	Temperature ($^{\circ}$ F)	CRT (s)	VMM
A1	75	88	21	102.2	3	Congested
A2	101	110	28	101.9	2	Pale
A3	84	90	20	101.8	2	Pale
A4	104	98	32	101.6	3	Pale roseate
A5	104	100	21	102.3	3.5	Pale
A6	70	75	19	102	3	Congested
A7	68	73	22	103.2	2	Congested
A8	72	78	23	102.3	3.5	Pale
A9	120	130	23	102.2	2	Congested
A10	67	73	24	100.8	3	Pale roseate
A11	81	79	20	100.3	2	Congested
A12	78	70	26	101	2	Pale
A13	72	73	20	102	2	Pale
Mean \pm SE	84.31 \pm 4.76	87.46 \pm 4.96	23 \pm 1.04	101.82 \pm 0.21	2.54 \pm 0.17	

4.4.3. Abdominal Examination

Obvious distension of abdomen was observed in four cases and localised visible swelling in two cases (A12 and A13). On palpation, observations ranging from normal to a firm and hard mass could be detected as per Table 4.

Auscultation revealed reduced gastro-intestinal motility in five cases, and in one case (A6) a gas and fluid mixed sound was heard throughout the abdomen. In other cases, no abnormal sound could be heard on auscultation. Dull or dull and flat sounds were heard on percussion in three cases. A fluid wave with a thrill was observed in the case with ascites (A9) and a fluid wave with resonance was noted in another case (A6). Pain on palpation was evident in seven cases (A2, A3, A5, A6, A7, A8 and A11). Details of abdominal examination are given in Table 4.

Table 4 – Abdominal examination findings

Case ID	Visual	Palpation	Auscultation	Percussion
A1	NAD	NAD	Reduced motility	Dull
A2	NAD	Localised hard mass in mid abdomen, pain on palpation	Reduced motility	NAD
A3	NAD	Hard mass towards caudal abdomen, pain on palpation	Reduced motility	Dull and flat
A4	NAD	NAD	Reduced motility	NAD
A5	NAD	Pain on palpation	Reduced motility	NAD
A6	Distended	Fluctuating, Fluid and gas filled abdomen, pain on palpation	Gas and fluid mixed sound	Fluid wave with resonance
A7	NAD	Normal, but evincing pain on deep palpation.	NAD	NAD
A8	Distended	Pain on palpation	NAD	NAD
A9	Distended	Fluctuating (with fluid)	NAD	Fluid wave with thrill
A10	NAD	NAD	NAD	NAD
A11	Distended	Firm, pain on palpation	NAD	Dull and flat
A12	Swelling left abdominal wall	Hard mass along left abdominal wall	NAD	NAD
A13	Swelling-left costal region	Hard mass along left thoraco-abdominal region, no pedicle	NAD	NAD

NAD – No abnormality detected.

4.4.4. Haematological Evaluation

Detailed haematology on the day of presentation is given as per Table 5.

4.4.4.1. Total Erythrocyte Count (TEC)

On day one, erythrocyte count of case A7, A12 and A13 were found to be lower than normal range. Mean value on the day of presentation was $5.78 \pm 0.26 \times 10^6 / \mu\text{L}$.

4.4.4.2. Total Leukocyte Count (TLC)

Leukocytosis was detected in ten animals on the day of presentation with the mean of $19.09 \pm 1.37 \times 10^3 / \mu\text{L}$. Only cases A5, A12 and A13 were having normal TLC values

4.4.4.3. Differential Leukocyte Count (DLC)

The relative percentage of lymphocytes and neutrophils were within the normal range in all the cases, except case with neutrophilia (A13). In two cases, A1 and A11, there was an increase in percentage of monocytes above the normal range. The mean was 77.15 ± 2.17 for neutrophils, 13.99 ± 1.31 for lymphocytes, 2.59 ± 0.58 for eosinophils and 6.28 ± 1.02 for monocytes.

4.4.4.4. Volume of Packed Red Cells (VPRC)

Volume of packed red cells was found to be less than the normal range in four animals, A3, A4, A12 and A13. In all other cases it was within normal range. The mean value was 35.72 ± 2.12 per cent.

4.4.4.5. Haemoglobin Concentration(Hb)

Initial haemoglobin concentration was within normal range for all the animals, except A12 and A13, where it was below the normal range. The mean was estimated as 12.34 ± 0.67 g/dL.

4.4.4.6. Platelet Count

The platelet count on the day of presentation was elevated in four cases (A3, A7, A8 and A9) and was reduced in five cases (A1, A6, A11, A12 and A13). The mean value on the day of presentation was $4.48 \pm 0.79 \times 10^5 / \mu\text{L}$.

Table 5 – Haematology on the day of presentation (Mean \pm SE)

Case ID	VPRC	TEC	Platelet	Hb	TLC	N	L	E	M	B
Unit	%	10 ⁶ / μ L	10 ⁵ / μ L	g/dL	10 ³ / μ L	%	%	%	%	%
A1	36.2	6.33	2.06	13	22.2	76.2	11.2	2.3	10.3	0
A2	44.7	7.05	6.19	16.3	22.7	84.3	8	3	4.7	0
A3	32.4	4.99	8.85	11	23.4	72.6	14.8	7.4	5.2	0
A4	34.7	5.96	5.34	12.9	19.1	66.4	21.9	2.2	9.5	0
A5	39	6.65	4.08	14.6	10.7	64.1	20.9	6.2	8.8	0
A6	40.2	6.45	1.38	12.4	27.1	78.7	17.3	2	2	0
A7	35.2	4.91	6.65	11.4	21.4	81.6	11.3	3.2	3.9	0
A8	39	5.65	7.11	12.6	20.5	80.3	12.6	1.6	5.5	0
A9	42.1	6.52	8.09	13.5	19.4	82.1	10.1	1.8	6	0
A10	38.3	6.37	4.97	13.6	19.6	83.6	9.5	0.7	6.2	0
A11	42.1	5.66	0.32	13.5	18.4	65.8	20.2	0	14	0
A12	20.1	4.65	1.65	7.8	10.3	77.9	14.3	2.3	5.5	0
A13	20.4	3.9	1.5	7.8	13.3	89.3	9.7	1	0	0
Mean \pm SE	35.72 \pm 2.12	5.78 \pm 0.26	4.48 \pm 0.79	12.34 \pm 0.67	19.09 \pm 1.37	77.15 \pm 2.17	13.99 \pm 1.31	2.59 \pm 0.58	6.28 \pm 1.02	

4.4.5. Serum Biochemistry

Detailed serum biochemistry profile of all the cases on the day of presentation is given as per Table 6.

4.4.5.1. Serum Alkaline Phosphatase (ALP)

Serum alkaline phosphatase was found to be within normal range in all the cases, except in two animals (A2 and A3), where it was towards the higher limit. The mean value on the day of presentation was 83.86 \pm 4.07 IU/L.

4.4.5.2. Serum Total Protein

Day one serum total protein was found increased in six cases (A1, A2, A6, A9, A12 and A13) and reduced in three cases (A4, A7 and A10) under study. Others had a value within normal range. Mean value was 7.33 \pm 0.55 mg/dL.

4.4.5.3. *Serum Albumin*

Serum albumin was found to be increased in five (A1, A6, A9, A12 and A13) and decreased in three animals (A4, A7 and A10). The mean value on the day of presentation was 3.25 ± 0.31 mg/dL.

4.4.5.4. *Serum Alanine Amino Transaminase (ALT)*

Serum alanine amino transaminase was found to be in normal range on the day of presentation in all the animals except animals A9 and A13, where the level was less. The mean value was found to be 17.43 ± 2.26 IU/L.

Table 6 – Serum biochemistry on the day of presentation (Mean \pm SE)

Case ID	Total protein (g/dL)	Albumin (g/dL)	ALT(IU/L)	ALP(IU/L)	Creatinine (mg/dL)
A1	10.54	4.91	27.35	89.5	0.58
A2	7.71	2.82	15.7	108.3	0.84
A3	6.43	2.88	21.4	100.6	0.97
A4	5.34	2.13	17.8	98.97	1.1
A5	5.98	2.88	22.71	78.23	0.75
A6	9.3	5.2	32.3	94.4	0.86
A7	4.3	1.72	15.72	65.83	1.50
A8	7.3	3.1	20.1	71.4	0.85
A9	8.24	3.50	2.48	62.34	0.78
A10	4.66	2.01	12.4	66.8	1.01
A11	6.95	2.63	15.2	79.97	0.94
A12	8.3	4.19	18.89	91.4	1.2
A13	10.26	4.32	4.51	82.5	1.6
Mean \pm SE	7.33 ± 0.55	3.25 ± 0.31	17.43 ± 2.26	83.86 ± 4.07	1.0 ± 0.08

4.4.5.5. *Serum Creatinine*

Serum creatinine level in all the cases was within the normal range. The mean on the day of presentation was 1.0 ± 0.08 mg/dL.

4.5. RADIOGRAPHIC FINDINGS

Overall abdominal detail was studied and each abdominal organ was evaluated based on Rontgen signs as per details given below.

Case No. A1: In the lateral survey radiograph, the stomach was found distended, with a thickened gastric wall. A barium series contrast radiography was performed and delayed gastric emptying was observed. The contrast material was retained in the stomach even after 20 hours post barium meal. The condition was tentatively diagnosed as delayed gastric emptying of unknown origin (Plate 3a, 3b).

Case No. A2: In the lateral survey radiograph, intestinal segment along the ventral aspect of abdomen was distended with contents granular in appearance. Diffuse lining of contrast material in intestinal segments were seen in a 24 hours post barium contrast radiograph (Plate 4a).

Case No. A3: Initial survey radiography revealed fluid or ingesta filled gastro-intestinal segments without any gas accumulation. There was a soft tissue consistency along the mid intestinal segments. No apparent diagnosis was possible. The animal was lethargic and was not taking anything orally, denying the possibility of contrast study (Plate 5a).

Case No. A4: Survey radiography revealed distended intestinal segments. Barium contrast radiography revealed highly distended small intestinal loops. Ratio of width of small intestinal segment with maximum distension (SI_{max}) and height of body of fifth lumbar (L5) vertebrae ($SI_{max} / L5$) was 3.02, which was highly suggestive of an obstruction. However, no foreign body was detected. The condition was tentatively diagnosed as foreign body obstruction (Plate 6a)

Case No. A5: Survey radiograph showed empty intestinal loops, slightly distended with gas. Barium contrast study was performed and the 48 hour post barium radiograph showed barium retention in the descending colon. Small intestines were normal without any prominent distension. Dried faecal obstruction or foreign body obstruction were suspected (Plate 7a).

Case No. A6: Lateral survey radiograph suggested a distended stomach. An abnormal gas filled circular cavity lined by opaque borders was observed just

caudal to gastric silhouette. An overall loss of organ detail was noticed in the abdominal radiography, giving a suspicion of fluid in the abdomen. Diffuse black shadows throughout the abdomen were also noticed (Plate 8a).

Case No. A7: After an inconclusive survey radiography, negative contrast study using air in the colon (pneumocolon) was carried out, which reflected an abnormal tissue density between urinary bladder and colon. The increase in density in that area was giving a suspicion of pyometra (Plate 9a).

Case No. A8: In survey radiography, a radiodense 'Y' shaped segment with a soft tissue density was observed between the colon and urinary bladder, suggestive of pyometra (Plate 10a).

Case No. A9: The survey radiograph revealed a granular, ground glass appearance of abdomen, without any organ details. Margins of the various abdominal organs were diffuse. Only a few gas filled intestinal loops were seen in between. The appearance was suggestive of severe fluid accumulation in the abdominal cavity (ascites) (Plate 11a).

Case No. A10: The lateral survey radiography revealed caudally displaced intestinal loops and a diffuse increase in overall density in the mid abdominal segment with lack of detail in that area. Stomach was distended and dorsally displaced. Hepatic and splenic contours could not be differentiated. The picture was giving a suspicion of hepatomegaly (Plate 12a).

Case No. A11: The lateral survey radiograph was showing an elongated splenic silhouette with an uneven contour, especially towards the dorsal borders. The intestinal loops were filled with ingesta and were dorsally displaced. There was an overall loss of organ detail in the radiograph (Plate 13a).

Case No. A12: A diffuse mass like density was observed near the hepatic area in lateral survey radiograph. The stomach was dorsally displaced and spleen and bowel were displaced caudally and medially. Overall area of hepatic silhouette was enlarged. It was not possible to accurately demarcate the origin of the mass, however, an abnormal mass in the anterior third of the abdominal cavity was diagnosed radiographically (Plate 14a).

Case No. A13: Lateral survey radiograph showed an increase in the radiodensity along ventro-lateral aspect of thoraco-abdominal junction. The ventro-dorsal projection suggested that the particular tissue density was continuous with hepatic silhouette, suggestive of a hepatic mass (Plate 15a).

4.6. SONOGRAPHIC FINDINGS

Overall abdominal echogenesity, difference in echotexture of individual abdominal organs and any abnormal echodensity in the abdomen were studied in detail and the findings are given below.

Case No. A1: Abdominal ultrasonography did not reveal any abnormality other than gastric distention with mixed echogenicity, suggestive of stomach filled with fluid, contents and gas (Plate 3c).

Case No. A2: Intestinal segments were showing hyperechoic patches suggestive of gas distension. There was no peristalsis or progressive motion, in the mid abdomen. A curvilinear hyperechoic line was seen in the mid abdomen with an acoustic shadow beyond it (Plate 4b).

Case No. A3: In transverse view, concentric ringed target sign was observed in the caudal abdominal region, with a “reverse G” shaped interior, suggestive of intussusception. The reverse G was hyperechoic with two anechoic patches in the centre. In longitudinal scan a layered appearance of alternating parallel hyperechoic and hypoechoic lines were demonstrated (Plate 5b, 5c)

Case No. A4: Non uniform intestinal peristalsis was observed, wherein some segments were showing hypermotility and some were having hypomotility. A hypoechoic round mass was found in the lumen of intestinal segment with attenuation of beam beyond it (Plate 6b).

Case No. A5: Segmental intestinal hypermotility was noticed, without much progressive motion of contents. No other abnormality was detected.

Case No. A6: Hyperechoic streaks were noticed throughout the abdomen with reverberation artifacts. Anechoic area was noticed caudal to the stomach, without any clear cut boundary. Anechoic fluid echogenecity was seen around spleen (Plate 8b, 8c).

Case No. A7: Anechoic and hypoechoic tubular pouch was observed near the bladder, probably at the area of uterus. No other abnormality could be detected (Plate 9b).

Case No. A8: Normal echotexture of various abdominal organs were observed.

Case No. A9: Uneven and irregular hepatic margins with rounded tips were observed. Liver lobes were having a moth-eaten appearance with hypoechoic and anechoic focal lesions in the hepatic parenchyma. Gall bladder was not distinguishable. Anechoic areas were detected in the abdomen surrounding almost all the abdominal organs (Plate 11b).

Case No. A10: Diffused reduction in echogenicity of liver was observed. Echogenicity of liver parenchyma seemed to be similar or slightly lesser than that of right renal cortex. Hyperechoic areas were observed around portal vessels (Plate 12b).

Case No. A11: Sonographic evaluation revealed an enlarged spleen with the head of spleen measuring 8.5cm (width) and body 2.1 cm. The spleen was homogeneously hypoechoic with a hyperechoic capsule (Plate 13b).

Case No. A12: A mass like lesion was seen along the abdominal wall and closer to the liver with a mixed echogenicity of parenchyma and a hyperechoic capsule. A smaller anechoic mass with a hyperechoic cortex was seen attached to the larger mass. Both the masses were distinct and not attached to the liver as evident by a continuous demarcation between the two (Plate 14b).

Case No. A13: A clear ovoid mass was seen attached to the abdominal wall with mixed echogenicity and non homogenous echotexture. It was having a hyperechoic centre and a hypoechoic cortical area. Doppler view revealed a hypervascular nature at the periphery of the lesion. The lesion was extending up to the liver and was having a clear demarcated margin. No abnormal sonographic changes were seen in the liver (Plate 15b,c).

4.7. DIAGNOSTIC LAPAROSCOPY

4.7.1. Port Placement

In all the cases, the primary port was placed about 1.5 cm caudal to umbilicus in the ventral midline and was used as the camera or telescope port. In three cases (A1, A8 and A9) three ports (one camera port and two instrument ports), were placed. Only two ports (one camera port and one instrument port) were placed in eight cases, out of which in four cases (A3, A4, A10 and A13) the additional port was towards left side of animal and in other four (A2, A5, A6 and A7) it was towards right side. All additional ports were either cranial to or in line with the camera port, except in case A5, in which it was caudo-lateral to the camera port. In two cases only camera port was placed for exploration (Table 7).

4.7.2. Laparoscopic Findings

Entire abdomen was explored for any gross abnormality of abdominal organs and peritoneal cavity. The observations were as per details given below.

Case No. A1: Gall bladder was found distended. Stomach was also distended with engorged gastric vessels. Thickening of gastric wall could be appreciated on probing the stomach. No foreign body or hard structure was felt inside or along the gastric wall. The duodenum was flaccid. Pyloric region was identified and a band like thickening was noticed along the pyloric sphincter. It was difficult to squeeze out the contents from the stomach through the pylorus using atraumatic graspers (Plate 3d).

Case No. A2: After initial exploration, the animal was tilted towards its right side. On further exploration using an atraumatic grasper, a thickened loop of jejunum was noticed amongst other flaccid or fluid filled intestinal segments. Probing with atraumatic grasper gave a feel of an intra-luminal mass suggestive of a linear foreign body. The segment was isolated and was found to be plicated (Plate 4c).

Case No. A3: Initial exploration revealed flaccid intestinal loops in the mid abdominal region. Animal was then tilted to its right side and kept in a Trendelenberg position. A distended segment of colon was observed towards the

left caudal aspect of abdomen. The wall of the affected area was thickened. Serosa of the segment was oedematous, congested and fragile. The caudal end of the distended segment could be identified as an abrupt flaccid ending. The cranial end could not be isolated. Probing and palpation of the affected distended segment with a grasping forceps gave a feeling of an intussusciens with an intussusceptum inside. An attempt was made to pull out the telescoped loops with graspers, but it was too tight to be extracted. An intussusception of distal intestinal segments involving ileo-colic segment or a linear foreign body was suspected (Plate 5d).

Table 7: Port placement for diagnostic laparoscopy

Case No	Primary (Camera) port	Secondary port	Tertiary port
A1	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	Left cranio lateral to first port
A2	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	-
A3	Midventral. 1-1.5cm caudal to umbilicus	Left cranio lateral to first port	-
A4	Midventral. 1.5cm caudal to umbilicus	Left cranio lateral to first port	-
A5	Midventral. 1.5cm caudal to umbilicus	Right caudo lateral to first port	-
A6	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	-
A7	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	Left cranio lateral to first port
A8	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	Left cranio lateral to first port
A9	Midventral. 1.5cm caudal to umbilicus	Right cranio lateral to first port	-
A10	Midventral. 1.5cm caudal to umbilicus	Left cranio lateral to first port	-
A11	Midventral. 1.5cm caudal to umbilicus	-	-
A12	Midventral. 1.5cm caudal to umbilicus	-	-
A13	Midventral. 1.5cm caudal to umbilicus	Left cranio lateral to first port	-

Case No. A4: Severe distension of small bowel was observed along with congested walls. Distended loops prevented further manipulation and visualisation of the entire abdomen. The walls of intestinal loops were stretched and thinned due to gas accumulation. No foreign body could be located (Plate 6c).

Case No. A5: Stomach was found distended and spleen was slightly enlarged. Some segments of ileum and colon were distended. Animal was then tilted to a Trendelenberg position to visualise the caudal abdomen. A hard and thick segment of descending colon was identified. There was gas accumulation towards the proximal aspect of this segment. The wall of affected segment of colon was congested. The segment was hard on probing. The segment was hard and tight making the movement of it difficult using an atraumatic grasper, for better visualisation (Plate 7b).

Case No. A6: Serosanguineous fluid mixed with gastro-intestinal contents was noticed in the abdomen. Serosa and capsule of all abdominal organs were coated with food particles and severe visible inflammatory changes were noted. Mesentery ballooned with fluid and contents were observed. There was severe peritonitis (Plate 8d, 8e).

Case No. A7: The animal was tilted towards its right side to identify the left uterine horn and identified the other horn using graspers. Uterine wall was bluish tinged. The uterine horns were thickened, cord like and enlarged. It was hard and tough on probing with graspers. Thick contents could be appreciated while lifting with graspers (Plate 9c).

Case No. A8: Uterine horns were moderately enlarged with pale walls. Probing revealed thick walled uterus with semisolid content inside (Plate 10b).

Case No. A9: Abdominal cavity was filled with massive amount of sero sanguineous fluid, which was removed using suction pump prior to further examination. Massive multinodular and multilobulated mass was found spread throughout the liver lobes, mainly affecting the entire right and left lateral lobes. The affected hepatic surface was uneven with the tumor growing beyond the hepatic surface and irregular borders. While taking biopsy the mass was found firm. Splenic capsule was found to be dry and shrunken, with uneven surface and

a firm mass in the parenchyma. Multiple metastatic nodules were seen on pancreas, spleen and on the serosal surface of intestine (Plate 11c,d,e,f).

Case No. A10: There was moderate amount of serosanguineous fluid in the abdominal cavity and signs of perihepatitis. There were patches of adhesions between liver and abdominal wall. Thickened liver parenchyma was noted on probing and while taking biopsy. Mild splenomegaly and splenic congestion were noticed (Plate 12c,d).

Case No. A11: Diffuse enlargement of spleen, with rounded borders was observed. The colour of spleen was bluish and there was sub capsular splenic oedema. There was mild oozing of dark coloured blood due to a small trochar injury. Spleen was pushing all the organs and was filling almost one third of the abdominal cavity (Plate 13c).

Case No. A12: A hard mass was seen along the left lateral abdominal wall, involving muscular tissue and subcutaneous tissue. Another round tumor like growth was noticed attached to the mass. They were pushing on to the liver, but not attached to it. Gross appearance and consistency of liver were found to be normal. Spleen was congested with sub capsular oedema (Plate 14c).

Case No. A13: A mass could be located on the left abdominal wall which was round and about 10-15 cm in diameter. It was firm and rubbery on palpation with a probe. The mass was not continuous with any abdominal organ. However, it was compressing the left lateral liver lobe, pushing it medially and was putting pressure on stomach and spleen. Splenic capsule was oedematous with engorged splenic vessels. There was subcapsular and interlobular lymph oedema on the liver surface with overall congestion (Plate 15d).

4.8. LINE OF TREATMENT FOLLOWED AND RESULT OF TREATMENT

Different lines of treatment were selected for each case based on individual merit following a critical assessment of the findings. Out of the thirteen animals selected, two were euthanized (A6 and A13), one died after two days (A12), one died after one week (A11) and one died after two weeks (A9). Eight animals had

an uneventful recovery. The treatments adopted and results obtained are described below.

Case No. A1: Laparotomy was performed and identified the stenotic pyloric region. A Y-U pyloroplasty was done to relieve the stenosis. The animal had an uneventful recovery and recurrence was not reported over a follow up period of one year.

Case No. A2: After laparotomy and exploration, the foreign body was located, exteriorised the affected segment and performed an enterotomy for removing the linear foreign body. The foreign body removed was a tuft of hairs, bristles and plastic threads collected to form a 34 cm long single piece. Routine closure of surgical incision was carried out. The animal recovered without any complications.

Case No. A3: Laparotomy and further exploration revealed the condition to be a double intussusception, involving an ileo-ileal segment which further telescoped into the colon, forming an ileo-ileo-caeco-colic intussusception. The ileo-ileal segment telescoped into the colon was manually relieved by milching the segment out. However, serosal adhesions prevented the intussusception of ileo-ileal segment to be relieved. Furthermore, the segments were oedematous, fragile and non viable, necessitating enterectomy and entero anastomosis. Animal had an uneventful recovery and showed no recurrence over a period of one year.

Case No. A4: After exploration, the foreign body was identified and enterotomy revealed a nutmeg seed inside the jejunum. Foreign body was removed after enterotomy and routine closure of surgical site and post operative care followed. The animal recovered without any complications.

Case No. A5: Exploratory laparotomy revealed a foreign body inside the colon, which was not moving inside. Enterotomy showed dried colonic faecoliths, which were removed, followed by routine closure of surgical sites. A follow up with laxative diets led to an uneventful recovery.

Case No. A6: Exploratory laparotomy revealed entire abdomen filled with serosanguineous fluid mixed with gastro-intestinal contents. There was severe peritonitis and the parietal and visceral peritoneum was completely coated with

gastro-intestinal contents. Serosal surface of all the organs were coated with gastro-intestinal contents and was highly inflamed. The prognosis was not favourable and considering the welfare of the animal, it was euthanized. Postmortem findings revealed a gastric perforation in the pyloric region along the greater curvature.

Case No. A7: A laparotomy was performed and the uterine horn was identified. The entire uterus along with the ovaries was removed surgically and the animal had an uneventful recovery.

Case No. A8: Explored the abdomen after performing a laparotomy. The uterus and ovaries were removed by ovariectomy. There were no post operative complications and the animal had never shown any clinical signs later.

Case No. A9: After diagnostic laparoscopy, with the consent of the owner, palliative care was given along with a course of antineoplastic chemotherapy. However the animal died after two weeks.

Case No. A10: Medical management was given with the administration of liver protectants and supplements. Animal showed improvement and became asymptomatic within one week. All clinical and physical parameters post therapy were normal after 10 days of treatment.

Case No. A11: Despite the symptomatic treatment provided, the condition of the animal worsened and it died after one week.

Case No. A12: Surgery was planned to remove the mass seen during diagnostic laparoscopy. The mass was large involving muscle and subcutaneous tissue with a smaller mass attached to the first mass towards its cranio-medial aspect, and together they weighed 2.3 Kg. In spite of supportive and palliative post operative care, the animal died after two days.

Case No. A13: After the laparoscopic examination, decision was made to proceed with a palliative care. However, the condition of the animal worsened and was euthanized after one week.

4.9. HISTOPATHOLOGICAL FINDINGS

Biopsy specimen was taken in two cases during laparotomy and three cases during diagnostic laparoscopy. The results of histopathology are given in Table 8.

4.10. FINAL DIAGNOSIS

The final diagnosis, after analysing the results from all the diagnostic techniques, are compiled as per Table 9

Table 9 –Final diagnosis

Case ID	Condition
A1	Hypertrophic Pyloric stenosis
A2	Linear foreign body obstruction of jejunum
A3	Double intussusception(ileo-ileo-caeco-colic)
A4	Foreign body in jejunum (Nutmeg seed)
A5	Colonic impaction
A6	Gastric perforation and peritonitis
A7	Pyometra
A8	Pyometra
A9	Cholangiocellular carcinoma
A10	Chronic hepatic injury
A11	Splenomegaly
A12	Haemangiosarcoma
A13	Fibroma

4.11. RESPONSE TO TREATMENT

Out of thirteen animals selected, eight animals had an uneventful recovery (A1, A2, A3, A4, A5, A7, A8, A10). All these eight animals were evaluated on 10th, 30th and 60th day after treatment. The response to treatments adopted is described below.

4.11.1. Clinical Examination

All the eight surviving animals were evaluated after 10 days of treatment and found to be showing no clinical signs of any abdominal discomfort. Sutures were removed in those underwent surgery. Evaluations on day 30 and 60 also showed no clinical or physical signs of illness.

4.11.2. Physiological Parameters

All the physiological parameters like respiratory rate, temperature, colour of mucous membranes, pulse rate, heart rate and capillary refill time were found to be in normal range, with slight variations in value between observations for individual animals on day 10, 30 and 60.

4.11.3. Abdominal Examination

Physical examination of the abdomen on 10th, 30th and 60th day did not reveal any abnormal findings

4.11.4. Haematological Evaluation

4.11.4.1. *Total Erythrocyte Count (TEC)*

Total erythrocyte counts of all the animals except animals A3 and A7 was found to be normal on day 10, 30 and day 60. For A3 and A7 the count was reduced on day 10, but came to normal by day 30.

4.11.4.2. *Total Leukocyte Count (TLC)*

Total leukocyte counts of all the seven animals with an initial higher leukocyte count on the day of presentation had a higher value on day 10 also. The day 30 values of leukocytes were normal for all the animals.

4.11.4.3. *Differential Leukocyte Count (DLC)*

DLC came back to normal values within one month in the two animals with abnormal initial values.

4.11.4.4. *Volume of Packed Red Cells (VPRC)*

Of the total four animals with subnormal values of VPRC on the day of presentation, two returned to normal on day 10. The remaining two animals had a normal VPRC value on day 30.

4.11.4.5. *Haemoglobin concentration*

Two animals had a haemoglobin level less than the normal range on the day of presentation. All the animals had normal value on subsequent observations.

4.11.4.6. Platelet count

Out of five surviving animals with an elevated platelet count initially, two returned to normal values on day 30 and all had a normal value on day 60.

4.11.5. Serum Biochemistry

4.11.5.1. Serum Alkaline Phosphatase

The values continued to be in normal range throughout the period of observation.

4.11.5.2. Serum Total Protein

Of the total eight surviving animals, four (A1, A2, A4 and A7) animals had an abnormal level of serum total protein on the day of presentation. Values of all the animals except in Case A1, reached normal by day 10. Serum protein in Case A1 became normal by day 30.

4.11.5.3. Serum Albumin

Three surviving animals had abnormal serum albumin levels initially and values were normal on day 10.

4.11.5.4. Serum Alanine Amino Transaminase (ALT)

All the animals were having normal ALT level throughout the period of observation.

4.11.5.5. Serum Creatinine

All the animals were having normal serum creatinine concentration throughout the period of observation.

4.12. DIAGNOSTIC EFFICIENCY

Diagnostic efficiency of radiography, ultrasonography and laparoscopy in diagnosing the conditions encountered in the present study was subjectively assessed by allowing twelve independent observers (Teaching faculty and

research scholars of Department of Veterinary Surgery and Radiology, CV&AS Pookode) to analyse the results of each diagnostic test for a particular condition. They were asked to arrive at a diagnosis for each test for individual cases. The scoring for each condition was based on subjective evaluation which was converted into a numerical score by using the conversion chart prepared (Annexure I). The results are tabulated as per Table 10, based on percentage of respondents giving a particular score for each case.

These diagnostic tools were also compared based on response of twelve independent observers on thirteen parameters (Annexure II) for each test, to evaluate the perception of individual observer towards each test. The results were statistically analysed using Friedmans's test followed by Wilcoxon Signed Rank Test. The results of the test are tabulated as per Table 11.

Table 11. Comparison of perception about different diagnostic methods

Diagnostic Test	Perception score (Mean \pm SE)
Radiography	32.08 \pm 0.398 ^a
Ultrasonography	31.25 \pm 0.392 ^a
Laparoscopy	14.67 \pm 0.142 ^b
Chi-square value	18.957**
p-value	<0.001

** Significant at 1% level

Means with same letter as superscript are homogenous for each parameter

Table 10. Per cent of observers giving each score (%)

Condition	D	Diagnostic score			
		0	1	2	3
Hypertrophic Pyloric stenosis	R	0	0	25	75
	U	33.33	66.67	0	0
	L	0	0	0	100
Linear foreign body obstruction of jejunum	R	0	0	66.67	33.33
	U	0	0	0	100
	L	0	0	25	75
Double intussusception(ileo-ileo-caeco-colic)	R	75	25	0	0
	U	0	0	0	100
	L	0	0	66.67	33.33
Foreign body jejunum (Nutmeg seed)	R	0	0	83.33	16.67
	U	0	0	16.67	83.33
	L	0	25	75	0
Colonic impaction	R	0	0	16.67	83.33
	U	83.33	16.67	0	0
	L	0	0	16.67	83.33
Gastric perforation and peritonitis	R	0	0	66.67	33.33
	U	0	0	66.67	33.33
	L	0	0	0	100
Pyometra	R	0	0	8.33	91.67
	U	0	25	75	0
	L	0	0	0	100
Pyometra	R	0	0	8.33	91.67
	U	100	0	0	0
	L	0	0	0	100
Cholangiocellular carcinoma (bile duct carcinoma)	R	100	0	0	0
	U	0	0	16.67	83.33
	L	0	0	0	100
Chronic hepatic injury	R	100	0	0	0
	U	0	58.33	41.67	0
	L	0	25	75	0
Splenomegaly	R	0	0	0	100
	U	0	0	25	75
	L	0	0	0	100
Haemangiosarcoma	R	0	66.67	33.33	0
	U	0	0	25	75
	L	0	0	0	100
Fibroma	R	0	83.33	16.67	0
	U	0	0	33.33	66.67
	L	0	0	8.33	91.67

0 – Not diagnosed
2 – Tentative diagnosis

1 – Doubtful diagnosis
3 – Confirmatory diagnosis

Table 8. Histopathological Findings.

Case ID	Specimen	Histopathological findings	Impression
A1	Full thickness section of pyloric sphincter	Muscular hypertrophy along with mild fibrous tissue infiltration in between muscle bundles.	Muscular hypertrophy of pyloric sphincter
A9	Biopsy of hepatic tissue	Acinar arrangement of biliary neoplastic cells separated by abundant amount of connective tissues. Cord like compressed hepatic parenchyma could be seen. Less differentiated tumour. Solid mass of epithelial component of neoplastic cells with vascular proliferation.	Cholangiocellular carcinoma.
A10	Biopsy of hepatic tissue	Fibrous tissue proliferation around portal triad. Suggestive of chronic insult.	Periportal fibrosis
A12	Section of tumor mass	Multiple cavernous blood vessels. Endothelial proliferation. Scattered neoplastic cells and some mitotic figures could be seen.	Haemangiosarcoma
A13	Biopsy of hepatic tissue and punch biopsy of tumor mass	Liver : congestion of central vein, haemosiderosis in the liver parenchyma Tumor tissue : bland fibroblasts throughout the field, separated by abundant collagen. Repetitive and interwoven collagenous fibers	Fibroma

Plate 3
Hypertrophic pyloric stenosis



Plate 3a : Survey radiograph
Distended stomach.
Thickened gastric wall



Plate 3b : Contrast radiograph
Barium retention, 20 hours post barium meal.

Distended stomach.
Thickened gastric wall

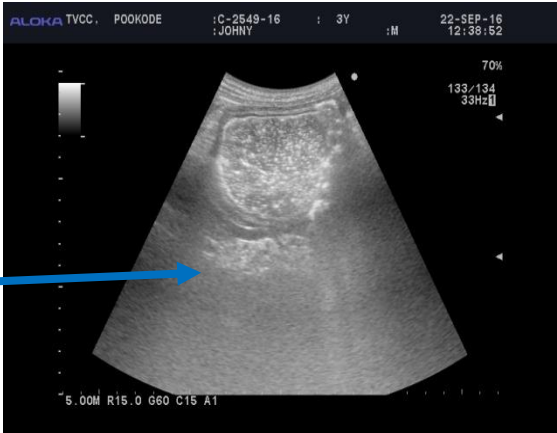
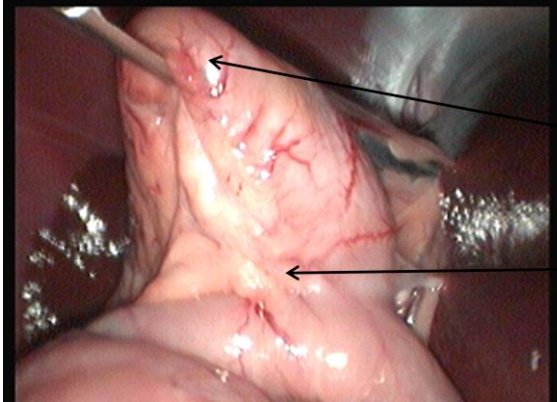


Plate 3 c : Sonogram



Flaccid duodenum
Band like thickening along the pyloric sphincter

Plate 3 d: Laparoscopic view

Plate 4
Liner foreign body : Jejunum



Plate 4a : Survey radiograph

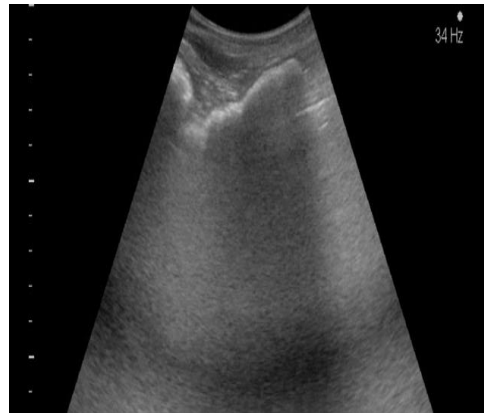


Plate 4b : Sonogram

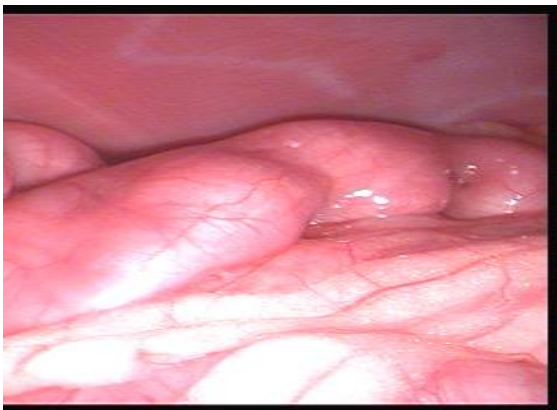


Plate 4c : Laparoscopic view

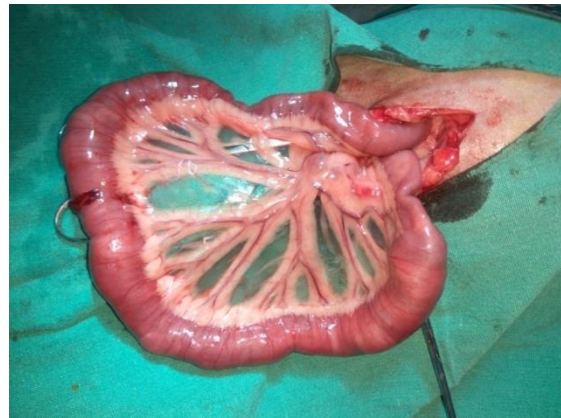


Plate 4d

Plate 4a : $S_{Imax}/L5 = 2.2$
Plate 4b : Curvilinear hyperechoic line with attenuation of beam
Plate 4c : Plicated intestinal segment
Plate 4d : Laparotomy view
Plate 4e : Linear foreign body



Plate 4e

Plate 5

Ileo-ileo-caeco-colic intussusception

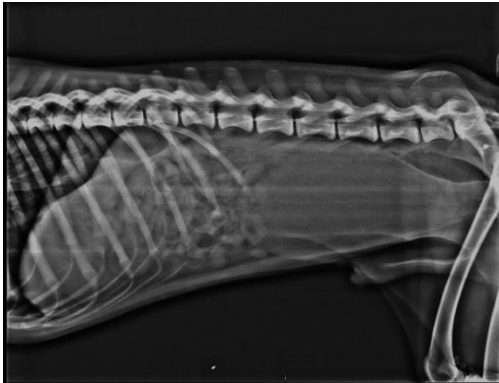


Plate 5a : Survey radiograph



Plate 5b : Sonogram



Plate 5c : Sonogram

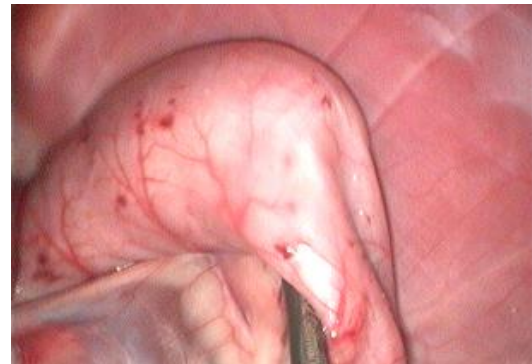


Plate 5d : Laparoscopic view

Plate 5a : Right lateral view

Plate 5b : Transverse view : reverse G shaped interior

Plate 5c : Sagittal view : Multilayered hyperechoic and hypoechoic lines.

Plate 5d : The caudal end - abrupt flaccid ending

Plate 5e : Laparotomy view of ileo-ileal segment



Plate 5e

Plate 6

Foreign body: Jejunum (Nutmed seed)

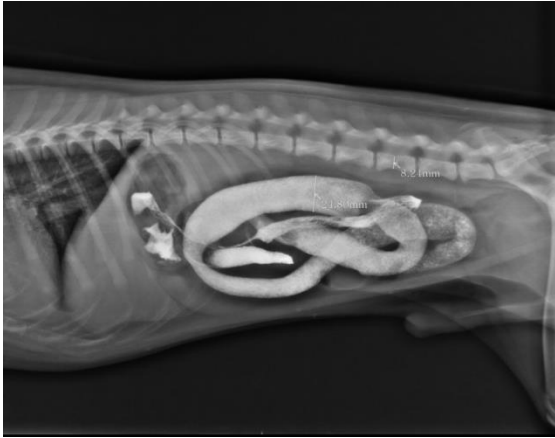


Plate 6a : Contrast radiograph

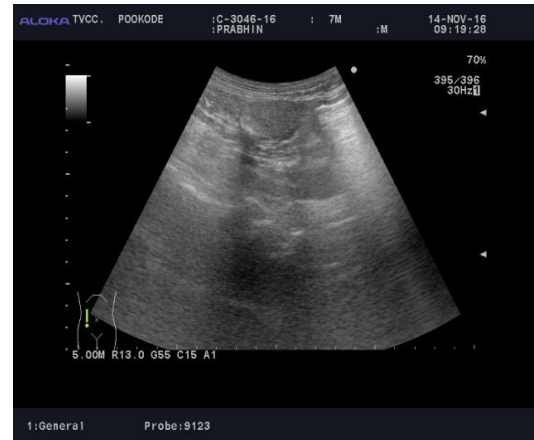


Plate 6b : Sonogram



Plate 6c : Laparoscopic view



Plate 6d

Plate 6a : Distended small intestinal loops, $\text{Simax/L5} = 3.02$

Plate 6b : Ovoid hypoechoic foreign body

Plate 6c : Severe distension of small bowel. Congested intestinal walls.

Plate 6d : Laparotomy view

Plate 7
Colonic Impaction



Plate 7a : Contrast radiograph



Plate 7b : Laparoscopic view

Plate 7a : Right lateral 48 hour post barium meal radiograph

Plate 7b : A hard and plicated segment of descending colon,
tense wall.

Plate 8
Gastric Perforation and Peritonitis

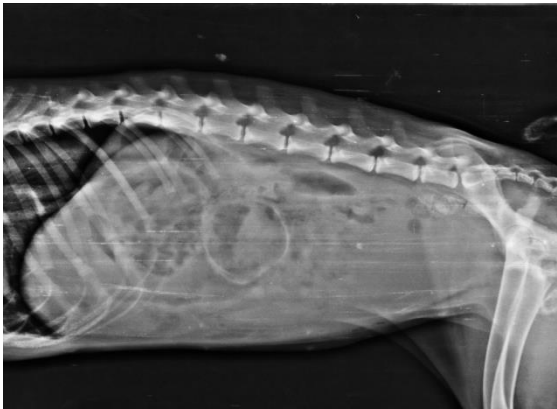


Plate 8a : Survey radiograph



Plate 8b : Sonogram



Plate 8c : Sonogram

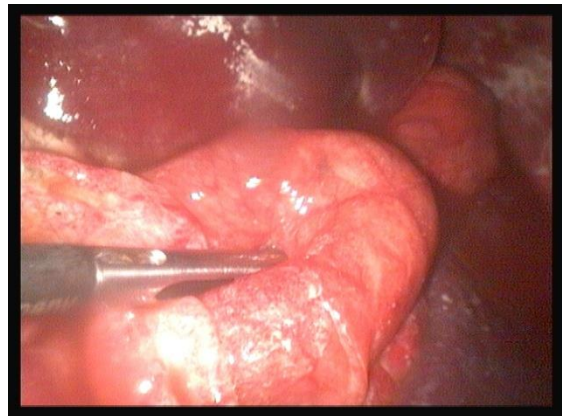


Plate 8d : Laparoscopic view

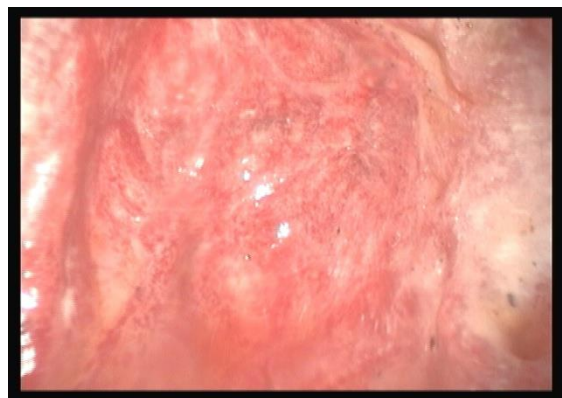


Plate 8e : Laparoscopic view

Plate 8a: Overall loss of organ detail. Diffuse black shadows throughout the abdomen.

Plate 8b: Fluid in the abdomen. Anechoic areas around abdominal organs.

Plate 8c: Hyperechoic streaks with reverberation artifacts,

Plate 8d: Serosanguineous fluid and gastrointestinal contents in the abdominal cavity.

Plate 8e: Severe peritonitis. Severe inflammatory changes all over the parietal peritoneum.

Plate 9
Pyometra

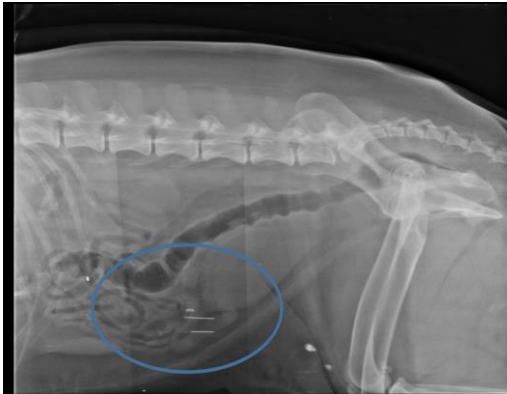


Plate 9a : Contrast radiograph



Plate 9b : Sonogram



Plate 9c : Laparoscopic view

Plate 9a : Pneumocolon radiography:
Abnormal tissue density between urinary bladder and colon

Plate 9b : Hypoechoic and anechoic contents in uterus

Plate 9c : Uterine wall bluish tinged. The uterine horns thickened, hard and enlarged. Thick contents could be appreciated.

Plate 10

Pyometra

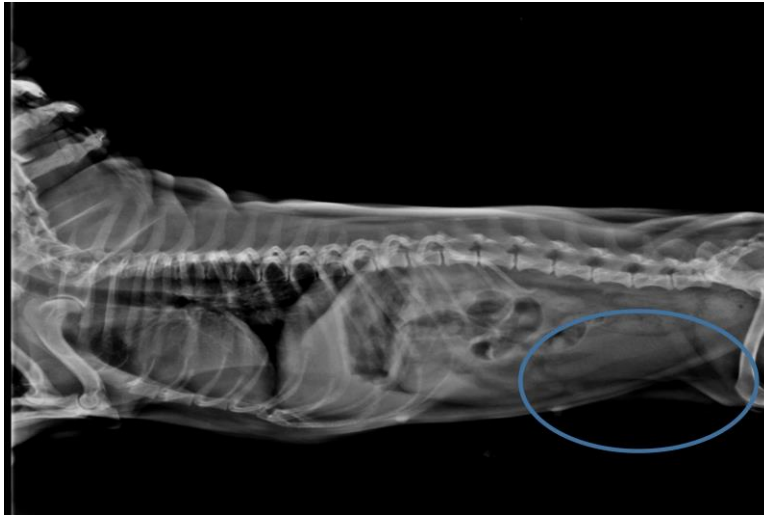


Plate 10a : Survey radiograph

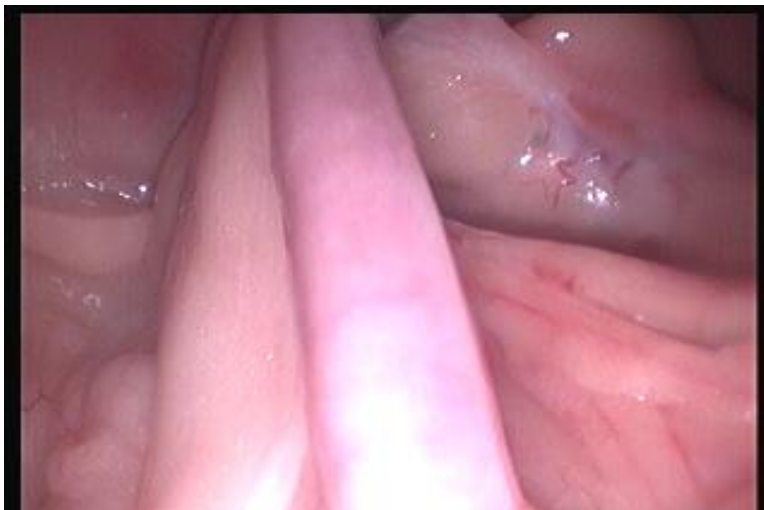


Plate 10b : Laparoscopic view

Plate 10a : Right lateral view: Abnormal tissue density between colon and urinary bladder.

Plate 10b : Uterine horns moderately enlarged, thick walled uterus, with semisolid contents

Plate 11
Cholangiocellular Carcinoma

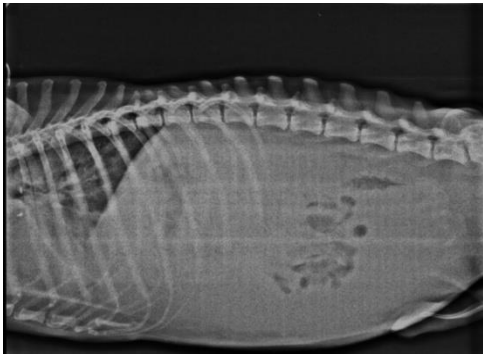


Plate 11a : Survey radiograph



Plate 11b : Sonogram

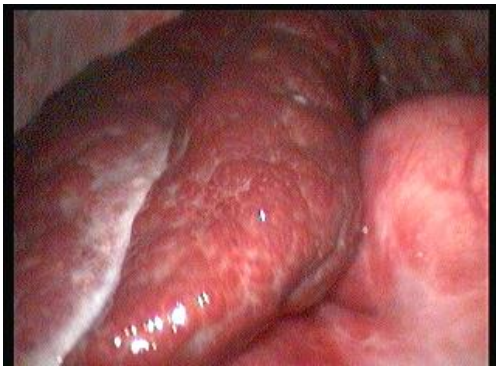


Plate 11c : Laparoscopic view

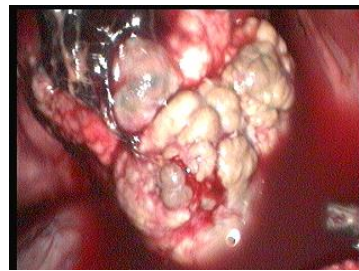


Plate 11d



Plate 11e



Plate 11f

Plate 11a : Ground glass appearance.
 Plate 11b : Hypoechoic and anechoic focal lesions in the liver parenchyma.
 Plate 11c : Massive multinodular and multilobulated firm mass, irregular borders.
 Plate 11d,e,f : Metastasis : pancreas, spleen, intestinal wall.

Plate 12
Chronic Hepatic Injury

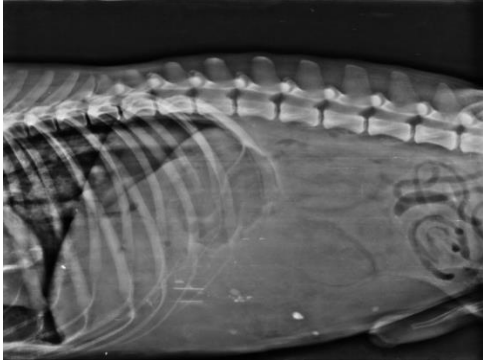


Plate 12a : Survey radiograph



Plate 12b : Sonogram

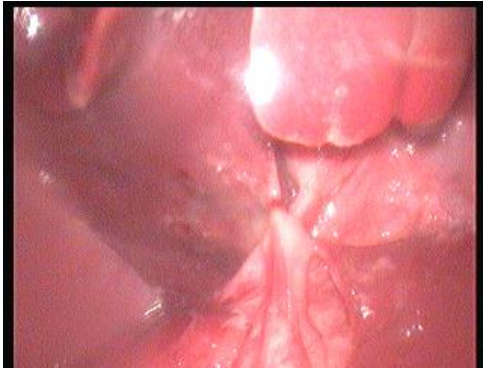


Plate 12c : Laparoscopic view



Plate 12d : Laparoscopic view

Plate 12a : Diffuse increase in overall density in the mid abdomen.

Plate 12b : Diffuse reduction in echogenicity of liver

Plate 12c : Adhesions of liver to abdominal wall.

Plate 12d : Signs of perihepatitis : inflammatory changes on serosal layer

Plate 13
Splenomegaly



Plate 13a : Survey radiograph



Plate 13b : Sonogram



Plate 13c : Laparoscopic view

Plate 13 a : Elongated splenic silhouette, uneven contour, dorsally displaced intestinal loops, overall loss of organ detail.

Plate 13 b : Enlarged spleen homogeneously hypoechoic

Plate 13 c : Diffuse splenic enlargement, rounded borders, sub capsular oedema.

Plate 14
Haemangiosarcoma



Plate 14a : Survey radiograph



Plate 14b : Sonogram



Plate 14c : Laparoscopic view



Plate 14d

Plate 14a : Diffuse mass like opacity near the hepatic area

Plate 14b : Mixed echogenicity and a hyperechoic capsule. Anechoic mass with hyperechoic cortex attached to the larger mass. Margin clearly demarcated.

Plate 14c : Hard mass along abdominal wall. Not attached to liver. Smaller mass attached to the primary mass.

Plate 14d : Surgically removed haemangiosarcoma.

Plate 15

Fibroma



Plate 15a : Survey radiograph



Plate 15b : Sonogram

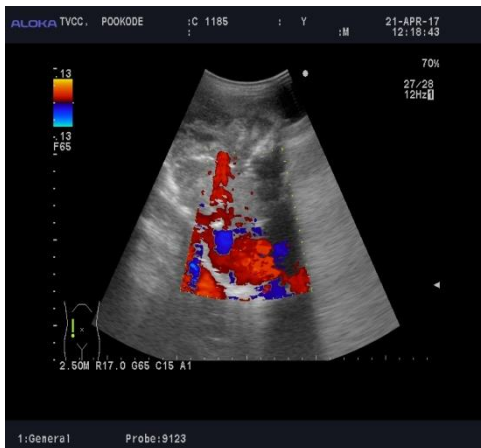


Plate 15c : Doppler view

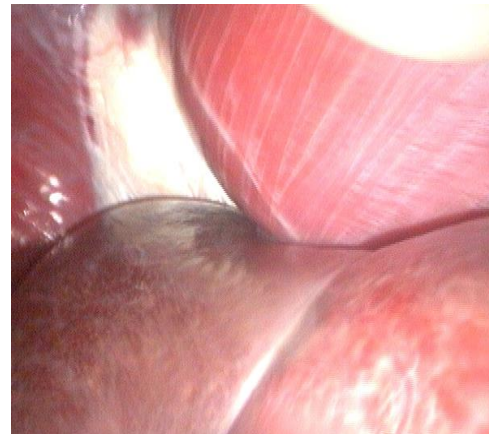


Plate 15d : Laparoscopic view

Plate 15a : Right lateral survey radiograph.

Plate 15b : Ovoid mass with mixed echogenicity, non homogenous echotexture.

Plate 15c : Doppler view – hypervascular periphery.

Plate 15d : Hard mass on the left abdominal wall.

Discussion

5. DISCUSSION

Intra abdominal disorders are one of the most commonly presented clinical conditions of dogs in any veterinary clinic. Symptomatic therapy is the initial line of treatment in most of the cases. Confirmatory diagnosis is very critical for effective management of complicated cases. A good knowledge about the diagnostic characteristics of different diagnostic tools is the key for efficient diagnosis. According to Ljunggren (1964), it was important to quickly determine if surgery was indicated in a particular case, as in some cases of misdiagnosis, surgery might be a fatal mistake.

This study was designed to evaluate the use of different diagnostic tools *viz*, radiography, ultrasonography and laparoscopy for diagnosing intra abdominal disorders in dogs. The study also dealt in detail about other diagnostic methods that are, physical and clinical evaluation, haematological study and serum biochemistry profile. The idea was to correlate all the findings and arrive at a comprehensive diagnosis of various abdominal disorders in dogs.

5.1. SELECTION OF CASES

Thirteen dogs with clinical manifestations of abdominal disorders presented to Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Pookode, Wayanad, were selected for the study. Selection was based on the complexity in diagnosing the condition and the cases which required no additional employment of any advanced diagnostic technique were not included in the study. The selection was irrespective of breed, sex, age and body weight of the animal without any bias.

5.2. SIGNALMENT

There were six non-descript dogs, three Rottweilers and one each, Labrador Retriever, Labrador-Rottweiler cross, Spitz and Pug in this study. More number of non-descript dogs in the study may be because of the fact that most households, in the specific location of study, preferred to keep local non-descript dogs rather than

an expensive exotic breed. Five female dogs were included in the study, of which two were diagnosed with pyometra. This concludes that only three female dogs were affected with sex independent abdominal disorders, compared to eight male dogs. This may be attributed to the larger male population in the locality, as the local population prefers to keep a male dog.

Even though average bodyweight of the animals under study was 19.45 Kg, dogs with 6.9 kg body weight and 34 kg body weight were also included in the study. Pups and geriatric animals were included in the study belonging to an age group ranging from six months to ten years.

5.3. ANAMNESIS

All thirteen cases had a history of vomiting in varying degrees and duration. According to Elwood *et al.* (2010), vomiting was an important clinical sign exhibited by dogs with various intra abdominal disorders; however it was difficult to differentiate reason for underlying diseases in animals with vomiting as a clinical sign. The disorders under study were related to gastro-intestinal tract, hepatobiliary system, spleen, female genital system and neoplastic conditions. Different researchers had observed vomiting in these conditions earlier (Johnson *et al.* (1989), Walters (2000b), Hinton *et al.* (2002), Brown (2003), Webster and Cooper (2009), Kim *et al.* (2012), Prathaban *et al.* (2013) and Ravikumar *et al.* (2015).

Webster and Cooper (2009) observed that clinical signs seen in hepatobiliary disorders were non-specific, as those signs were also related to gastro-intestinal disorders, urinary disorders and central nervous system defects. Similar signs were observed in the present study in the animal with cholangiocellular carcinoma. Same was the case with the animal with splenomegaly, where again the signs were non-specific (Johnson *et al.*, 1989).

Occasional blood tinged vomitus and melena observed in linear foreign body obstruction could be related to intestinal erosions due to the foreign body as observed by Twedt (2010). In pyloric stenosis vomiting was reported around four to seven hours after feeding and the contents were mainly partially digested food.

As the contents were partially digested and the time was approximately the time of gastric emptying, it could be related to a delayed gastric emptying (Twedt, 2010). The condition was finally diagnosed as a case of hypertrophic pyloric stenosis.

Anorexia either partial or complete, observed in all cases were similar to the observations made by other researchers (Johnson *et al.* (1989), Walters (2000b), Webster and Cooper (2009), Prathaban *et al.* (2013), Elhiblu (2015) and Ravikumar *et al.* (2015). According to Monroe (2000), in order to confirm the actual cause of anorexia other diagnostic methods like radiography, ultrasonography or endoscopy might be employed.

Weight loss seen in nine cases could be due to the anorexia leading to weakness and cachexia as observed by Shulman (2010). According to Foley (2010) intraluminal and extraluminal obstruction of colon could lead to tenesmus. This could be observed in case A5.

Twelve cases presented were treated symptomatically prior to presenting in TVCC, Pookode, and seven cases among them, were treated for gastritis. This was because of the fact that the symptoms were referring to gastritis and it was the most common intra abdominal disorder usually encountered as reported by Simpson (2010).

The dogs diagnosed with gastro-intestinal foreign body were found to be having a greedy feeding nature as observed by Kumar and Tayal (1994). Case A6 with gastric perforation was not in a collapsed state similar to the observations of Stanton and Bright (1989).

In the colonic impaction, the clinical signs were less acute, there was no dehydration and weight loss. These could be due to a lesser degree of fluid and electrolyte loss, as the caudal most segment of intestine was affected. The distension of intestine was not so evident on physical examination because, the length of normal intestine was enough to accommodate and contain intestinal distension in that case (Jawre, 2008)

Signs shown in pyometra cases were similar to those reported by Schlafer and Foster (2016). Cases with pyometra were showing polyurea and polydipsia as

observed by Nicholes (2001). According to Schlafer and Foster (2016), the extragenital clinical signs shown by an animal with pyometra was due to severe toxemia and intermittent bacteremia.

5.4. FINDINGS OF CLINICAL EVALUATION

5.4.1. Clinical Examination

Nine cases were lethargic and none were recumbent at the time of presentation.

5.4.2. Physiological Parameters

Physiological parameters of all the gastro-intestinal tract related disorders were almost within normal range, barring a few values and these values were nonspecific, only suggesting presence of some systemic disease.

The values in double intussusception case were normal, similar to findings of Kim *et al.* (2011). Prathaban *et al.* (2013) and Ravikumar *et al.* (2015) also observed almost similar values, though Prathaban *et al.* (2013) noticed hyperpnoea and severe dehydration, and Ravikumar *et al.* (2015) noticed an increased body temperature. The visible mucous membrane was pale due to anaemia and could be related to the low haemoglobin and VPRC values in the case.

In gastric perforation, the heart rate was towards the lower normal limit, CRT was increased and visible mucous membranes were congested. It could be attributed to signs of mild shock.

The body temperature of animals with closed pyometra was towards a higher range. According to Smith (2006), female dogs with pyometra typically are afebrile. Although the temperature was within normal range, the higher range suggested that the animals could have had fever initially. As the condition advances, the animal would move towards a state of hypothermia and start showing signs of shock and toxemia as per Pretzer (2008). The changes in CRT and colour of mucous membrane could be suggesting mild toxemia in those cases.

5.4.3. Abdominal Examination

Pain was manifested by signs like guarding the abdomen when touched or palpated, whining while palpating and restlessness. Walters (2000a) explained that pain could be due to pathological changes like, inflammation, ischemia, distention, or rupture of abdominal organs. In the cases under study, pain was due to pathologies of abdominal viscera, parietal peritoneum, or from extra-abdominal sites. In case of linear foreign body, the large mass palpated was the bundled or plicated intestinal segment and was evincing pain, similar to findings of MacPhail (2002).

In two cases, fluid accumulation was the reason for abdominal distension. Johnson *et al.* (1989), Hinton *et al.* (2002), Fransson and Ragle (2003) and Smith (2006) could observe similar findings. In space occupying lesions like fibroma and haemangiosarcoma, visible swelling was seen towards the skin surface, although a larger portion of the mass was intra abdominal. The findings of abdominal palpation and percussion were not generally confirmatory for diagnosing abdominal disorders, except in conditions like, intestinal mechanical obstruction, organomegaly and fluid and gas filled abdomen. The findings in mechanical obstruction were similar to observations made by Khan *et al.* (2011), Kim *et al.* (2012), Nath *et al.* (2011), Prathaban *et al.* (2013), Radlinsky (2013) and Ravikumar *et al.* (2015). All gastro-intestinal tract related disorders were having reduced motility similar to findings of Radlinsky (2013).

5.4.4. Haematological Evaluation

The sub normal value of total erythrocyte count in one pyometra case, along with a lower value for haemoglobin and VPRC showed anaemia and may be due to the reduced erythrocyte production resulting from systemic inflammatory response, as observed by Fransson and Reagle (2003). In both pyometra cases, although no significant neutophilia was there, the values were towards the higher range. Correlating this with the abnormally high TLC value, it could be assessed that the change was due to the localised inflammatory response due to the localised nature of pyometra, as explained by Benjamin (2001).

The haemato-biochemical values in hepatopathies were usually misleading as per Chaudhary *et al.* (2008) and in the present study also the only abnormal haematological value in the case A10 with chronic hepatic injury was leukocytosis.

In pyloric stenosis, most of the haematological values were within normal range as reported by Simpson (2010). Only variation was leukocytosis, due to gastritis and very mild reduction in VPRC which was found non specific, as the haemoglobin concentration and total erythrocyte count were normal.

Reduced levels of VPRC, erythrocyte count and haemoglobin in cases of haemangiosarcoma, fibroma and intussusception were suggestive of anaemia in those animals. The very low value of VPRC in case A12 and A13 (20.1 per cent and 20.4 per cent, respectively) could be due to the growing neoplasm diagnosed in these two cases. Similar observations were reported by Walters (2000b) and Khan *et al.* (2011). Agreeing with the findings of Walters (2000b), these cases were also having thrombocytopenia. Anaemia and thrombocytopenia in case of haemangiosarcoma could be due to non-specific tumour effects, sequestration or haemorrhage into the tumor sinuses or body cavities as observed by Oksanen (1978). According to Ng and Mills (1985), possible development of disseminated intravascular coagulation and subsequent consumption of platelets could cause thrombocytopenia. Leukocytosis was not seen in this case contrary to other reports. Other haematological findings were similar to that reported by Ng and Mills (1985).

The leukocytosis in dog with double intussusception was in agreement with the findings of Jawre *et al.* (2008), Kim *et al.* (2011) and Ravikumar *et al.* (2015).

5.4.5. Serum Biochemistry

Contrary to findings of Patnaik *et al.* (1980) and Trigo *et al.* (1982), the serum ALP level was not found elevated and serum ALT level was reduced in the case of cholangiocellular carcinoma.

In pyometra cases, there was hypoalbuminaemia which could be due to an acute phase reaction as observed by Fransson and Ragle (2003). However they

also got hyperglobulinaemia in pyometra which was not there in the said case, evident from the low total protein level. The findings were also contrary to that observed by Smith (2006).

Serum biochemistry in double intussusception was normal as reported by Jawre *et al.* (2008), except that they could observe an elevated serum alkaline phosphatase in their case which was not observed in the present study.

Chaudhary *et al.* (2008) observed the values of alkaline phosphatase and alanine aminotransferase to be slightly increased or within normal range in cirrhosis and fibrosis. In the study, the case with chronic hepatic injury and periportal fibrosis was also showing normal ALT and ALP values. However, many other researchers got elevated values of ALT and ALP in hepatic diseases (Singh *et al.*, 2010 and Webster, 2010). Reduced serum total protein and albumin were indicative of liver disease as per Singh *et al.* (2010).

5.5. RADIOGRAPHIC FINDINGS

In all the cases two orthogonal views were taken for a better perception of abdominal cavity as observed by Bischoff (2003).

5.5.1. Gastro-intestinal tract related conditions

Out of the thirteen cases, six cases were diagnosed as abdominal disorders with gastro-intestinal tract as the organ system affected. One animal was diagnosed with pyloric stenosis, one with double intussusception (ileo-ileo-caecocolic intussusception), three cases of mechanical obstruction of intestine, and one case had a gastric perforation of unknown reason.

Lateral survey radiograph of pyloric stenosis demonstrated a distended stomach with thickened gastric wall. The distension noticed was due to the delayed gastric emptying because of stenosis at the pyloric orifice (Radlinsky, 2013). Thickened gastric wall was suggestive of gastritis. The contrast series study using barium sulphate provided further confirmation in the diagnosis. Different researchers have reported different normal timings for contrast media emptying from stomach (Thornton, 1962, Ljunggren, 1964 and Simpson, 2010).

But in any case, the maximum time reported was 12-16 hours. Therefore the retention of barium in stomach even after 20 hours in this particular case could confirm the condition as delayed gastric emptying.

In cases with mechanical obstruction of intestine, the obstruction as such was visible in one case. However, there were enough signs in all cases to suspect an obstruction. In all the three cases there was prominent distension of intestinal loop which could be a sign of intestinal obstruction (Ljunggren, 1964). In the case with nutmeg seed, the ratio between maximum diameters of small intestine (S_{max}) to height of fifth lumbar vertebrae (L5) was 3.02 ($S_{max}/L5$), which highly suggested a mechanical obstruction. This was in agreement with the observations of Finck *et al.* (2014). In the animal with linear foreign body, also there was distension of intestinal segments and the $S_{max}/L5$ ratio was 2.2. According to Finck *et al.* (2014) it falls between the range of absence and presence of obstruction. Therefore additional tests were needed to confirm an obstruction. However, in this case a segment of distended intestine was showing granular contents. These findings were due to the radiographic appearance of threads, plastic fibres, bristles and hairs in the linear foreign body which was removed during enterotomy. Plain lateral radiograph of linear foreign body did not reveal any plication. According to MacPhail (2002), plicated or bunched intestinal radiographic pattern, often considered classic in linear foreign body and abnormal distension of intestinal loops would not be evident always. In case of colonic obstruction, a 48 hour post barium radiograph was showing barium retention towards the descending colon, which was suggestive of an obstruction at this level.

According to Khan (2011), the accumulation of gas proximal to the intussusception might aid in its diagnosis by a plain radiograph. Contrary to this, in this particular study the initial survey radiography could reveal only fluid or ingesta filled gastro-intestinal segments without any gas accumulation or distension. Literatures suggested that only in some cases of intestinal intussusception, abdominal radiography could give a diagnostic picture. Both survey radiographs and contrast studies could often present nonspecific lesions

(Patsikas *et al.*, 2003 and Kim *et al.*, 2012). A contrast study could diagnose intussusception, but as the animal was lethargic and was reluctant to take anything orally, no contrast study could be performed. The soft tissue consistency along the mid intestinal segments was not of diagnostic significance. Subsequently no apparent diagnosis was made.

Hinton *et al.* (2002) and Rasmussen (2003) observed that, a decreased abdominal detail and free abdominal gas were the major findings of abdominal radiography in gastro-intestinal perforation. These were due to leakage of gastro-intestinal contents and gas from the affected gastro-intestinal segments. In case A6 with gastric perforation, a loss in abdominal detail was present along with diffuse free gas. The circular gas filled cavity lined by opaque borders observed just caudal to the stomach, which was later identified as a mesenteric pouch abnormally filled with leaked gastric contents.

5.5.2. Pyometra

Uterus would be visible as a tubular or convoluted soft tissue structure in the caudal ventral abdomen, when it becomes larger (Ackerman, 1981). Normal non-gravid uterus is usually difficult to be seen in a survey radiograph because, it will be having a small diameter and its opacity will be similar to adjacent intestinal loops. Hammond (2009) opined that, sometimes the distension of uterus with pyometra would be small to be seen in a normal survey radiograph. Radiographic findings in one of the cases of pyometra in the present study were in agreement to that and the uterus was not clearly visible and diagnosis was inconclusive. As the primary suspicion was pyometra, a negative contrast medium (air) was introduced to colon and created a pneumocolon, as per procedure defined by Nyland and Ackerman (1978), to isolate uterus. An abnormal tissue opacity was seen between urinary bladder and colon. Thornton (1962) stated that, an abnormal tissue opacity or mass like lesion identified between the urinary bladder and colon in a radiograph could be that of uterus, because of its anatomical location. The tissue opacity was due to pus in the uterus. Lateral survey radiograph in the second case showed a 'Y' shaped segment with a tissue

density towards the caudal abdomen. That was the uterine horns with semisolid contents in the caudal abdomen merging to the enlarged neck of the uterus which was observed between rectum and urinary bladder on lateral radiograph (Ljunggren, 1964). Radiographic characteristics like size, shape and radio-opacity of an early pregnant uterus, pyometra, mucometra, and uterine torsion, are all similar, as all will have a soft tissue or fluid radiopacity. Ackerman (1981) and Pretzer (2008) observed that there would be a practical difficulty in differentiating these cases during radiography. Hence it warrants further diagnostic approaches for conclusive diagnosis.

5.5.3. Hepatobiliary Disorders

In case A9 as the primary presenting sign was ascites, the survey radiograph revealed granular appearance of abdomen, without any organ detail, suggestive of severe fluid accumulation in the abdominal cavity (ascites). Margins of abdominal organs were not clear as it was vague due to the large quantity of fluid in the abdomen. Reasons for the fluid accumulation could not be assessed from radiography. These findings of homogenous, ground glass appearance of abdomen were similar to those by other researchers, Thornton (1962), Chaudhary *et al* (2008) and Kumar and Srikala, (2014). As Thornton (1962) suggested, other procedures were necessary to differentiate the condition causing fluid collection in the abdomen. Therefore, radiography was inconclusive in this case.

In the case of A10, eventhough there was a suspicion of hepatomegaly, there was no sign of any mass continuous with liver shadow and no displacement of stomach as observed by Thornton (1962). The caudal displacement of intestinal loops was the only radiographical finding suggestive of an apparent hepatomegaly, which was only suggestive of some hepatic disease (Chaudhary *et al*, 2008). According to Ljunggren (1964), the diffuse increase in overall density was due to presence of peritoneal fluid in the abdominal cavity and because of that it was not possible to differentiate hepatic and splenic contours in case A10.

5.5.4. Splenomegaly

In the case A11, diagnosed as splenomegaly, the splenic silhouette was elongated due to generalised splenomegaly. There were no well-defined masses with definite margins which was later on confirmed by diagnostic laparoscopy. According to Root (1974), definite limits of size of spleen could not be accurately compared as the size and position of normal spleen was extremely variable and greatly influenced by its position. The intestine was displaced because of the position of the spleen.

5.5.5. Space Occupying Neoplastic Conditions

The case A12 of haemangiosarcoma, was having a soft tissue opacity on lateral and ventro-dorsal radiographs. The displacement of stomach dorsally was evident and was showing the space occupying nature and extent of the mass. In the case A13, fibroma, was also showing a similar radio-opacity. It was not possible to clearly demarcate the liver in case of both the space occupying lesions. In case A13 it was misdiagnosed as a hepatic mass, because of its close association with the liver. In A12, the enlarged hepatic silhouette was directing towards a hepatic involvement, although diagnosis was not confirmed. Thrall *et al.* (2009) observed that, radiographs of neoplasms would have different shades of soft tissue opacity based on the consistency of the mass. The displacement of adjacent organs or structures could be used to identify the location and origin of the mass.

5.6. SONOGRAPHIC FINDINGS

5.6.1. Gastro-Intestinal Tract Related Conditions

Out of the six cases with gastro-intestinal tract related affections, in three cases (double intussusception and two foreign bodies) confirmatory diagnosis was possible with the help of ultrasonography. In other cases finite confirmation was not possible. However, signs relating to nonspecific gastro-intestinal affections were observed.

Patsikas *et al.* (2003) and Kim *et al.* (2012) opined that, ultrasonography was a more sensitive and specific method for accurate diagnosis of intestinal

intussusception. In case A3, the 'reverse G' shape observed was similar to what observed by Patsikas *et al.* (2003). The hyperechoic 'reverse G' might be mesenteric fat and compressed intussusceptum trapped inside with a small amount of fluid as anechoic patch. A third ring (colonic segment) was noticed during retrospective examination of sonogram in a case of double intussusception by Kim *et al.* (2012). In this case the third ring was not identified. Double intussusception showed only standard intussusception signs and was indistinguishable from classical intussusception during preoperative ultrasonography (Kim *et al.*, 2012). According to Patsikas *et al.* (2003), multiple parallel hyperechoic and hypoechoic lines were due to the layers of intestines overlapping each other.

In animals with foreign body obstruction distension of small intestine was a common observation. The foreign body as such could be observed in two cases. In case A4, the foreign body was identified as a hypoechoic structure with an attenuation of beam beyond it. This appearance could be due to the nutmeg seed soaked in fluid giving the particular texture and echogenicity.

Hypermotility of distended intestinal segments and mixed hyper and hypomotility along adjacent segments were signs of mechanical obstruction and the findings were similar to those observed by Tidwell and Penninck (1992). Hypomotility observed in A2 was due to the chronic nature of linear foreign body as observed by Gomaa *et al.* (2012). The curvilinear hyperechoic line was the plicated intestinal segment in that case, similar to the observations of MacPhail (2002).

Fluid-filled stomach and pyloric wall thickening were the ultrasonographic features reported in cases of pyloric stenosis by Radlinsky (2013) and Pennink *et al.* (1990). According to Pennink *et al.* (1990), the pyloric thickening observed would be localised, circumferentially symmetrical and with reduced gastric motility. In the present case, there was gastric distension along with reduced gastric motility and emptying. The pyloric region could not be identified for examination and therefore no inference was made.

Hinton *et al.* (2002) and Gomaa *et al.* (2012) observed free gas as hyperechoic streaks with acoustic shadowing, throughout the abdomen in cases of gastrointestinal perforation. The same features, along with reverberation artifacts were observed in the current study, The anechoic area noticed caudal to the stomach was actually a pouch of mesentery filled with gastric contents which leaked out of the gastric perforation, as confirmed during diagnostic laparoscopy. This was misinterpreted as a fluid filled foreign structure during ultrasonography. Signs of peritonitis were not observed, as it was difficult to study the wall of peritoneum in detail because of presence of gas in abdomen. Similar observations were made by Rasmussen (2003), where he opined that only non descript changes were seen in peritonitis due to gastric perforation.

5.6.2. Pyometra

In case of pyometra, when the distension of uterine horns were mild, it would be difficult to identify uterus from the surrounding small intestinal segments which would be of similar diameter and echogenicity. Lack of wall layering of the uterine horns and lack of peristaltic wave helped to diagnose a mild distension of uterus with fluid and semisolid contents in case A7. This was similar to the observations of Hammond (2009). In case A8 also the distension was mild and it could not be identified in the ultrasonography. Ultrasonographic findings in the cases of pyometra were not similar to the observations made by many other researchers (Bigliardi *et al.*, 2004 and Smith, 2006), because of the small size of closed pyometra in both the cases.

5.6.3. Hepatobiliary Disorders

According to Nyland *et al.* (1995), focal or multifocal hypoechoic or mixed lesions with parenchymal changes were more common in hepatic carcinomas, rather than hyperechoic lesions. Irregular hypoechoic and anechoic cavitations in the longitudinal sonogram of liver were observed in case A9 with biliary carcinoma similar to findings of Anjou (2008). Nyland *et al.* (1981) reported abnormal echogenicity in the area of gallbladder and porta hepatis, which was

seen throughout the lobes in this case. It was not possible to differentiate whether it was a primary tumor or a secondary metastasis or to ascertain the type of the tumor by ultrasonography. This was also reported by Nyland *et al.* (1995). The rounded margins of liver in A9 was indicative of hepatomegaly as per findings of Anjou (2008) and Kumar and Srikala (2014). Anechoic areas detected in the abdomen surrounding all the abdominal organs was suggestive of ascitic fluid similar to observations of Kumar and Srikala (2014).

Diffuse reduction in echogenicity of liver observed in case A10 with chronic hepatic injury could be due to hepatic congestion (Kealy *et al.*, 2011). Periportal fibrosis was detected as hyperechoic areas around portal vessel, which was later confirmed by histopathology.

5.6.4. Splenomegaly

The splenic size was assessed by ultrasonography in the animal with splenomegaly. As the parenchyma was homogeneously hypoechoic, presence of any focal lesion was ruled out. However, generalised affection could not be confirmed.

5.6.5. Space Occupying Neoplastic Conditions

In both the cases of soft tissue tumors on abdominal wall, the ultrasonographic view gave a mixed echogenic lesion with non homogenous echotexture. The findings were similar to the observations of Kramer and Anjou (2008). In case A12, haemangiosarcoma, another smaller anechoic mass could be seen attached to the main mass. The anechoic nature was due to the pooled blood in the mass, which was confirmed during surgery. The masses were distinct. In both cases, the clear demarcated margin clarified that the masses were not attached to any organ especially to liver, even though they were found to be in close proximity to the liver. The hypervascular nature of fibroma as confirmed by colour flow study indicated increased blood flow to the mass. According to Thiel *et al.* (2003), the malignancy of a tumor could not be ascertained by the hypervascularity alone.

5.7. DIAGNOSTIC LAPAROSCOPY

5.7.1. Port Placement

The primary port was placed 1.5 cm caudal to umbilicus in all cases. This was similar to what was explained by Monnet *et al.* (2008) and Rawlings (2011). The primary port was used to pass the telescope. The placement helped to visualise both cranial and caudal aspect of the abdominal cavity by rotating the camera in all directions. After assessing the abdominal cavity with the camera inserted through the initial port, introduction of second port was based on the organ of interest to be examined, as reported by Patel *et al.* (2014). In pyloric stenosis and both the cases of pyometra, three ports were placed as two working instruments were required to properly identify and examine the affected site or organ. According to Freeman (2009) two sets of grasping forceps could be employed for tracing and exploring organs in a “hand-over-hand” manner. In case of colonic impaction, as the area of interest was towards the caudal aspect of the abdominal cavity, the secondary port was placed caudo-lateral to the primary port, towards the right side. In case of Pug with splenomegaly, no additional ports were introduced as the space in the abdominal cavity was further reduced by the enlarged spleen and diagnostic assumptions were already made. In haemangiosarcoma case also, only one port was placed because the diagnosis was already made and a laparotomy was planned.

5.7.2. Laparoscopic Findings

5.7.2.1. *Gastro-Intestinal Tract Related Conditions*

In all the cases of gastro-intestinal tract disorders, some gross abnormality could be observed during diagnostic laparoscopy. The affected intestinal segments were observed for viability by checking the colour, arterial pulsation, thickness and peristalsis as explained by Radlinsky (2013). The handling of affected segments were restricted to bare minimum because, according to MacPhail (2002) there was chances of iatrogenic perforations and it would be difficult to identify perforations due to the presence of mesenteric fat.

In pyloric stenosis due to muscular hypertrophy, the constricted pyloric sphincter was observed. On probing the thickened muscular sphincter could be felt. The pyloric sphincter was thickened because of the hypertrophy and subsequent fibrosis of the sphincter, which was confirmed during histopathology (Mohan, 2010). Because of the constriction, it was difficult to evacuate contents from stomach during laparoscopic examination. Thickened gastric wall might be due to the ensuing gastritis (Sastry and Rao, 2009).

In intestinal obstruction, laparoscopic gross signs were observed in all cases like thickening, congestion and oedema of intestinal wall. Distension of affected segments was similar to gross pathologic findings of Sastry and Rao (2009). These findings were generally giving an indication of mechanical obstruction. The congestion and hyperaemia were due to the acute obstruction to the venous flow resulting from compression of thin walled veins which finally resulted in venous stasis. A delayed intervention could lead to ischemic necrosis of the bowel wall due to strangulation and thrombosis of vasculature. In severe cases the colour of wall could be blue to black compared to normal pink to red (Radlinsky, 2013 and Vegad, 2015). In none of the cases of obstruction studied in the present study these discolourations were noticed.

One common finding in all intestinal obstructions was severely distended intestinal loops. According to Radlinsky (2013), the portions cranial to obstruction would be distended with gas and fluid along with areas of ischemia. The distension was very severe in case A4, and was preventing further manipulation and examination using laparoscopic probes and graspers. Therefore the foreign body (nutmeg seed) could not be located in that case. Plicated appearance of the affected segment and presence of a thick, solid and elongated content inside the lumen along with other gross pathological lesions of the wall was helpful in diagnosing the linear foreign body in case A2. The distended descending colon with a hard content inside was diagnostic in the case of colonic impaction (A5).

According to Kim *et al.* (2012), double intussusceptions were primary ileo-ileal intussusception which later on intussuscepted into the colon through the ileo-colic orifice to form an ileo-ileo-caeco-colic intussusception. This was observed

as the thickened segment of colon with a flaccid caudal end in case A3. The distended segment of colon observed was swollen, oedematous, congested and fragile, similar to the findings of Jawre (2008) and Sastry and Rao (2009). Jawre (2008) also noticed invaginated loops of ileum in caecum during diagnostic laparoscopy in a case of ileo-caecal intussusception. The invagination could not be identified in the present case, as the neck of the intussusception was cranially located and was not able to be identified through laparoscopy. Laparoscopy did not give an impression of an alarming situation as there was only thickening and distension without any signs of necrosis. However, that was a wrong finding as during surgery it was diagnosed that there was severe necrosis and black discolouration of the ileo-ileal segment. The gross pathological findings were similar to the observations of Vegad (2015). As only the colonic segment was visible at the time of laparoscopy, the damage to ileo-ileal segment could not be appreciated. The condition was finally diagnosed to be an obstruction of intestine, either a linear foreign body or an intussusception.

The findings in intestinal obstruction indicated that an intra-luminal mechanical obstruction could only be identified in laparoscopy, by the changes seen on the affected intestinal wall. Similar to findings of Tumariya (2007) it was observed that laparoscopy was very effective in direct visualization of intestine and its size, colour, external texture and peripheral blood circulation could be easily studied, but it was not possible to visualize their internal contents. As the segment could only be palpated with laparoscopic probes and graspers, 'the feel of touch' which was possible during a laparotomy was lacking in case of diagnostic laparoscopy. Maiti *et al.* (2006) could also diagnosed intestinal intussusception and obstruction in dogs using diagnostic laparoscopy.

In the case with gastro-intestinal perforation, the presence of sero-sanguineous fluid and gastro-intestinal contents in the abdominal cavity helped in diagnosing the condition. The site of perforation could not be located. Post mortem examination revealed the presence of a punctured wound along the cranio-dorsal aspect of the pylorus. The small size of perforation, its location and

the contaminated state of the abdominal cavity prevented locating the perforation accurately. The poor prognosis was very evident from the laparoscopic findings.

5.7.2.2. Pyometra

The characteristics of uterus and uterine horns observed in both the cases of pyometra were indicative of closed cervix pyometra which could either be in its early stage or in a later stage with the contents getting dehydrated and inspissated to form a thick and viscid exudate as per findings of Schlafer and Foster (2016). Probing ruled out the possibility of midpregnancy. The gross appearance of a uterus with chronic closed cervix pyometra as explained by Schlafer and Foster (2016) was not observed in both the cases.

5.7.2.3. Hepatobiliary Disorders

Cholangiocellular carcinoma of liver was multilobulated and massive in size. Almost all lobes were affected and most severe lesions were seen on left lateral and right lateral lobes. Similar findings were described by Patnaik *et al.* (1980). Tumor protruding from capsule with an umbilicated appearance as described by Cullen and Pop (2002) was not seen in the present case. The mass was lobulated with irregular border. The texture of cholangiocellular carcinoma was firm due to the abundance of connective tissue, which differentiated it from a soft and friable hepatocellular carcinoma (Cullen and Pop, 2002). Metastasis to pancreas and spleen was similar to the findings of Patnaik *et al.*, (1980), although they could not find any metastatic lesions on the intestinal wall, which was also there in the present case. Raghuvir (2008) could also diagnose cholangiocellular carcinoma in dogs using diagnostic laparoscopy.

Lesions of chronic hepatic injury (A10) was seen in a hunting dog with a history of a gore injury during a wild boar attack, one year back. Subsequently it developed adhesions between abdominal wall and liver which was seen on the liver surface. Laparoscopy allowed to take a specific and selective biopsy of liver for histopathology, which further confirmed periportal fibrosis suggestive of chronic injury.

5.7.2.4. Splenomegaly

In the case of splenomegaly, the texture and appearance of spleen was giving an impression of congested splenomegaly. Spleen was “bloody” in appearance as explained by Valli *et al.* (2016). Splenic volvulus was ruled out. Diagnostic laparoscopy clearly diagnosed the condition to be a non surgical condition, not requiring any surgical intervention. The splenomegaly diagnosed by radiography and ultrasonography was not giving a confirmation towards the diffuse nature of splenomegaly and could not differentiate between congested or non congested nature of the enlargement. The oozing blood from a canula puncture site was hinting towards congested state of spleen and hence, no biopsy was tried (Valli *et al.*, 2016). Since the animal was a Pug, the size of the abdomen prevented further manoeuvrability and detailed examination of other organs. An initial blood smear examination was negative for any blood parasites. However, after the diagnostic laparoscopy, it was again suspected for a systemic infection and decided to treat accordingly. Maiti *et al.* (2006) could also diagnose splenomegaly in dogs using diagnostic laparoscopy.

5.7.2.5. Space Occupying Neoplastic Conditions

In animal A12, the haemangiosarcoma was a larger mass of 18 cm in diameter and a smaller one of seven centimeters. It was grey and firm in appearance. During surgery, it was observed that the cut section was reddish with haemorrhagic sinuses inside the tumor. Similar observations were made by Ng and Mills (1985). There were haemorrhages into the peritoneum. The gross appearance was mostly matching with those described by Oksanen (1978).

Fibroma seen in case A13 was round in shape. No evident metastasis could be seen during laparoscopy. Fibromas are benign neoplasms of fibrocytes. They would be having abundant collagenous stroma. The characters were similar to those explained by Hendrick (2002). Lesions on the liver could be due to the fact that liver is sensitive to systemic diseases affecting other organs and there was chances of hepatic lesions in para neoplastic conditions as reported by Webster and Cooper (2009). The extensive growth was exerting pressure on other vital

organs and was causing severe venous congestion in liver and spleen. This was evident from the histopathology of liver, which was showing congestion of central vein and severe haemosiderosis.

In both the space occupying lesions, laparoscopy could clearly indicate the extent of the mass and adhesions to the abdominal wall. Laparoscopy helped to scan the whole abdomen for signs of further adhesions and metastasis.

5.8. LINE OF TREATMENT FOLLOWED AND RESULT OF TREATMENT

The results from different diagnostic methods were compiled to arrive at a final diagnosis in each case and line of treatment was decided upon.

The case of gastric perforation was euthanized on the same day, taking animals welfare into consideration.

According to Hendrick (2002), fibromas could be surgically removed based on its extent. The fibroma in the present study was extensive in nature. Although no metastasis was identified during laparoscopy, it was not sure about its malignancy. Therefore the decision was taken for a palliative approach till the final result of histopathology was available. Since, the condition of the animal got worsened, the animal was euthanized after one week, considering the animal's welfare.

In case of splenomegaly, an initial blood smear was negative for any blood parasites. However, after the diagnostic laparoscopy, it was again suspected for a systemic infection and decided to treat accordingly. The condition of the animal never improved and it died in one week.

In cholangiocellular carcinoma, because of the metastatic nature of the tumor, only palliative care was given. Prognosis was grave. But, as the owner was apprehensive, euthanasia was not carried out. However, the animal died after two weeks.

In case of haemangiosarcoma, none of the diagnostic modalities could differentiate whether the tumor was malignant or benign. Hence, it was decided to go for a surgical excision under owner's consent. The subject case was later on

diagnosed to be a stage III haemangiosarcoma on histopathology. Prognosis of stage III was not favourable and there was risk of failure of surgery (Schultheiss, 2004). According to Ward *et al.* (1994), extensive surgical excision and adjuvant chemotherapy and radiotherapy were required for stage III haemangiosarcoma. A mass weighing 2.3 Kg was removed, but even after providing extensive critical post operative care, the animal could not be saved.

The remaining eight animals were successfully treated, out of which seven had surgical intervention.

The pyloric stenosis was surgically corrected with a Y-U pyloroplasty as described by Radlinsky (2013).

In case of foreign bodies, enterotomy was performed to remove the foreign body and closed the intestinal incision with simple interrupted suture patterns. According to MacPhail (2002), multiple enterotomies were performed in linear foreign body to prevent iatrogenic injuries while extracting the the foreign body. Contrary to this in case A2, only a single enterotomy could remove the foreign body.

The ileo-ileo-caeco-colic intussusception was corrected by an enterectomy and entero-anastomosis as described by many researchers (Kim *et al.*, 2012).

Ovariectomy was the best option in the case of closed-cervix pyometra. After stabilising the patients, both cases of closed-cervix pyometra, were surgically corrected by complete ovariohysterectomy. Eventhough the distension of affected horns were not alarmingly huge, medical management was not attempted, as both the cases were closed pyometra and the owners were not interested in keeping the animal for breeding. According to Smith (2006), medical management in case of closed-cervix pyometra could occasionally result in uterine rupture, seepage of uterine contents into the abdomen and could be life-threatening .

In the case of chronic hepatic injury the treatment with liver protectants and supplements were beneficial and the animal recovered. This was due to the capacity of liver to regenerate from injuries (Webster, 2010).

5.9. POST TREATMENT EVALUATION

In all the eight surviving animals, all parameters which were abnormal at the time of presentation became normal within a period of 30 days. All these animals were followed up for 60 days and all of them had an uneventful recovery without any relapse.

5.10. DIAGNOSTIC EFFICIENCY

The assessment of diagnostic efficiency based on evaluation by twelve independent observers were discussed. For the sake of discussion, scoring of atleast 75 per cent or more observers in each category was considered.

Diagnostic laparoscopy was giving a confirmatory diagnosis according to 75 per cent or more observers in ten of the cases studied. The number for ultrasonography was six and for radiography it was five, out of the total 13 cases. On further analysis it could be observed that laparoscopy alone was giving confirmatory diagnosis in two cases *viz*, gastric perforation and fibroma, according to 75 per cent or more observers. The number was two (ileo-ileo-caecocolic intussusception and foreign body in jejunum) for ultrasonography. All the methods were confirmatory in splenomegaly case according to atleast 75 per cent observers. None of the methods could give confirmatory diagnosis in the case of chronic hepatic injury. Laparoscopy had at least given a doubtful diagnosis in all cases. That too, there was only two cases *viz*, nutmeg seed (foreign body) obstruction in intestine and chronic hepatic injury, in which only 25 per cent respondents felt that laparoscopy was giving a doubtful diagnosis. In case A4, the severe intestinal distension was preventing manipulation and therefore the seed could not be located, however according to 75 per cent respondents, the distension was enough to give an indication about presence of foreign body. In the chronic hepatic injury case, the confusion was to confirm whether the lesions seen on liver was indeed the reason for the clinical signs. The adhesion and perihepatitis were enough for 75 per cent respondents to believe that liver was the source of illness.

Combining 'doubtful diagnosis' and 'not diagnosed' category, 75 per cent or more observers believed that radiography was not giving any diagnostic value

in four cases *viz*, double intussusception, cholangiocellular carcinoma, chronic hepatic injury and fibroma, and ultrasonography in three cases *viz*, hypertrophic pyloric stenosis, colonic impaction and pyometra. Of the three failed cases in ultrasonography, in two cases it was because of the failure in identifying the affected segment. In case of a pyometra, the distension was not that severe and therefore the uterus could not be identified amongst the intestinal loops. The radiograph of cholangiocellular carcinoma was not giving any information because of the presence of ascitic fluid in the abdomen. In double intussusception, radiography could have given a diagnosis if a contrast study was carried out. Radiography could not give any indication of parenchymal changes of liver in case of chronic hepatic injury. In case of fibroma, it was not possible to derive any information from the radiograph other than the presence of a mass extending into the abdomen.

The result of Friedman's test and Wilcoxon Signed Rank Test for testing the perception of individual observer towards each test was clearly showing a lower perception for laparoscopy. No further cluster analysis was done on the result. However, the result clearly suggested that conducting a diagnostic laparoscopy was neither desirable nor practical according to response of clinicians. Although Moore and Ragni (2012) opined that diagnostic laparoscopy being a minimally invasive procedure was extremely safe compared to exploratory laparotomy and the diagnostic quality was enhanced because of the magnification of the telescope, it was not a popular choice amongst clinicians.

Summary

6. SUMMARY

The present study was conducted to evaluate the use of radiography, ultrasonography and laparoscopy for the diagnosis of intra-abdominal disorders, and suggest the most suitable diagnostic tool for each case. Thirteen dogs with abdominal disorders presented to the Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Pookode, were selected for the study. Selection was irrespective of sex, age and breed. The selected cases were subjected to radiography, ultrasonography and diagnostic laparoscopic examination for diagnosis of the condition. The results of the study are summarised as follows.

Different dog breeds belonging to Rottweilers, Labrador Retriever, Spitz, Labrador - Rottweiler cross, Pug and six non-descript dogs were included in this study. There were eight males and five females and their body weight ranged from 6.9 kg to 34 kg and the age group included was from six months to ten years. The disorders under study were related to gastro-intestinal tract, hepatobiliary system, spleen, female genital system and space occupying neoplastic conditions.

Presenting history and clinical signs were usually non specific in all the cases. The most commonly encountered signs were vomiting, anorexia, lethargy, diarrhoea or constipation, melena, changes in watering habits and urination, dehydration and weight loss. All the cases studied were having vomiting and anorexia as a common sign in varying degrees and duration. All other signs were present in some animals and absent in others. It was difficult to differentiate reason for underlying diseases in animals with these nonspecific signs and only subtle indications were available. Twelve of the cases presented were treated symptomatically prior to presenting in TVCC, Pookode. In seven cases the line of treatment generally followed was for gastritis, because of the fact that the symptoms were suggestive of gastritis and it was the most common intra abdominal disorder usually encountered.

Physiological parameters of all the animals were almost within normal range, barring a few values and these values were mostly nonspecific. They were

only suggesting presence of some systemic disease. Anaemia was seen in some cases, evident from the pale visible mucous membrane, especially the two space occupying neoplastic conditions encountered in the study. Signs of shock was observed in some cases like the one with gastric perforation. The body temperature of animals were generally within normal range and the animals with closed pyometra was having temperature towards the higher range.

Physical examination of abdomen served as an important tool for diagnosing various underlying abnormalities. Pain on palpation was seen in most of the cases especially those with gastro-intestinal disorders. Visible mass was diagnostic in fibroma and haemangiosarcoma; however, the extent of growth could not be appreciated. Palpable mass was another important feature in some of the conditions like in some cases of foreign body in gastro-intestinal tract and organomegaly. Abdominal distension was seen in some animals due to fluid, gas or organ enlargement. Auscultation could reveal reduced motility in the gastro-intestinal tract disorders.

Elevated total leukocyte count was the most common haematological abnormality encountered and was due to the underlying inflammatory changes and infection in those cases. The sub normal value of erythrocyte count, volume of packed red cells and haemoglobin level were correlating with the anaemic state of haemangiosarcoma, fibroma and ileo-ileo-caeco-colic intussusception.

Serum biochemistry profile was not showing any significant variation enabling any specific diagnosis. Variations in total protein, albumin and ALT were seen in some cases. Creatinine was found to be within normal range in all the animals under study.

In pyloric stenosis, contrast radiographic study with barium meal revealed retention of barium in stomach even after 20 hours and could confirm the condition as delayed gastric emptying. Gastric distension with reduced gastric motility and emptying were the sonographic findings. The pyloric region could not be identified for examination. Constricted and thickened sphincter was observed during diagnostic laparoscopy. The condition was surgically corrected with a Y-U pyloroplasty.

In the radiographs of all the cases with mechanical obstruction of intestine, there was prominent distension of intestinal loops. In the case with nutmeg seed as foreign body, the ratio between maximum diameters of small intestine (SI_{max}) to height of fifth lumbar vertebrae (L5) was 3.02 ($SI_{max}/L5$), which was suggestive of mechanical obstruction. Granular contents in a segment of distended intestine was suggestive of linear foreign body in another case. In case of colonic obstruction a 24h post barium radiograph was showing barium retention towards the descending colon, which was suggestive of an obstruction at this level. Ultrasonography also revealed distension of intestines in such cases. The foreign body could be observed in two cases. In case A4, the foreign body was identified as a hypoechoic structure with an attenuation of beam beyond it, along with non uniform intestinal peristalsis. Plicated intestinal segment as a curvilinear hyperechoic line with attenuation of beam and hypomotility of segments were due to the linear foreign body. In colonic impaction the observations were inconclusive. Diagnostic laparoscopy also showed severely distended intestinal loops. Plicated segment, thickened and congested wall and hard luminal content on probing were seen in linear foreign body and colonic impaction. In all the cases foreign bodies were removed by performing enterotomy.

Survey radiograph of ileo-ileo-caeco-colic intussusception did not reveal much information and contrast study was not performed on that animal. A 'reverse G' sign on transverse view and multiple parallel hyperechoic and hypoechoic lines on sagittal view confirmed the case to be an intussusception, but could not diagnose as double intussusception. In diagnostic laparoscopy the affected segment was observed as a distended and thickened segment of colon with a flaccid caudal end. The neck of the original intussusception was not identifiable through laparoscopy. Hence it was diagnosed as obstruction due to linear foreign body or intussusception. The condition was corrected by enterotomy and entero-anastomosis.

A decreased abdominal detail and free abdominal gas were the major findings of abdominal radiography in gastro-intestinal perforation. Free gas as hyperechoic streaks with acoustic shadow in the abdomen was seen during ultrasonography.

Serosanguineous fluid with scattered gastro-intestinal contents in the abdomen and severe peritonitis could confirm a gastro-intestinal perforation eventhough the site of perforation was not exactly located. Mesentry was ballooned with fluid and contents, which misled the radiographic and sonographic diagnosis. Because of the poor prognosis, animal was euthanized.

An abnormal tissue density between urinary bladder and colon on negative contrast lateral radiography was diagnosed as pyometra in one case. In another case a 'Y' shaped segment with a tissue density towards the caudal abdomen in the lateral survey radiograph, was enough for diagnosing pyometra. Hypoechoic and anechoic contents in the uterus was diagnostic in one case. In the other case uterus could not be identified among the intestinal loops. The uterine horns were thickened and moderately enlarged with palpable semisolid contents in cases of pyometra. The condition was corrected surgically by performing ovariohysterectomy.

In cholangiocellular carcinoma, as the primary presenting sign was ascites, the survey radiograph revealed a ground glass appearance and no further diagnosis was possible. Irregular hypoechoic and anechoic cavitations in the liver and hepatomegaly were observed during ultrasonography. It was not possible to differentiate the type of the tumor and whether it was a primary tumor or a secondary metastasis. The tumor was multilobulated and massive in size on laparoscopic view. Almost all lobes were affected. Metastatic lesions were there in pancreas, spleen and intestinal wall. The extent of tumor was more clearly assessed by laparoscopy. The animal died after two weeks.

In the case of chronic hepatic injury, hepatomegaly was suspected after survey radiography. Diffuse reduction in echogenicity of liver due to hepatic congestion and hyperechoic areas around portal vessels due to periportal fibrosis could be seen during ultrasonography. Laparoscopy revealed sanguineous fluid in the abdominal cavity, perihepatitis, thickened parenchyma and adhesions of liver to abdominal wall. The condition was successfully managed by medical therapy.

Elongated splenic silhouette suggestive of splenomegaly was observed in the lateral survey radiograph in one case. Splenomegaly was evident in

ultrasonography also. Diagnostic laparoscopy clearly diagnosed the condition to be a non-surgical condition. The texture and appearance of spleen was giving an impression of congested splenomegaly. The animal died after one week.

Radiography of space occupying neoplastic conditions, haemangiosarcoma and fibroma could only reveal extension into abdomen and space occupying nature of the tumor. Hepatic involvement was suspected in both the cases. Mixed echogenic lesion with non homogenous echotexture was seen in the sonogram. In both cases, the clear demarcated margin clarified that the masses were not attached to any organ especially to liver. During diagnostic laparoscopy, the actual extent and nature of lesion and size of the mass could be assessed in both cases. Both masses were not continuous with any abdominal organ. Although type of neoplasm was not identified, prediction of prognosis was possible in both cases. Haemangiosarcoma was surgically removed, but the animal died after two days. The case of fibroma was euthanised after one week.

Diagnostic laparoscopy was giving a confirmatory diagnosis according to 75 per cent or more observers in ten of the cases studied. The number for ultrasonography was six and for radiography it was five. On further analysis it could be observed that laparoscopy alone was giving confirmatory diagnosis in two cases (gastric perforation and peritonitis, and fibroma) according to 75 per cent or more observers. The number was two (ileo-ileo-caeco-colic intussusception and foreign body in jejunum) for ultrasonography. All the methods were confirmatory in splenomegaly case according to atleast 75 per cent observers. None of the methods could give confirmatory diagnosis in the case of chronic hepatic injury. Laparoscopy had at least given a doubtful diagnosis in all cases and there was no case in which there was no diagnosis possible. Out of that, there were only two cases in which only 25 per cent respondents felt that laparoscopy was giving a doubtful diagnosis.

Combining 'doubtful diagnosis' and 'not diagnosed' category, 75 per cent or more observers believed that radiography was not giving any diagnostic value in four cases (double intussusception, cholangiocellular carcinoma, chronic

hepatic injury and fibroma) and ultrasonography in three cases (hypertrophic pyloric stenosis, colonic impaction and pyometra).

The result of Wilcoxon Signed Rank Test for testing the perception of individual observer towards each test was clearly showing a lower perception for laparoscopy. However, the result clearly suggested that conducting a diagnostic laparoscopy was neither desirable nor practical according to response of clinicians. Correlating the efficiency and perception scores it was clear that eventhough there was a greater diagnostic value for laparoscopy, it was not a popular choice amongst clinicians.

To conclude,

1. Intra abdominal disorders could affect any abdominal organ and the history, clinical signs, physical examination, physiological parameters, haematology and serum biochemistry often gives subtle information in case of complex conditions.
2. Most cases were treated previously as a case of gastritis or other similar gastro-intestinal disorders, as the clinical signs exhibited by them were misleading.
3. Radiography and ultrasonography are non invasive and easy to perform compared to laparoscopy which was minimally invasive.
4. In the present study, laparoscopy was found to be giving more confirmatory findings in complicated cases. It could be used to take specific, selective and multiple biopsies. A more accurate prediction of prognosis was possible by using laparoscopy.
5. In case of intra-luminal or intra-parenchymal lesions, laparoscopy was found to give only a tentative diagnosis compared to radiography and ultrasonography. Hence, in such cases radiography and ultrasonography should be the choice of diagnostic technique.
6. For extra luminal lesions and neoplastic growths, laparoscopy was the best tool for diagnosis as it helps to assess the extent of growth, collect biopsy specimen and to predict the prognosis.

7. Poor perception was found to be a draw back in recommending usage of laparoscopy by most of the clinicians eventhough they could confirm the diagnostic efficiency of laparoscopy.
8. A comprehensive and complementary approach should be followed while employing advanced diagnostic tools. Results should be interpreted by complementing results of each diagnostic method, other clinical and laboratory test results and presenting clinical signs.

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7. REFERENCES

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**RADIOGRAPHY, ULTRASONOGRAPHY AND LAPAROSCOPY FOR
THE DIAGNOSIS OF INTRA-ABDOMINAL DISORDERS IN DOGS**

PRAMOD U

(15-MVP-017)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF VETERINARY SCIENCE

(Veterinary Surgery and Radiology)

2017

**Faculty of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University**



**DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
POOKODE, WAYANAD – 673 576
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ABSTRACT

Intra-abdominal disorders in dogs are always presented as a diagnostic paradox. The non-specific clinical signs, physiological parameters, physical examinations, haematological and serum biochemistry profile will all provide subtle indications towards the affected organ or system. The present study was undertaken to study the characteristics of radiography, ultrasonography and laparoscopy in diagnosis of these complicated conditions.

The initial clinical studies and examinations revealed non-specific signs in most of the cases studied. In mechanical obstructions of gastro-intestinal tract and parenchymal lesions of organs, radiography and ultrasonography were providing more accurate information. In those cases laparoscopy could arrive at a diagnosis by observing the gross pathological changes. However, the provision for taking selected and multiple biopsies enabled the technique to give a precision diagnosis, superior to the findings of other non-invasive techniques in case of parenchymal lesions of liver. In case of space occupying neoplastic conditions, although radiography and ultrasonography could identify the lesions, the extent of lesion and the prognosis was better evaluated by laparoscopy. The biopsy taken under laparoscopic guidance gave an accurate diagnosis of the type of tumor in both the cases. In case of a generalised organomegaly, all the techniques could give a positive diagnosis. The ability to predict the prognosis was another quality of laparoscopy seen in the present study. In two cases this helped to take a decision to euthanize the patient thereby avoiding further suffering to the animal.

Out of thirteen cases studied, radiography could give confirmatory diagnosis in five and ultrasonography in six conditions as per 75 per cent or more independent observers. However, the number for laparoscopy was far superior, and it could diagnose ten cases positively. The failure rate of laparoscopy was also very low, and there was not a single case where laparoscopy could not provide diagnostically significant information. The radiographic and

ultrasonographic observations showed that, both these techniques could be used as an initial diagnostic tool in any diagnostic protocol. There was a lesser perception of clinicians to use diagnostic laparoscopy as a routine diagnostic method. The technique was having a long learning curve. The minimally invasive nature and time taken for completion of test could all add on to the negative feedback of the technique. Whereas the expertise required for performing ultrasonography was also equally challenging and it was difficult for another observer to read a previously recorded sonograph.

It was observed that for intra-luminal lesions laparoscopy was less efficient compared to other techniques. In extra-luminal and space occupying intra-peritoneal lesions laparoscopy was more effective. Laparoscopy could be routinely used in all the cases which should be subjected for an exploratory laparotomy. The study of three diagnostic methods on various intra-abdominal conditions encountered in the current study had given the impression that in most of the cases the findings of these techniques were complementary to each other. To arrive at a conclusion it is required to perform more than one test.

Research Synopsis

KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY

FACULTY OF VETERINARY & ANIMAL SCIENCES

PROGRAMME OF RESEARCH WORK FOR THESIS OF MASTERS DEGREE

1. Title of thesis:

Radiography, ultrasonography and laparoscopy for the diagnosis of intra-abdominal disorders in dogs

2a. Title of the departmental/KVASU research project of which this forms a part:

Nil

b. Code No. if any, and order by which departmental/KVASU research project is approved:

Not applicable

3a. Name of student:

Pramod U.

b. Admission Number:

15 - MVP – 17

4a. Name of Major Advisor (Guide):

Dr. Syam K. Venugopal

b. Designation:

Professor & Head,
Department of Veterinary Surgery and
Radiology,
College of Veterinary and Animal Sciences,
Pookode, Wayanad - 673 576

5. Objective of the study:

To evaluate the use of radiography, ultrasonography and laparoscopy for the diagnosis of various intra-abdominal disorders in dogs and to suggest most suitable diagnostic test for specific disorders.

6. Practical/Scientific utility:

Intra-abdominal disorders of unknown origin are one of the frequently presented canine clinical problem in any veterinary hospital. Timely diagnosis of these conditions is the key in successful management and treatment of disorders affecting various abdominal organs like liver, spleen, stomach, intestine, kidneys, bladder, uterus and prostate. Conditions other than frank cases of foreign body or luminal obstructions pose difficulty in diagnosis. Various extra luminal space occupying lesions and changes in shape, texture, and location are some of such situations. Various diagnostic tools like radiography, ultrasonography and laparoscopy are being used frequently to diagnose these conditions. However, comparative data on the reliability and efficacy of these three methods for intra-abdominal disorders in dogs are found lacking.

The present study envisages to study the reliability and diagnostic efficiency of

radiography, ultrasonography and laparoscopy for intra-abdominal disorders in dogs. If any relevant variation in efficacy is observed, the diagnostic protocols studied may be categorised as more effective and less effective.

7. Important publications on which the study is based:

Felts *et al.* (1984) stated that, diagnosis of intestinal obstruction was confirmatory by radiography while rarely diagnostic by abdominal palpation

Myers and Penninck (1994) concluded that, ultrasonography is more sensitive than survey radiography in the detection of gastro intestinal smooth muscle tumors.

Richter (2001) stated that laparoscopic techniques had been developed in veterinary medicine for minimally invasive evaluation of several organs, including liver, extrahepatic biliary system, pancreas, kidneys, spleen, bowel and genitourinary tract. Limited abdominal exploration (keyhole) for laparoscope guided organ examinations and excision biopsy is indicated to ascertain a correct diagnosis, specific therapy and accurate prognosis.

Mantis *et al.* (2006) compared ultrasonography, contrast radiography and exploratory surgery in the diagnosis of ectopic ureters in dogs and concluded that ultrasonography was the choice for the evaluation of the uretero-vesicular junctions.

Maiti *et al.* (2008) affirmed that laparoscopy is considered as one of the most promising minimal invasive

diagnostic devices for diagnosis of different intra-peritoneal disorders in different small animal species.

Webb and Trott (2008) concluded that laparoscopy offered a minimally invasive route by which pancreatic biopsies can be obtained. Results of this retrospective study suggested that laparoscopy is a safe and potentially under-utilized diagnostic tool in animals where exocrine pancreatic disease is a prominent differential diagnosis, as in dogs and cats examined for vomiting, anorexia or both.

Sharma *et al.* (2011) compared radiography and ultrasonography and concluded that, both abdominal radiography and abdominal ultrasonography were accurate for diagnosing small-intestinal obstruction in vomiting dogs and either may be used depending on availability and examiner choice. Abdominal ultrasonography had greater accuracy, fewer equivocal results and provided greater diagnostic confidence compared with radiography

8. Outline of the technical programme:

All the cases of suspected canine abdominal disorders, presented to the Teaching Veterinary Clinical Complex, Pookode, will be screened for the study. Among the screened cases, those having a complicated clinical presentation, irrespective of age, sex and breed, will be subjected to radiography and ultrasonography to diagnose the condition. Cases which require further investigation may be subjected to laparoscopic examination also. A minimum of twelve such cases will be included in the study.

All cases will be subjected to plain survey radiography and contrast radiography - in orthogonal views, according to assumptions made after clinical evaluation, to study the morphological features of various abdominal organs - shape, size, location, number, margination and radio opacity.

A detailed trans abdominal ultrasonographic study will be performed separately on all the cases, to evaluate the pathology of various abdominal organs *viz* liver, spleen, stomach, intestine, kidneys, bladder, uterus and prostate.

A diagnostic laparoscopy will be performed on all the cases, to evaluate structural appearance of all the abdominal organs and the cavity as such.

The findings of radiography, ultrasonography and laparoscopy will be correlated with the clinical evaluation to arrive at a final diagnosis. The accuracy of these diagnostic tools will be further confirmed at the time of surgery, in those cases where the condition demands surgical intervention and may be categorised as more effective and less effective.

9. Main items of observations to be made:

1. Detailed physical and clinical examination before application of diagnostic tools
 - a) History
 - b) Examination of abdomen (Visual, palpation, auscultation, percussion)
 - c) Physiological parameters – Heart rate, temperature, rate of respiration, pulse, capillary refill

time and visible mucous membrane.

- d) Haematological parameters – Haemoglobin, packed cell volume (PCV), total leucocyte count (TLC), differential leucocyte count (DLC) and platelet count.
- e) Serum biochemistry – Total protein, albumin, alanine amino transaminase, creatinine, and alkaline phosphatase.

2. Radiographic evaluation of abdominal organs.

- a) Shape
- b) Size
- c) Location
- d) Number
- e) Margination
- f) Radio opacity

3. Ultrasonographic evaluation of abdomen

- a) For abnormal echogenicity of organs
- b) Content evaluation of abdominal cavity

4. Laparoscopic examination

- a) For overall morphology of abdominal organs
- b) Assessing gross changes in general anatomy
- c) Collecting biopsy specimens, depending on the case.

5. Surgical intervention if the condition warrants, and findings during exploration.

6. Response to treatment.

10. Facilities

a. Existing:

Radiographic, ultrasonographic and laparoscopic units existing in the Department of Veterinary Surgery and Radiology and Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Pookode, Wayanad - 673 576

b. Additional facilities required:

Accessories, consumables, kits for serum biochemistry etc.

11. Duration of study

Four semesters

12. Financial estimate

Anaesthetics, antibiotics and other drugs and consumables for laparoscopy	: Rs. 10000.00
Serum kits and other costs involved in lab examination	: Rs. 10000.00
Contingencies	: Rs. 5000.00
Total	: Rs. 25,000.00

Signature of Student:

Signature of Major Advisor:

Place: Pookode

Date: 09.08.2016

Name and signature of members of the Advisory Committee

Chairman

Dr. Syam K. Venugopal

Professor and Head,
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APPENDIX – I

References

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APPENDIX-II

Time frame of work

Semester I

1. Collection of literature
2. Planning of program for research
3. Preparation of synopsis

Semester II

1. Collection of literature
2. Review of literature
3. Procurement of materials
4. Pilot study

Semester III

1. Review of literature
2. Research work

Semester IV


1. Research work
2. Writing of thesis
3. Submission of thesis

CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998).

Place: Pookode

Date: 09.08.2016



Dr. Syam K. Venugopal

Major Advisor

Annexure

ANNEXURE - I

Scoring chart for diagnostic efficiency

Condition	Observation and corresponding score			
	0	1	2	3
Hypertrophic Pyloric stenosis	Not diagnosed	Some gastric related disorder	Gastric outflow disorder	Pyloric stenosis
Linear foreign body obstruction of jejunum	Not diagnosed	Intestinal tract related disorder	Intestinal obstruction	Linear foreign body in intestine
Double intussusception(ileo-ileo-caeco-colic)	Not diagnosed	Intestinal tract related disorder	Intestinal obstruction	Intussusception
Foreign body jejunum (Nutmeg seed)	Not diagnosed	Intestinal tract related disorder	Intestinal obstruction	Foreign body in intestine
Colonic impaction	Not diagnosed	Intestinal tract related disorder	Intestinal obstruction	Colonic impaction
Gastric perforation and peritonitis	Not diagnosed	Suspecting fluid and gas in abdomen	Confirmed presence of fluid and gas in abdomen	Perforation of gastro-intestinal tract and peritonitis
Pyometra	Not diagnosed	Doubtful, uterus not clearly identified	Uterus seen, not sure about distension and contents	Distended uterine horns with contents not of foetal origin
Pyometra	Not diagnosed	Doubtful, uterus not clearly identified	Uterus seen, not sure about distension and contents	Distended uterine horns with contents not of foetal origin
Cholangiocellular carcinoma	Not diagnosed	Liver suspected as organ affected	Abnormal liver, might be neoplasia	Neoplastic liver
Chronic hepatic injury	Not diagnosed	Liver suspected as organ affected	Abnormal liver with some lesions	Chronic hepatic injury
Splenomegaly	Not diagnosed	Spleen suspected to be the organ affected	Abnormal spleen, splenomegaly suspected	Splenomegaly
Haemangiosarcoma	Not diagnosed	Tumor without any information on origin and extend	Extend some what clear. Proximity to liver, not sure about attachments	Extend clear. Not attached to liver or any other abdominal organs
Fibroma	Not diagnosed	Tumor without any information on origin and extend	Extend some what clear. Proximity to liver, not sure about attachments	Extend clear. Not attached to liver or any other abdominal organs

ANNEXURE - II

Scoring chart for observer's perception on diagnostic method

Factor	R	U	L
Ease of performing the test			
Expertise required to perform the test			
Expertise required to read the result			
Time taken for completion			
Owner compliance			
First choice of clinicians			
Risk while performing			
Requirement of patient control/anaesthesia			
Pre operative patient preparation			
Cost of installation			
Cost of resources per test			
Dependence on animal condition			
Arrangements required			

Scoring

1 – Least favourable score

2 – Intermediate score

3 – Most favourable score

R – Radiography

U – Ultrasonography

L – Laparoscopy

CURRICULUM VITAE

Name of Candidate : PRAMOD U.
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Abstracts : 01

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- Indian Society for Veterinary Surgery - 2016

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