Surgical exploration and management of intra-abdominal physical obstruction of the gastrointestinal tract in cattle through left ventrolateral oblique laparotomy approach

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CERTIFICATE-I

This is to certify that the thesis entitled "**SURGICAL EXPLORATION AND MANAGEMENT OF INTRA-ABDOMINAL PHYSICAL OBSTRUCTION OF THE GASTROINTESTINAL TRACT IN CATTLE THROUGH LEFT VENTROLATERAL OBLIQUE LAPAROTOMY APPROACH**" submitted in partial fulfillment of the requirements for the award of the degree of **Master of Veterinary Science** in the subject of Veterinary Surgery and Radiology of the Orissa University of Agriculture and Technology, Bhubaneswar is an authentic record of bona fide research work carried out by **Balakrushna Dwibedy** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the evidence and help obtained by him from various sources during the course of investigation has been duly acknowledged.

30/06/2015

(Dr. Sadananda Nayak)
CHAIRMAN,
ADVISORY COMMITTEE

CERTIFICATE-II

This is to certify that the thesis entitled **"Surgical exploration and management of intra-abdominal physical obstruction of the gastrointestinal tract in cattle through left ventrolateral oblique laparotomy approach"** submitted by **Balakrushna Dwibedy** to Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfillment of the requirements for the degree of **MASTER OF VETERINARY SCIENCE (VETERINARY SURGERY AND RADIOLOGY)** has been approved/disapproved by the student's Advisory committee and the External Examiner.

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ABBREVIATIONS USED

5-HTR	5-Hydroxy Tryptamine Receptor
AV	Abomasal Volvulus
bpm	beats per minute
CBC	Complete Blood Count
CDD	Cecal Dilatation and Displacement
CT	Computed Tomography
DA	Displacement of Abomasum
DNS	Dextrose Normal Saline
EDNRB	Endothelin Receptor Type B
ELSC	External Loop of Spiral Colon
ENS	Enteric Nervous System
et al.	and others
^{0}F	Degree farenheit
GI	Gastrointestinal
HMIS	Horizontal Mattress Interrupted Sutures
IM	Intramuscular
IV	Intravenous
kVp	KiloVolt potential
LDA	Left Displacement of Abomasum
mAs	milli-Ampere-second
mEq/L	milli equivalent per Liter
mmol/L	milli moles per Liter
mRNA	Messenger RiboNucleic Acid
NS	Nromal Saline
NSAID	Non Steroidal Anti Inflammatory Drugs
PCV	Packed Cell Volume
PLAC	Proximal Loop of Ascending Colon
RDA	Right Displacement of Abomasum
SC	Subcutaneous
SSIS	Sero-Submoucosal Interrupted Sutures
TLC	Total Leucocyt Count
TRP	Traumatic Reticulo Peritonitis
TVFA	Total Volatile Fatty Acids
VFA	Volatile Fatty Acid

ABSTRACT

Sixteen presented undiagnosed clinical cases of gastrointestinal obstruction in cattle were selected for this study, and a left ventrolateral oblique laparotomy approach under regional anesthesia was evaluated for its effectiveness in exploratory diagnosis and surgical treatment. Rumenotomy and ruminal exploration was done after exteriorizing the dorsal sac. Any obstruction diagnosed was relieved. The rumen was then closed and the rest of the gastrointestinal tract explored for any obstruction which was also attempted for correction.

In all the 16 cases an exploratory diagnosis was possible and the diagnostic efficiency of this approach was found to be 100%. The animals were divided into 2 groups by the following criteria. Group I included 10 animals in which the diagnosed surgical condition was easily accessed and corrected. Complete obstruction of the reticulo-omasal orifice with a large phytobezoar (n=1), omasal impaction (n=2), ruminoreticular foreign bodies (n=2), traumatic reticulitis (n=2) and concurrent omasal impaction and rumenoreticular foreign bodies (n=3) were diagnosed. The phytobezoar and foreign bodies were removed manually or by magnet swapping and omasal impaction was treated by omasal flushing.

Group II included 6 animals in which the diagnosed surgical condition was approached and treated with “some difficulty” or could not be corrected. Conditions like cecal dilation and displacement (n=2), intestinal volvulus (n=1), obstruction of the abomasum with phytobezoars (n=1) and diaphragmatic hernia (n=2) were diagnosed. One case of cecal dilatation was treated by typhlotomy, intestinal volvulus by resection and anastomosis and abomasal obstruction by abomasotomy. Another case of cecal dilation needed total typhlectomy which was done by right flank approach as the ileocecocolic junction was not approachable from this site. Diaphragmatic herniorrhaphy by a second operation was declined by the owners in both cases. Out of the 14 animals treated, 3 died and 11 animals recovered giving a postoperative survival rate of 78.6%.

Hematobiochemical parameters were extremely helpful in guiding post-operative fluid, electrolyte and drug therapy but provided limited diagnostic information in this study.

During systematic exploration, the approachability of different parts of the gastrointestinal system was studied. The forestomachs were easily accessible; jejunum and $2/3^{rd}$ of the cecum were exteriorizable. The descending duodenum up to its caudal flexure, distal loop of colon and transverse colon were neither palpable nor exteriorizable. The remaining portions of the small and large intestines were palpable but not exteriorizable.

Based on the palpability and exteriorizability of different parts of the gastro-intestinal tract, the exploratory diagnosis obtained in 100% cases under study and occurrence of common obstructions, a left ventro-lateral oblique laparotomy approach was found to be effective for exploration and surgical correction of physical obstructions of the GI tract commonly occurring in cattle when a definitive preoperative diagnosis is not possible.

CHAPTER-I

INTRODUCTION

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INTRODUCTION

In general large animal practice, gastrointestinal diseases constitute the largest group of clinical problems encountered in cattle. Among the variety of alimentary diseases encountered, the common clinical symptoms reported are scanty or total absence of fecal output, complete or partial anorexia, and varying degrees of abdominal distension with or without abdominal pain.

These conditions pose a significant diagnostic challenge to the veterinarian under field conditions with limited diagnostic facilities. There are a multitude of diseases that can lead to scanty or absent fecal output and associated symptoms where a definitive diagnosis is not always possible.

Surgical conditions of the forestomachs like impaction, obstruction of the reticulo omasal orifice, ruminoreticular foreign bodies or displacement of abomasum can exhibit these symptoms. The same symptoms are also manifested by obstructive diseases of the small and large intestines: volvulus, intussusception, strangulation, cecal affections, extraluminal (tumours) or intraluminal obstructions (bezoars). Internal hernias (gut tie, diaphragmatic or omental hernias), although rarely found, can give rise to similar symptoms. Functional obstructions of the gastrointestinal system (vagal indigestion, paralytic ileus) also mimic the same symptoms and need to be carefully distinguished from the physical conditions.

Different distention patterns of bovine abdomen (left or right side distension, upper or lower quadrant distension) may give a rough idea of the organ involved, but further tests are required to find the exact location of the lesion. Simultaneous auscultation and percussion can give valuable clues. A ping on the left side indicates left abomasal displacement, rumen collapse or tympany; but the same on the right side can be due to right displacement of abomasum, cecal dialation and torsion, duodenal or intestinal affections. Hypermotility of rumen with L-shaped distension and scanty fecal output inidicates vagal indigestion, and absence of borborygmus is indicative of paralytic ileus. Though palpation and percussion are valuable tools they cannot always lead conclusively to a clear diagnostic picture.

Rectal palpation is a routine diagnostic tool in cattle and is widely practiced by all large animal clinicians. It can detect the diseases of caudal large intestine and sometimes intestinal intussusception. However the cranial parts of the gastrointestinal system and even the cecum when affected with retroflexion are beyond the reach of trans-rectal palpation.

Obstruction of the intestines leads to profound dehydration. Sequestration of gastric acids in the intestines causes hypochloremic and hypokalemic alkalosis. Obstruction of higher intestine can lead to reflux of abomasal contents in to the rumen and there is consequent rise in ruminal acidity and chloride content. Change on ruminal pH and chloride is also dependant on several dietary factors. Estimation of serum electrolytes, ruminal pH and chloride content can give a general picture of animal's metabolic and acid base status and can form a useful basis for resuscitation, monitoring and prognostic evaluation rather than diagnosis of the nature and location of obstruction.

Ultrasonography can diagnose most of the abdominal conditions and is a revolutionary imaging tool in the field of veterinary medicine. Radiography also serves a useful purpose in diagnosing some of the abdominal conditions in cattle. Unfortunately, neither of these expensive tools was available for this study.

Successful treatment of GI obstruction in cattle requires an accurate diagnosis. In the absence of USG and radiography, the other traditional methods of diagnosis are to be followed. Functional causes of obstruction are to be carefully differentiated from the physical ones. A physical cause of obstruction if diagnosed specifically can be treated by a definitive surgical approach. For example a case of cecal dilation and torsion requires a right flank laparotomy, and for rumenoreticular foreign bodies a standing left flank laparotomy approach has been recommended.

In the absence of a confirmed diagnosis, abdominal exploration has been used extensively and a right flank approach is commonly employed. However, if during a right flank exploration the surgeon learns that omasal impaction is the cause of obstruction it has to be approached form a rumenotomy incision through the left flank. In the standing left flank approach for rumenotomy, exploration of the right side of the abdomen is not possible.

Hence, to deal with undiagnosed cases of GI obstruction in cattle an alternate novel laparotomy incision is required through which the forestomachs can be surgically approached and exploration of the right side of the abdomen can be done. In addition this approach can facilitate surgical handling of some obstructive conditions. Therefore, a left ventrolateral oblique incision is employed for the purpose of this study with the following objectives.

1. To study the usefulness of a left ventrolateral oblique laparotomy approach in the exploration and surgical management of GI obstruction in cattle.
2. To study the approachability of the organs commonly affected with physical obstruction through this approach.
3. To devise a plan for systematic exploration, detection and surgical correction of the obstruction.
4. Management of multiple causes of obstruction through a common laparotomy approach.

CHAPTER-II

REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

Diseases of the digestive system of cattle are frequently encountered in day to day field practice. For effective diagnosis, considerable effort and diligent clinical examination should be made that can only lead to formulation of effective therapeutic strategy. Therefore a thorough understanding of all the disease processes of the gastrointestinal system is required.

Singh *et al.* (1993) have stated that surgical diseases of the digestive tract in ruminants are numerous and represent a major clinical problem, and abdominal surgery generally constitutes the single largest group of operations carried out in ruminants.

Gelberg (2007) has mentioned that the herbivores have a complex alimentary system containing fermentation chambers (either a rumen or expanded cecum); consequently they are at the added risk of suffering from many clinically important gastrointestinal disturbances not common to other species. Hence a large part of the practice of veterinary medicine is devoted to the diagnosis and treatment of alimentary disorders.

Thomas (2009) has reasoned that as the cattle have a unique digestive system that makes them more efficient at digesting a wide variety of feeds, it is vulnerable to a great number of digestive problems; all these conditions can cause discomfort, ill health and, in some cases, death if not discovered and treated in time.

2.1. INCIDENCE AND ETIOLOGY

2.1.1. Physical obstruction

2.1.1.1. Impaction of Rumen

Singh *et al.* (1993) have indicated primary ruminal impaction to occur in cattle and buffaloes mostly with depraved appetite as they eat plastics, ropes, or leather pieces that make large tight balls inside the rumen due to churning movement. Fubini and Ducharme (2004) have attributed disorders of fore stomachs in adult cattle to a variety of causes, including those that are dietary, inflammatory, and/or mechanical. Smith (2015) states that curious ruminants sometimes consume plastic bags, discarded rectal palpation sleeves and other non degradable materials that accumulates in the rumen to cause obstruction.

2.1.1.2. Traumatic reticulo-peritonitis (TRP)

As per Singh *et al.* (1993), indiscriminate feeding habits and depraved appetite in cattle and buffaloes lead to ingestion of foreign bodies which can be potential or non potential. Potential foreign bodies (sharp metals) may cause traumatic reticulo-peritonitis, traumatic pericariditis, vagal indigestion, pyothorax, abscessation of the liver and spleen, diaphragmatic hernia or traumatic pneumonia. Non potential foreign bodies (blunt metals) can lie or be passed out harmlessly through the feces.

Fubini and Ducharme (2004) in agreement with Singh *et al.* (1993) have described a similar etiology for TRP and further stated that 70% of the foreign bodies are wire, 30% are nails or steel objects; but bezoars, plastic bags or placenta constitute only a minor proportion. As per the observations of Radostits *et al.* (2007), TRP is caused by penetration of the reticulum by metallic foreign objects ingested in prepared feed; hence the disease is almost unknown in cattle maintained entirely on pasture.

Divers and Peek (2008) have indicated that TPP is one of the oldest diseases recognized in cattle but still occurs with alarming frequency under modern management; ingested metallic objects drop into the rumen, and within 24 to 48 hours are propelled into the reticulum where they remain because of gravity or entanglement with the reticular mucosa.

Smith (2015) states that traumatic reticuloperitonitis or hardware disease is the common cause of anterior abdominal pain in cattle, and has identified three distinct consequences of TRP: penetration of reticular wall only with intramural inflammation, penetration into the peritoneal cavity causing localized peritonitis, or migration into the peritoneal or thoracic cavities causing more severe disease.

2.1.1.3. Traumatic pericarditis

Radostits *et al.* (2007) attributed traumatic pericarditis to migrating metal foreign bodies from the reticulum and observed approximately 8% cases of TRP to develop pericarditis with increasing incidence in the peripartum period; most of the cases die or suffer from chronic pericarditis and do not return to completely normal health.

2.1.1.4. Omasal impaction

Singh *et al.* (1993) has reported that omasal impaction occurs in cattle and bufflaoes mostly secondary to rumen impaction and is a result of poor quality feed as the omasum gets distended with stagnation of ingesta. Radostits *et al.* (2007) are of the opinion that omasal impaction as a clinical entity is difficult to define and is usually diagnosed at necropsy when the omasum is enlarged and excessively firm and reputed to occur under drought feeding conditions especially when feed is tough and fibrous.

Hussain *et al.* (2013) in their study observed the prevalence of primary omasal impaction to be 4.10% and attributed the cause to feeding of dry, finely machine-chopped straw during dry season with water deprivation, high fibre and low TDP content of the straw and contamination of straw with soil particles in all animals.

2.1.1.5. Abomasal impaction

Ashcroft (1983) in 75 cases of abomasal impaction found 60% cases to be dietary in origin and 20% cases to be associated with TRP; but the rest 20% did not fit into either category. Radostits *et al.* (2007) reasoned that the consumption of excessive quantities of poor-quality roughage low in digestible protein and energy, ingestion of dirty or sandy root crops or feeding hay on sandy soils were the primary causes of abomasal impaction.

Erickson and Hendrick (2011) recorded an outbreak of sand impaction in a herd of beef cattle fed silage contaminated with soil and mentioned abomasal impactions to occur infrequently and sand impaction to be extremely rare in cattle. Smith (2015) opines that abomasal impaction can be primary or secondary resulting in failure of aboral transport of ingesta and further maintains that calves on low-quality milk replacers may be impacted by eating bedding, indigestible objects or trichobezoars and adult animals on low-fiber diets by consuming wood or baling twine.

2.1.1.6. Abomasal displacement

Singh *et al.* (1993) has emphasized that abomasal displacement is of common occurrence in countries where feed consists of more of grains and concentrates than roughage but the incidence in India and other tropical countries is very low probably due to a high roughage based diet. As abomasum is a wandering organ due to its loose attachments, it can displace easily to the left or right or rotate on its mesenteric axis resulting in abomasal volvulus (AV).

Fubini and Ducharme (2004) has observed that all of the abomasal displacement syndromes occur more commonly in high-producing dairy cows but also appear sporadically in calves, dairy bulls, and beef cattle; and has added that abomasal displacement to the left is most common representing 85% to 96% of all displacements.

Radostits *et al.* (2007) has indicated that the cause of abomasal displacement in cattle is multifactorial but related primarily to feed intake before and after calving. Decreased ruminal fill associated with anorexia, reduced forage to concentrate ratio and increased incidence of other postpartum diseases causing abomasal atony predisposes to abomasal displacement.

As observed by Divers and Peek (2008), abomasal displacements (DA) are the most commonly detected abdominal disorder attempted for surgical correction in dairy cattle in western countries and left displacements (LDA) are fairly common than right displacements (RDA). Smith (2015) emphasizes that abomasal hypomotility due to ketosis, low serum calcium, hyperinsulinemia, and reduced insulin sensitivity is the single most important factor predisposing to displacement.

2.1.1.7. Abomasal volvulus

Divers and Peek (2008) have suggested that AV develops following RDA, but it does not follow in all cases of RDA and cases of AV have acute (24 to 48 hours) onset and progression of illness. Smith (2015) believes that abomasal volvulus or right torsion of the abomasum, occurs in all classes of cattle leading to complete obstruction of the flow of ingesta into the duodenum and is therefore a surgical emergency.

2.1.1.8. Duodenal Obstruction

Van der Velden (1983) described a syndrome of functional duodenal outflow obstruction in eighteen cases and opined that the condition resulted from disturbance in normal retrograde motility patterns that originated at the sigmoid flexure. Garry *et al.* (1988a) have said that mechanical obstructions of the duodenum are very rare and mostly the consequence of either phytobezoars or blood clots from intestinal ulcer. Braun *et al.* (1993) observed duodenal ileus to result from adhesions of duodenum to the liver due to hepatic abscesses. Koller *et al.* (2001) recorded rare cases of ileus in two Swiss Braunvieh cows in late pregnancy due to strangulation of the duodenum at its caudal flexure by the gravid uterus.

Boerboom *et al.* (2003) supported the finding of Braun *et al.* (1993) by reporting an unusual case of duodenal obstruction caused by malposition of the gallbladder in a heifer. Fubini and Ducharme (2004) identified sporadic cases of duodenal outflow obstruction caused by inflammation of the duodenum resulting from ulcers, penetrating foreign bodies, intra- or extra-luminal masses or adhesions in the vicinity of sigmoid flexure. Radostits *et al.* (2007) postulated that fiber-balls or phytobezoars leading to duodenal obstruction might be common in areas where fibrous feeds form a large part of the diet.

Braun *et al.* (2011), while reporting a rare case of duodenal ileus in a cow with calf feeding nipple, implicated that mechanical duodenal ileus could be caused by phytobezoars, trichobezoars (usually in calves), sand, gravel or blood clots; and mechanical compression due to omental abscesses, hepatic abscesses, gravid uterine horns or lymphosarcoma. Vogel *et al.* (2012), describing a new syndrome causing ileus of the duodenal sigmoid flexure in Holstein cattle, presumed that the etiology and pathophysiology of the condition were not clear but ascribed a potential role to duodenal ulcers or previous omentopexy.

2.1.1.9. Intestinal obstruction

Singh *et al.* (1993) have observed that obstruction of the intestine in ruminants is sporadic and infrequent, and caused by any mechanical or functional interference with progression of the intestinal contents. Of all the causes of intestinal obstruction in cattle, intussuception appears to be the most common followed by mesenteric torsion and paralytic ileus.

Fubini and Ducharme (2004) have emphasized that obstructive lesions of the small intestine are not common but still seen on a regular basis and the cause is not always apparent. Intussusception has been associated with viral enteritis, alteration of diet and a nidus such as a small polyp or nodule that causes aberrant intestinal motility. The most common location of small intestinal obstruction in the adult cow is the distal jejunum and ileum, which results in ileus and sequestration of fluids in the upper gastrointestinal tract.

Divers and Peek (2008) have stated that mechanical obstructive diseases of the small intestine are not as common as fore-stomach and abomasal disorders, but they occur regularly enough to warrant concern in the differential diagnosis of abdominal distention in cattle.

Smith (2015) has opined that functional obstructions (pseudoobstruction or ileus) are the consequence of neuromuscular perturbations of the gastrointestinal tract where as mechanical obstructions are the consequence of physical obstruction of the intestinal tract secondary to digestive tract lesions (intussusception, volvulus, or congenital lesions) or extradigestive lesions (mesenteric fat necrosis, fibrous adhesions, or hernia).

2.1.1.10. Intussusception

Horne (1991) recognized four types of intussusception in cattle: enteric type, ileocecocolic type, cecocolic type, and colonic type. The enteric type or jejunojejunal intussusception involving the distal third is more common in cattle due to the length and mobility of the jejunal mesenteric attachments. However in calves, the incidence of intussusception is more uniformly distributed among the four types.

Strand *et al.* (1993) described intussusception of the colon into spiral colon in an adult bull where a polyps in the mucosa dragged a section of the colon into an invagination.

Constable *et al.* (1997) in a retrospective study of 336 cases of intussusception found no sex or seasonal predilection and the common locations were the small intestine (84%), followed by colocolic (11%), cecocolic (3%) and ileocolic (2%). Calves of 1 to 2 months age were at greater risk for developing intussusception, and intussusceptions distal to the ileum were more commonly found in calves.

Dharmaceelan *et al.* (2008) reported jeujuno-jejunal intussusception and its successful surgical management in two Kangeyam bullocks and opined that bowel inflammation or drinking of very cold water leading to hyper peristalsis and mechanical causes were the common predisposing factors for intussusceptions.

Pravettoni *et al.* (2009) recorded a case of recurrent jejuno-jejunal intussusception in a 75-day-old female Brown Swiss calf and identified widespread myenteric ganglionitis as the inciting cause.

2.1.1.11. Intestinal volvulus

Anderson *et al.* (1993) have reported that volvulus of the small intestine is rare and sporadic in cattle and there may be a decreased risk in cattle over 7 years of age compared to calves below 2 months of age. Singh *et al.* (1993) have described intestinal volvulus as axial rotation of the mesentery and attached small intestine that occurs sporadically in cattle reportedly following rolling to correct uterine torsion or abomasal displacement.

In the opinion of Fubini and Ducharme (2004), the distal jejunum and ileum are prone to volvulus due to long mesentery and greater mobility and ileus may predispose to the condition. Anderson and Ewoldt (2005) have suggested that volvulus of the large and small intestine around the mesenteric root leads to severe colic and relatively rapid abdominal enlargement.

2.1.1.12. Cecal dilation and torsion

Singh *et al.* (1993) have observed that dilation and torsion of the cecum involves its distension, displacement and torsion which is common in dairy cattle following parturition. Green and Husband (1996) have successfully treated a cow affected with cecal volvulus and implicated high grain feeding as the inciting cause.

Fubini and Ducharme (2004) have postulated hat diets excessively rich in rumen-resistant starch lead to increased carbohydrate fermentation in the large intestine and consequent increase in VFA production leading to development of spontaneous cecal dilatation and dislocation (CDD).

Engel *et al.* (2006) identified significantly lower concentrations of mRNA coding for 5-HTR_{1B} (5-hydroxy tryptamine receptor-1B), 5-HT_{2B}, and 5-HTR_4 in the intestines of cows with CDD (cecal dilation and displacement) than in the intestines of healthy dairy cows, especially for 5-HT_{2B} and 5-HTR_4 in the ELSC (external loop of spiral colon) which suggested that serotonergic mechanisms were involved in the pathogenesis of CDD. Mesaric and Modic (2007) have reported a case of dilation and torsion of the caecum in a cow caused by a trichobezoar in a 7-year-old 8 month pregnant Brown Swiss cow.

Divers and Peek (2008) have explained that volatile fatty acid production under high grain feeding, hypocalcemia, endotoxemia secondary to metritis or mastitis, or indigestion that result in gastrointestinal ileus predispose to cecal dilatation which is common in early lactation.

Braun *et al.* (2012) in a study of 461 cases of cecal affections diagnosed cecal dilation in 291 animals (63.2%), cecal dilation and retroflexion in 94 animals (20.4%), cecal dilation and torsion in 20 animals (4.3%); but in the remaining 56 animals no diagnosis could be made. Garrett and Singh (2012) reported a rare case of a colon-associated cystic mass firmly attached to the proximal loop of the ascending colon in conjunction with cecal dilatation in a 7-year-old Holstein cow.

2.1.1.13. Colonic obstruction

Divers and Peek (2008) presumed that regional inflammation resulting in adhesions, space-occupying masses, intra-peritoneal injections through the right paralumbar fossa or adhesions from previous surgery through right flank could result in partial or complete colonic obstruction which was rare and sporadic in dairy cattle.

2.1.1.14. Internal hernia

Ducharme *et al.* (1982), while reporting a case of intestinal entrapment in a rent of the falciform ligament of a cow, indicated that 26% of cows examined at slaughter had a persistent round or falciform ligament, and believed that tears in the falciform ligament leading to intestinal entrapment could be among the most common causes of the relatively rare problem of intestinal incarceration in cattle.

Fubini and Ducharme (2004) have postulated that persistent vitello-umbilical band that runs from the ileum to the umbilicus, persistent round ligament of the liver that runs from the liver to the umbilicus, urachal remnant traveling from the urinary bladder to the umbilicus, paraovarian bands that run from the ovary or broad ligament to the omentum, remnants of the ductus deferens in steers, or a mesenteric rent may lead to entrapment and obstruction of small bowel.

Armstrong *et al.* (2007) have mentioned that internal hernias are uncommon cases of acute intestinal obstruction when a viscus protrudes through an intraperitoneal orifice but remain within the peritoneal cavity. The orifice may be normal (epiploic or omental/winslow's foramen), paranormal (paraduodenal or retrocaecal peritoneal fossa acting as a trap for the bowel), or abnormal (a pathologic transomental hole).

Muggli *et al.* (2014) reported a rare case of simultaneous herniation of the gravid uterus through a mesoduodenal defect as well as internal herniation of the small and large intestines in the omental bursa of a 3 year old, 5 month pregnant Swiss Braunvieh cow without incarceration or strangulation of the intestines.

Gut tie

Radostits *et al.* (2007) have reported that spermatic cord after open castration may recoil through the inguinal ring and become entangled around small intestine, or traction of the spermatic cord may tear the peritoneal fold of the ductus deferens permitting loops of intestine to pass through resulting in obstruction and incarceration.

Diaphragmatic hernia

Singh *et al.* (2006) have indicated that diaphragmatic hernia is common in adult milch buffaloes around parturition and has also been infrequently reported in cows and buffalo bulls. The main causes are progressive weakening of the diaphragm adjacent to a hardware perforation and increased intra-abdominal pressure for any rason. Higher prevalence in buffaloes may be attributed to the lesser collagen content, elasticity and vascularity of diaphragm in this species.

Smith (2015) states that defects in the diaphragm of cattle are uncommon which may be congenital, or acquired. Local inflammatory process (TRP), sudden external trauma (fighting, hanging up on a fence) or internal pressure (parturition, acute tympany) may cause diaphragmatic hernia through which the reticulum usually herniates but other abdominal organs may also be involved if the rent is large.

2.1.2. Congenital causes of physical obstruction

Barker and Van Dreumel (1993) has given a detailed description of the different congenital abnormalities of the GI tract found in cattle and has observed that segmental congenital anomalies may be stenotic with partial obstruction or atretic with complete obliteration of lumen (atresia ani, atresia recti, atresia coli, atresia ilei, atresia jejuni). Rectal palpation of the amniotic vesicle for early pregnancy diagnosis (<42 days of gestation) and a hereditary involvement have been implicated in the etiopathogenesis.

Forzán and McClure *et al.* (2005) diagnosed the first case of colorectal aganglionosis with megacolon (similar to human Hirschsprung's disease and equine 'lethal white foal syndrome') in a 3-day-old Holstein calf and observed a histologic lack of submucosal and myenteric ganglia of the enteric nervous system (ENS). They identified the disease to be inherited and the result of mutations in the genes encoding for endothelin receptor type B (EDNRB) or EDNRB ligand endothelin 3 (ET-3).

2.1.3. Miscelleneous causes of physical obstruction

Neoplasia

Bertone (1990) have mentioned that though intestinal tumors are rare in cattle, adenocarcinoma, lymphosarcoma, adenoma, adenomatous polyps, leiomyoma, leiomyosarcoma and fibrosarcoma have been reported.

Fubini and Ducharme (2004) indicated that neoplasia could affect vagal innervation by infiltration leading to functional or mechanical obstruction of the abomasum and further insisted that neoplasia could cause extraluminal intestinal obstruction affecting any part of gastrointestinal tract.

Divers and Peek (2008) suggested that the abomasum was one of the favorite targets for multicentric lymphosarcoma in cattle which may invade the wall of the abomasum or the pyloric region resulting in an outflow disturbance. Sasaki *et al.* (2012) reported a case of abomasal ulcer caused by yolk sac tumor in a 2-month-old male Holstein calf showing clinical signs of melena, abdominal bloating and pain.

Fat Necrosis

El-Sebaie and El-Amrousi (1995) observed that mesenteric fat necrosis affected cattle of all breeds leading to intestinal obstruction and implicated dietary factors such as consumption of feed containing saturated long chain fatty acids, trace element deficiency and hormonal disturbances as predisposing factors.

Fubini and Ducharme (2004) have reported that fat necrosis or lipomatosis encroach on the intestinal lumen, especially in older over conditioned animals leading to a very insidious onset of disease with decreased amounts of loose manure, abdominal distention and mild colic.

Reproductive lesions

Divers and Peek (2008) said that adhesions of the small intestine secondary to puncture of the dorsal cranial vagina by infusion pipettes and the ensuing chemical or bacterial peritonitis could result in partial or full intestinal obstruction.

Phytobezoars, trichobezoars and placenta

Radostits *et al.* (2007) have opined that obstruction by trichobezoars is more common in cold climates where cattle confined outside have long shaggy hair coats, and licking themselves or other herd mates leads to ingestion of hair that forms hairballs causing obstruction of the gastrointestinal tract.

Tschuor *et al.* (2010) described a case of LDA and concurrent pyloric obstruction due to a phytobezoar in a 4.5-year-old Holstein-Friesian cow. Smith (2015) has implicated that trichobezoars are common in calves maintained on a low-roughage diet which leads to constant licking of hair coats, and added that ingestion of the placenta occasionally results in obstruction in adult cows.

Torsion of the Mesenteric Root

Simkins (1998), describing a case of mesenteric torsion in a mature cow which recovered following surgery, insisted that torsion of the mesenteric root was most common in calves and young cattle and that the colon and the intestines might be dilated before torsion could develop.

Fubini and Ducharme (2004) have described torsion of the mesenteric root as a dramatic illness because so much of the bowel is involved in the twist and has been reported rarely after casting and rolling a cow for surgery.

Intra-abdominal and retro-peritoneal abscesses

Fubini and Ducharme (2004) have postulated that cattle can have intra-abdominal abscesses associated with the reticulum, liver, omentum, or uterus, or retroperitoneal abscesses secondary to intra-abdominal medication, surgical intervention, or pyelonephritis that may cause obstruction of the GI tract.

Radostits *et al.* (2007) stated that a blood clot from a manually expressed corpus luteum on an ovary or traumatic duodenitis caused by migration of a metallic foreign body might cause obstruction of the adjacent bowel segment.

Omental bursitis

Fubini and Ducharme (2004) said that a perforating ulcer on the medial wall of the abomasum along the lesser curvature, perforation of the ventral wall of the rumen or reticulum by a foreign body, necrotic rumenitis secondary to a bacterial or mycotic infection could result in spillage of ingesta into the omental bursa resulting in omental bursitis. Radostits *et al.* (2007) have attributed similar reasons to omental bursitis.

2.1.4. Functional obstruction

Vagus indigestion

As per the opinion of Stockhofe-Zurwieden *et al.* (1992), vagal indigestion syndrome (Hoflund syndrome) comprises a group of motor disturbances that hinder passage of ingesta from the reticulorumen or abomasum or both. The pathogenesis of the disease has yet to be completely clarified because many investigations have yielded conflicting information.

Sattler *et al.* (2000), in a retrospective and prospective study on cases of right displacement of abomasum and volvulus, observed that vagus indigestion was a delayed fatal outcome after the surgical correction of RDA/AV in most cases and ascribed it to four factors: vagus nerve damage, overstretching of the abomasal wall with neuromuscular junction alterations, abomasal necrosis and peritonitis.

Fubini and Ducharme (2004) have implicated that the vagus nerve can be damaged or inflamed in areas other than the abdomen (including the pharynx, larynx, esophagus, and thoracic cavity), so a disease process near the vagal nerve in any of these locations can result in ruminal dysfunction and is termed vagal indigestion. Divers and Peek (2008) in agreement with Fubini and Ducharme (2004) explained that the vagus nerve might be damaged anywhere along its anatomic course from brainstem to the forestomachs.

Paralytic Ileus

Smith (2015) has stated that failure to pass feces is usually a sign of intestinal obstruction, but lack of peristalsis of the gastrointestinal tract mimics complete intestinal obstruction and is called ileus or pseudo-obstruction of the intestinal tract.

Peritonitis

Fubini and Ducharme (2004) have mentioned that peritonitis may be due to infectious or non infectious causes. Non infectious causes are mechanical trauma during surgery, chemical irritation by urine or bile, or caustic lavage solutions where as infectious causes are rupture of intestines, infection associated with *Chlamydia* *psittaci* and *Haemophilus spp.* Smith (2015) presumes that peritonitis remains a frustrating disease for all food animal clinicians.

2.2. CLINICAL SIGNS AND SYMPTOMS

Barker and Van Dreumel (1993) emphasize that in congenital defects of the GI tract in cattle, clinical signs usually become evident within a few days after birth. Affected neonates show depression and mild colic and progress to cardiovascular collapse after the intestine proximal to the obstruction becomes distended with fluid and gas.

Koller *et al.* (2001) reported cases of duodenal ileus due to gravid uterus in two pregnant Swiss Braunvieh cows with signs of mild colic, anorexia, moderately disturbed general condition, prolonged capillary refill time, increased heart rate, intermittent arrhythmia, markedly reduced ruminal activity, no gastrointestinal activity and no faeces passed for 12 hours.

Cockcroft and Jackson (2004) have indicated that in LDA milk yield and appetite are depressed in affected cases and concurrent conditions such as mastitis, endometritis, or primary ketosis should always be ruled out. Fubini and Ducharme (2004) have described omental bursitis as an uncommon clinical condition in which the affected cattle show vague signs of a chronic illness, decreased appetite, scant manure, and depressed milk production.

Engel *et al.* (2006) have stated that cecal dilation and displacement (CDD) is characterized by reductions in appetite, milk yield and fecal output, and signs of mild colic. Dilatation of the cecum generally precedes dislocation. Singh *et al.* (2006) described the clinical signs of diaphragmatic hernia as partial anorexia, suspended rumination, recurrent tympany and scant faeces.

Mesaric and Modic (2007), in a cow suffering from cecal dilation and torsion, observed the animal to be anxious, uncomfortable and completely anorectic; having mild abdominal distension over the right paralumbar fossa; and showing signs of colic like kicking at her abdomen and treading. Rectal examination revealed an empty rectum and a gas-distended, freely movable blind end organ filling the pelvic inlet.

Dharmaceelan *et al.* (2008) observed clinical signs like suspended rumination, cessation of defecation, kicking at the abdomen and rocking horse appearance with bilateral abdominal distension for last one week in two Kangeyam bullocks diagnosed with intussusception.

Imran *et al.* (2011c) used ultrasonography for diagnosis of intussuception in six cows and observed the initial signs of acute intestinal colic manifested by vigorous kicking at belly, paddling of limbs, tremors of muscles especially of hind quarters, shifting recumbency, and repeated attempts to void feces along with flatus.

Ruf-Ritz *et al.* (2013) in their report of 18 cases with internal hernia stated that the general appearance and demeanor were abnormal in most cows and all had signs of obstructive intestinal disease including reduced intestinal motility and lack of faeces. The clinical signs were not pathognomonic for internal herniation because similar signs also occur in ileus of other etiologies.

2.3. CLINICAL EXAMINATION

Divers and Peek (2008) have found that clinical examination is a search for clues in an attempt to solve the mystery of a patient's illness. These clues are found usually in the form of "clinical signs" which are observed and analysed diligently to reach at a diagnosis.

Imran *et al.* (2011c) in six cows suffering from intussusceptions found the rectal temperature to be subnormal, the respiratory rate elevated and shallow, and the heart rate slightly elevated initially that increased considerably with progression of the disease.

Garrett and Singh (2012), in a cow affected with cecal dilatation, found the vital parameters as: rectal temperature of 39.2°C, heart rate of 80 beats/min, respiratory rate of 32 breaths/min, 3 rumen contractions in 2 min, negative for urine ketones, packed cell volume of 30%, plasma total protein of 70 g/L and a dehydration of 5%.

2.3.1. Temperature

Radostits *et al.* (2007) have stated that the temperature is taken per rectum ensuring that the thermometer bulb is held against the mucosa with the mercury column shaken down and allowing two minutes of contact time. The normal temperature in cattle is 38. 5°C (101. 5°F) and the critical point is 39.5° C (103.0°F).

2.3.2. Pulse

Radostits *et al.* (2007) have indicated that the pulse should be taken at the middle coccygeal or facial arteries in cattle. Normal pulse rate in adult cattle is 60-80 per minute and in young calves 100-120 per minute.

2.3.3. Capillary refill Time

Radostits *et al.* (2000) have emphasized that capillary refill time is a useful indicator of peripheral circulation, cardiovascular function and hydration status. A value of less than 2 seconds is normal and a refill time of 10 seconds is indicative of fatal circulatory failure. Jackson and Cockcroft (2002) have mentioned that CRT is recorded by putting digital pressure on an area of non-pigmented mucosa of the lips, dental pad or vulva leaving a pale area and then observing the time taken for the normal color to return.

2.3.4. Accessing dehydration

Constable *et al.* (1998) have observed that in acute diarrhea the degree of enopthalmos is the most reliable indicator of dehydration, but in chronic diarrhea or cachexia the skin tent in the cervical region or over the eyelids is most reliable as eye ball position is dependant of body fat stores. Fecteau ME (2015) has described the thumb rule for estimation of dehydration based on several factors including eyeball recession, upper eyelid skin tent, heart rate, and mucous membrane moistness in adult ruminants.

2.3.5. Palpation, percussion and succussion

Belknap and Navarre (2000) have said that pings are tympanic resonance caused by a gas-fluid interface in a distended organ and can be detected by simultaneous auscultation and percussion. He described different types of pings on the right and left side of the bovine abdomen implicating their diagnostic significance based on location and intensity.

Garrett and Singh (2012), in a case of cecal dilation in a cow, found auscultation and percussion of the abdomen to reveal a large area of high-pitched resonance in the dorsal half of the right abdomen extending from the paralumbar fossa to the 10th intercostal space.

2.3.6. Rectal palpation

Garry *et al.* (1988a) have opined that rectal examination in duodenal ileus usually does not lead to a clear diagnosis because the dilated intestine lies too far forward and the only consistent sign is a markedly impacted rumen due to reduced emptying.

Constable *et al.* (1997) suggested that intussusception was palpable in only a minority of affected adult cattle (23%), and the distended loops of the small intestine were palpable per rectum in only 50% of cases with intussusception and found ultrasonography or exploratory laparotomy to be useful for confirmatory diagnosis.

On rectal palpation, Koller *et al.* (2001) in two cows with duodenal obstruction found an L-shaped impacted rumen that extended over to the right side, and a taut segment of small intestine passing in front of the pelvis or an unidentifiable rope-like structure on the right of the rumen and ventral to the left kidney.

Radostits *et al.* (2007) have mentioned that palpable abnormalities of the digestive tract include distension of the loops of the intestine with fluid or gas, presence of hard masses of ingesta as in cecal and colonic impactions, and sometimes intestinal obstruction due to volvulus or intussusceptions; however, cranially located intussusceptions causing acute intestinal obstruction are not palpable per rectum.

Divers and Peek (2008) have stated that rectal examination may confirm many causes of abdominal distention suspected by the external examination, including cecal distention/volvulus, small intestinal distention, ruminal enlargements, rumen collapse, pneumoperitoneum, some right-sided abomasal displacements with volvulus, some abdominal or pelvic abscesses, fat necrosis, and occasional neoplastic lesions.

Imran *et al.* (2011c), in six cases of intussusceptions in cows, found absence of fecal material and dryness of rectal mucosa on transrectal examination and only in 4 cows they could feel the obstructed portion as a hard and thick impacted mass along with distended intestinal loops with a tentative diagnosis of intestinal intussusceptions. Rectal examination could not reveal any palpable mass in the remaining two cases.

Garrett and Singh (2012), on rectal palpation in a cow, found a large dilated structure in the right caudal abdomen presumed to be the cecum and tentatively diagnosed cecal dilation.

2.3.7. Abdominal pain

Belknap and Navarre (2000) has explained that abdominal pain is classified into 2 main categories: visceral pain (hollow viscera and solid organs) and parietal pain (parietal peritoneum, abdominal muscles and rib cage). Because parietal pain is exacerbated by pressure and tension modification the patient is responsive to external palpation such as xiphoid grunt test/pole test or withers pinch test. Visceral pain is typically recognized by active manifestations of colic: kicking at the abdomen, treading with the rear feet, feeling of discomfort (lying down, standing up and stretching out) and grinding the teeth.

Cockcroft and Jackson (2004) reported that the *Eric Williams test* was a more subtle technique for the early detection of traumatic reticulitis but could only be performed if rumenoreticular motility was intact.

2.3.8. Examination of rumen motility

Jackson and Cockcroft (2002) stated that rumen movements could be detected and measured by observation of the sublumbar fossa, palpation of the rumen or auscultation of the rumen and opined that auscultation of the rumen movements by stethoscope was the most sensitive of the three methods.

Imran *et al.* (2011a) observed that changes in the rumen motility were good indicators of disease. Hypomotility (less than 1 movement every 2 minutes) or rumen stasis might cause a free-gas bloat and be associated with a number of conditions including milk fever, ruminal acidosis and painful conditions of the abdomen. Hypermotility (more than 5 movements every 2 minutes) was less common and could be found in frothy bloat, vagal indigestion and Johne's disease.

2.3.9. Examination with metal detectors

Cockcroft and Jackson (2004) have indicated that metal detectors can be used to detect reticular foreign bodies but they are of limited value as they fail to distinguish between potential and non-potential metallic objects.

2.3.10. Radiography

Fubini *et al.* (1990) have observed that radiographic images in adult cattle are one of the most helpful ancillary examinations for the diagnosis of reticuloperitonitis. Braun (2005) has reported that radiographic examination of the adult bovine abdomen is challenging because of the large size of the patient and the need for expensive equipment with high milliampere-seconds (mAs) and kilovolt potential (kVp).

2.3.11. Ultrasound

Braun (2005) states that abdominal ultrasound provides a readily available, real-time, noninvasive method of imaging the abdomen in ruminants suspected of abdominal disease and in many cases precludes the need for exploratory laparotomy. Braun (2009) described the detail procedures for patient preparation, restraint and systematic ultrasonographic examination of gastrointestinal tract in cattle.

2.3.12. Packed cell volume and total solids

Fecteau (2005) has interpreted that shock, sepsis, and toxemia cause hemoconcentration and dehydration and are associated with an increase of PCV and total solids. Wittek *et al.* (2010) in one study found that the serum total protein concentration was significantly lower in cows with septic peritonitis when compared with cows suffering from nonseptic peritonitis.

2.3.13. Blood gas analysis and electrolytes

Horne (1991) has implicated that a consistent clinical feature of cattle with complete small intestinal intussusception is the gradual development of a hypochloremic, hypokalemic metabolic alkalosis; and more proximal the lesion, more rapid is the development of these biochemical abnormalities.

Roussel *et al.* (1998) have postulated that blood gas analysis as well as determination of electrolyte imbalance may be useful before initiation of treatment. Most adult ruminants with acute abdominal diseases suffer from metabolic alkalosis which is often associated with abomasal volvulus, intussusception, cecal disorders, abomasal ulcers, peritonitis, renal diseases, and reticuloperitonitis. Metabolic acidosis may be observed if urinary tract disease or enteritis with severe diarrhea is present. Roussel (1999) observed hypochloremia and hypokalemia to be frequently combined with metabolic alkalosis.

Koller *et al.* (2001), in a cow with duodenal obstruction, found hematocrit values to be mildly increased (36%; normal value 25–35%) with hypokalemia (3.4 mmol/L; normal value 4.8– 6.2 mmol/L) and in another cow blood samples showed a mildly increased hematocrit (37%; normal value 25–35%), mild hypokalemia (3.8

mmol/L; normal value 4.8–6.2 mmol/L) and increased ruminal chloride (35 mmol/L; normal value 15–25 mmol/L).

Otter (2013) has advocated that the serum electrolytes— bicarbonate, sodium, potassium and chloride— may be worth evaluating for animals with suspected metabolic imbalance caused by diet-induced acidosis or gastrointestinal disease. Their concentrations determine the 'acid-base balance' of the blood, which is derived from the difference between the anions and cations [(Na^+ + K^+) – (Cl^- + HCO_3^-)] which is also called the 'anion gap'.

2.3.14. Blood potassium

Kerr (2002) has advocated analyzing plasma rather than serum within 8 hours of collection as release of potassium from all cellular elements during clotting can cause false elevation of potassium in the sample.

2.3.15. Blood lactate concentration

In the opinion of Magdesian (2004), improving blood lactate concentration in critically ill horses is an important indicator of adequate response to treatment and a good indicator of reperfusion of ischemic tissues, and hence its estimation is an invaluable tool in management of the critical patient.

Figueiredo *et al.* (2006) have said that blood lactate concentration is frequently used to assess a compromised cardiovascular or respiratory system, to monitor the response to treatment, and to establish a prognosis for survival.

2.3.16. Complete biochemical profile

Cockcroft and Jackson (2004) have interpreted that electrolyte measurements may reveal hypochloraemia and hypokalaemia which may be present in animals with left displaced abomasum. A low packed cell volume (PCV) may indicate a bleeding abomasal ulcer while a raised PCV may suggest dehydration. Leucocytosis with relative neutrophilia and high fibrinogen may indicate an inflammatory process.

Ruf-Ritz *et al.* (2013) observed haemoconcentration, prerenal azotaemia, leukocytosis and hyperbilirubinaemia in cattle affected with ileus due to internal hernia. Smith (2015) stated that evaluation of specific enzyme activity (e.g., hepatic enzymes, BUN, and creatinine) combined with physical examination and other ancillary tests might be useful in establishing a diagnosis and assessing progress.

2.3.17. Acetonemia and acetonuria

Carrier *et al.* (2004) have reported that cow-side tests using strips for ketone bodies are now available and have the advantage of being inexpensive, giving immediate results, and can be used as frequently as necessary. Tests run on milk are less variable, more accurate and give fewer false negatives with subclinical ketosis. Cockcroft and Jackson (2004) have reported that ketosis is invariably present in cows with LDA and can be identified by a 'pear drops' smell on the breath or by testing the urine, milk or saliva for ketones using Rothera's test or reagent strips for urinalysis.

2.3.18. White blood cell count and differential

Smith (2015) believes that hematologic findings are rarely specific to a condition and reflect the underlying inflammatory process, provide information about the acuteness of the disease and the severity of the associated sepsis and toxemia, and is also an important ancillary test to monitor the response to treatment.

2.3.19. Examination of rumen fluid

Collection

Geishauser (1994) has indicated that rumen fluid can be obtained with a stomach tube and contamination of sample with saliva is avoided by collecting 500ml of rumen fluid by free flow. Alternatively, rumen fluid samples can also be obtained by percutaneous aspiration of the ventral sac of the rumen on the lower left ventrolateral abdominal quadrant.

Garrett *et al.* (1999) have postulated that it is impossible to completely avoid saliva contamination of rumen fluid collected by stomach tube and a minor false elevation of the pH is likely which can be minimized by collecting a minimum of 100 to 200 mL of sample. White (2004) described the technique of rumenocentesis for collection of ruminal fluid that can be used to diagnose various ruminal problems.

Ruminal Fluid pH

Leedle *et al.* (1995) have observed lower pH to develop faster with amylolytic fermentation than with the cellulolytic one. Maekawa *et al.* (2002) have reported that immediately after feeding, ruminal pH increases with addition of saliva which gradually decreases over 2- to 4-hours as the feed undergoes fermentation. As fermentation declines, the pH rises with salivary buffering and acid end product absorption; hence, feeding history is important for interpretation of rumen pH.

Cockcroft and Jackson (2004) postulated that anorectic cattle without abomasal reflux would have an alkaline pH in the range of 7.5 to 8, because of the constant production of alkaline saliva and lack of substrate for the rumen flora to produce volatile fatty acids. In cases of ruminal acidosis (carbohydrate engorgement) and abomasal reflux associated with obstruction the pH will be 5 or less.

White (2004) has advocated that rumen pH is best determined using a portable pH meter and the use of pH indicator papers are not recommended due to difficulties in interpretation of colour changes.

Krause and Oetzel (2006) have indicated that the pH of ruminal fluid fluctuates within a broad range of normal values with shifts of 0.5-1.0 pH unit during a 24-hour period and depends on the type of feed, fermentation pattern and intervals between feeding.

Microscopic examination

Cockcroft and Jackson (2004) have opined that rumen fluid from normal healthy cattle contains large numbers of highly active protozoa and have advocated that the sample should be agitated to re-suspend the organisms and protozoan activity is observed using a low power (x 10) objective by observing a drop of the sample placed on a warm glass slide covered with a cover slip.

Radostits *et al.* (2007) have mentioned that normally 5-7 protozoa are active per low-power field, but in lactic acidosis the protozoa are usually absent as all are killed when the rumen pH drops below 5 or a few dead ones are visible.

Ruminal chloride

Radostits *et al.* (2007) recommends determining rumen chloride concentration by straining and centrifuging the fluid and then analyzing the supernatant for chloride levels. The normal value is 10-25 mEq/L in cattle which increases in abomasal reflux, ileus or with high salt intake. Imran *et al.* (2011c) in six cases of intussusceptions in cows observed the rumen chloride concentration to be 66.1 ± 8.036 mEq/L (Reference < 30mEq/L).

Mishra *et al.* (1989) studied the sodium, potassium, magnesium, chloride and TVFA concentrations along with the pH of ruminal and abomasal contents in six adult corss bred Jersey cattle induced with pyloric obstruction. They found increased ruminal and abomasal chloride and decreased pH of both chambers, increased TVFA, sodium and magnesium content of rumen fluid but decreased sodium, normal TVFA and magnesium of abomasal fluid.

2.4. DIAGNOSIS

Fubini and Ducharme (2004) have indicated that in case of fat necrosis it may be possible to palpate hard intra-abdominal masses rectally or image them with ultrasound. Wittek *et al.* (2005) reported that physical examination findings and results of serum biochemical analyses did not facilitate the diagnosis of abomasal impaction in lactating Holstein cows and that exploratory right flank laparotomy was necessary to make the diagnosis.

Armstrong *et al.* (2007) observed in human patients that the clinical diagnosis of internal hernias was difficult, but CT scan was very useful in confirming the obstruction with internal hernia leading to planning of an emergency operation. Karapinar and Kom (2007) used trans-rectal ultrasonography to diagnose intussusception in a cow where rectal palpation or trans-abdominal ultrasonography did not lead to a conclusive diagnosis.

Athar *et al.* (2010) in a study concluded that ultrasonography was more accurate than radiography in the diagnosis of diaphragmatic hernia in cows and buffaloes with less discomfort for the patient and less stressful for the animals than radiography because it did not involve use of harmful radiations.

Imran *et al.* (2011b) states that the omasum is not easily accessible for clinical examination by palpation, percussion or auscultation because of its topographic location under the costal part of the abdominal wall. It can neither be examined by rectal palpation nor radiographed, thus making the diagnosis of omasal impaction very difficult.

Braun *et al.* (2012) in a study of 461 cattle affected with cecal dilatation, torsion or displacement observed that only 42 cattle (9% of all patients) had distension of the right flank and opined that distension of right flank commonly reported as a sign of cecal dilatation was not a reliable diagnostic sign.

Ruf-Ritz *et al.* (2013) in 18 clinical cases of internal herniation in cattle found clinical and ultrasonographic findings to be non-specific and the final diagnosis was made during exploratory laparotomy.

Wilson *et al.* (1984) have suggested that if insertion of the laparoscope can be simplified to a trocarization procedure, it can be used more extensively in the diagnosis of TRP in the bovine.

2.5. TREATMENT

2.5.1. Conservative treatment

Argenzgio and Whitlock (1980) advocated use of calcium gluconate injection intravenously and cholinergic drugs like neostigmine (@ 2-4 mg/1000lb) to re-establish gastrointestinal motility and prevent further gas accumulation. Oka *et al.* (1988) have successfully used 20 g of isoprothiolane orally once a day for 8 weeks in Japanese Black cows suffering from fat necrosis and found encouraging results. Steiner *et al.* (1995) identified that bethanecol (0.07mg/kg) and neostigmine (0.02 mg/kg) subcutaneously reversed intestinal myomotility and might be suitable for medical treatment of ileus and cecal dilation.

Sattler *et al.* (2000) described that the attempted medical treatments in some cows with abomasal displacement included IV fluids, metoclopramide @ 0.1 mg/kg body weight SC q8h, neostigmine 2 mg per animal IM q4h, cisaprid @ 0.1 mg/kg BW per rectum q12h for 3 treatments, exercise, laxatives (magnesium oxide or magnesium sulfate), and supportive care; and reported that no significant clinical improvement was observed and most of them required surgery.

Meylan (2008) recorded conservative medical management of cecal dilation with oral administration of mineral oil and parenteral prokinetic drugs such as bethanecol and neostigmine. Imran *et al.* (2011c) reported that six cows suspected to have intussucsception were initially treated with intravenous dextrose normal saline, purgatives, and rumenotorics by referring veterinarians.

Braun *et al.* (2012) suggested conservative treatment of cecal dilation without torsion or retroflexion in vitally stable animals with basal fluid therapy of 10 litres sodium chloride and glucose solution (50 g glucose and 9 g sodium chloride/L) intravenously daily. Additionally, 42.5 mg neostigmine per animal can be given daily slow IV (diluted in 5 lit of NS) to promote cecal motility and discontinued when the heart rate decreased to less than 60 bpm .

2.5.2. Surgical treatment

2.5.2.1. Anesthesia

Morishima *et al.* (1981) have experimentally demonstrated that adult, newborn and fetal sheep did not differ much in the extent of toxicity induced by a toxic dose of lidocaine, and contrary to the belief, they found that neonatal and fetal sheep require higher doses for toxicity than adult sheep. Kumar and Chouhan (1993) described the technique of paravertebral anesthesia in cattle and stated that compared to infiltration analgesia, proximal thoracolumbar paravertebral block offers a wide and uniform area of analgesia and muscle relaxation of all abdominal muscles and peritoneum.

Rosenberg *et al.* (2004) has reported that maximum recommended dose of local anesthetics is a multifactorial concept that should take into consideration individual patient factors carefully like age, underlying diseases (cardiac, renal, hepatic), physiological state (e.g. pregnancy) and formulation of the drug (with or without adrenalin).

Tranquilli *et al.* (2007) described line infiltration and inverted 7 or inverted-L block to be the easiest and most commonly employed technique for anesthesia of the flank region, but the deeper muscles and the peritoneum might not be completely desensitized. Clarke *et al.* (2014) stated the maximum dose limit for lidocaine to be 6 mg/kg in cattle and that Epinephrine (1:200000) could be added to the solution to prolong the duration of analgesia and increase the maximum safe dose limit.

2.5.2.2. Surgical approach

Right higher flank incision in standing position has been suggested as conventional method for surgery of the cecum (Pearson, 1963; Espersen, 1964; Singh *et al.*, 1977; Green and Husband, 1996; Garrett and Singh, 2012).

Oeheme and Prier (1974) and Frank (1981) have emphasized that ventral approaches in lateral recumbency allow equal accessibility to either side in case of cesarean section, correction of abomasal disorders and manipulation of digestive organs involved in torsion or volvulus. They have recommended for entering the abdomen either lateral or medial to the subcutaneous abdominal vein by incising from anterior part of udder towards umbilicus.

O'Connor (1980) has recommended a left ventrolateral oblique incision in right lateral recumbency in front of the udder parallel to the left subcutaneous abdominal vein for cesarean section. Schummer *et al.* (1981) has described the relevant anatomic position of the digestive organs in the abdominal cavity. Smith (1985a) strongly recommended restraint in lateral recumbency for extended surgical procedures of the intestines through right flank rather than in the standing animal. Singh and Patil (1993) have described in detail the different laparotomy approaches for different abdominal surgeries in ruminants.

Kemble *et al.* (1994) found difficulty in exteriorizing the cecum through standing right flank laparotomy and positioned the animal in left lateral recumbency for more extensive exposure in case of a caecal volvulus in a cow. Parish *et al.* (1995) have described a left oblique celiotomy approach for cesarean section in cattle and have opined that it gives better exposure for exteriorization of the gravid uterus. Panda (2002) compared higher left flank laparotomy and left ventrolateral oblique laparotomy incisions to approach the rumen and cecum and found the later to be more effective for simultaneous surgical manipulations of rumen and cecum in experimental bovine calves.

Tschuor *et al.* (2010) recorded abomasotomy via a right flank approach in a standing cow and described that the recommended approach was a right paramedian or right paracostal incision with the patient in lateral or dorsal recumbency. Dyce *et al.* (2010) has described the blood and nerve supply to the muscles of the abdominal wall of cattle.

Hendrickson and Baird (2013) have opined that flank laparotomy through the left paralumbar fossa is commonly used in cattle for exploration if a problem is suspected on the left side, and the right paralumbar approach is used for exploratory laparotomy if a problem is suspected on the right side. When the problem is unknown right flank laparotomy is also chosen as it allows maximum exploration of the abdomen. A ventrolateral oblique laparotomy can be done on the left or right side and may be indicated for cesarean section.

2.5.2.3. Surgical technique

Ide and Henry (1964) reviewed in detail four major abnormalities of the bovine abomasum: LDA, RDA, AV, abomasal ulceration; and advocated right paramedian laparotomy for correction of all surgical conditions of the abomasum.

Duchrame *et al.* (1988) reported 43 cases of colonic atresia in calves in which resection of the affected part of the colon and end to end or end to side anastomosis between the proximal spiral loop of the ascending colon and the descending colon were done and the long term survival rate in the operated calves was only 35%.

Fubini *et al.* (1992) in a comparative study of two techniques for abomasal displacement concluded that there is little difference in the cost of doing a right paramedian abomasopexy versus a right paralumbar fossa omentopexy, no difference in either the breeding performance after surgery or incidence of incisional complications. But based on the milk yield at one month after surgery, study results suggested a slight preference for a right paramedian abomasopexy.

Dehghani (1995) compared four rumenotomy techniques in 20 cattle: skin suture fixation, Weingarth's ring, stay suture, and skin clamp fixation. They concluded from their observations that skin suture fixation and skin clamp fixation were superior to Weingarth's ring or the stay suture techniques; and recommended that as skin clamp fixation was comparable to skin suture fixation and required a shorter operative time, clamp fixation could be considered as an alternative to the more commonly used skin suture fixation technique.

Singh *et al.* (1996) reported diaphragmatic hernia in a cow and performed herniorrhaphy in the standing position by thoracotomy approach. Nayak *et al.* (2000) described the omasal flushing technique and reported successful management of omasal impaction in four crossbred Jersey cows by the procedure. Koller *et al.* (2001) in two cases of duodenal obstruction by gravid uterus passing through a mesoduodenal defect, transsected the duodenum, and made end to end anastomosis with polyglyconate in single layer approximating sutures. The mesoduodenal defect was closed with polyglactin in continuous pattern to prevent further incidents and the patients recovered uneventfully.

Lee *et al.* (2002) successfully corrected left displacement of abomasum (LDA) by left paramedian abomasopexy in six HF cows under xylzine sedation and dorsolateral recumbency and considered it as an easy and major alternative surgical technique for treatment of LDA. Mesaric and Modic (2007), in a cow suffering from cecal dilation and torsion, performed typhlotomy and colotomy through a standing left-flank laparotomy and removed a large trichobezoar from the proximal loop of ascending colon.

Dharmaceelan *et al.* (2008) performed intestinal resection and anastamosis in two bullocks in two layers: first layer of simple interrupted suture with No 2-0 polyglactin 910 and second layer reinforced with Lembert's suture using No 2-0 chromic cat gut and finally checked for the perfect sealing of the suture line.

Al-Timmemi *et al.* (2010) conducted an experimental study on two anastomosis techniques in goats using one row of sero-submoucosal interrupted sutures (SSIS) in one group, and one row of horizontal mattress interrupted sutures (HMIS) in the other group and concluded that the SSIS technique demonstrated less adhesion, lower degree of luminal stenosis, higher bursting pressure, better mucosal healing with epithelial recovery and less local edema, and therefore was closer to "ideal healing" than the HMIS technique.

Tschuor *et al.* (2010) described a 3 layer closure for abomasotomy incision: the abomasal mucosa with 2-0 monofilament glucomer suture material in a continuous appositional pattern, the serosa and muscularis with No 1 monofilament glucomer suture in a simple continuous pattern followed by a second closure using the same suture material in a cushing pattern. Garrett *et al.* (2012) has opined that correction of cecal dilatation in cattle is most often accomplished with typhlotomy via a standing right flank laparotomy.

2.6. PROGNOSIS

Oehme and Prier (1974) suggested that the rapidity in corrective surgery performed following onset of illness in obstructive gastrointestinal diseases associated with vascular compromise plays a major role in excellent recovery.

Smith (1978) found that poor short-term prognosis was associated with serum chloride concentrations less than 79 mEq/L, Simpson *et al.* (1985) found a similar prognosis with base excess values of −0.1 or less, and Garry *et al.* (1988b) found anion gap values of more than 30 mEq/L to be associated with a poor to grave prognosis.

Smith (1985b) in agreement with Oehme and Prier (1974) observed that volvulus or mesenteric root torsion becomes rapidly fatal if not corrected early.

Dharmaceelan *et al.* (2008) concluded that intestinal obstruction, unlike in horses, is not immediately fatal in ruminants and the course may take 8-14 days; however an early diagnosis and immediate surgical intervention are vital for successful outcomes.

Toor and Saini (2008) observed that the presence of reticulo-omasal orifice tone and a plasma chloride level above 75 mmol/L were indicators of a good prognosis in buffaloes affected with omasal impaction.

Hussain *et al.* (2013) observed that neutrophillic leukocytosis with marked left shift and toxic changes in neutrophils along with lower chloride (<70 mmol/L) and potassium (<2 mmol/L) levels, increased lactate (>9 mmol/L), and highly distended omasum on rumenotomy were indicators of poor prognosis.

CHAPTER-III

MATERIALS AND METHODS

CHAPTER-III

MATERIALS AND METHODS

For the purpose of this study, all the bovine cases exhibiting obstructive gastrointestinal symptoms presented to the college for a period of one year were carefully screened. A total of 47 cases were thoroughly examined by the usual diagnostic methods like observing vital signs, auscultation, palpation, percussion, and hemato-biochemical examination as described below. Radiography and ultrasonography were not used due to non availability of facilities.

Based on the clinical examination detailed below, in 31 animals (66%) a defininitive diagnosis could be done; they were treated by the usual surgical or medical protocols and excluded from the study. In the remaining 16 animals (34%) a definitive diagnosis could not be established and surgical exploration was done through a left ventrolateral oblique laparotomy for diagnosis and treatment. These 16 animals of either sex and irrespective of age formed the subjects of the present study.

3.1. SIGNALMENT

The age sex, breed, pregnancy, lactation status, pedigree, and last date of breeding were recorded. The relevant data have been recorded in table 3.

3.2. HISTORY

A brief and complete history about onset of disease, time of onset, symptoms observed and duration of illness, drop in milk yield, reduction in appetite and food consumption, and management practices were reviewed and recorded. The previous treatments used, evidence of abdominal pain, nature and volume of the feces voided were also recorded. The observations are presented in table 4.

3.3. CLINICAL EXAMINATION

3.3.1. Vital signs

***Temperature*:** Rectal temperature was taken by putting a lubricated mercury thermometer, with the mercury column shaken down, carefully into the rectum and ensuring contact of the bulb with the rectal mucosa for at least 2 minutes.

Respiration: Rate of respiration was determined in the standing quiet animal without any disturbance by counting movements of the chest wall or flank over a period of 1 minute and was recorded as breaths/minute. Respiratory depth (swallow or deep), rhythm (regular, irregular or hurried) and abnormal respiratory sounds (grunting or moaning) were carefully observed and recorded.

Pulse rate: It was taken from the middle coccygeal artery by palpating along the midline of the ventral surface of the tail approximately 5 to 10 cm from the tail head. ***Heart rate*** was determined by auscultation with a stethoscope.

Visible Mucous Membrane: The eyelids were everted and the colour of the conjunctiva was examined and recorded as pale, pink, bright, bluish, yellow, or injected. In females the vulval mucous membranes were also examined.

***Capillary refill time*:** It was determined by compressing the mucosa of the mouth or vulva to expel capillary blood, leaving a pale area, and recording time taken in seconds for the normal pink color to return.

***Dehydration status*:** It was determined by examination of the extent of eyeball recession, upper eyelid skin tent, and nature of mucous membrane and the percentage calculated by the thumb rule described by Fecteau (2015) and given below in Table 1.

Table 1. Thumb rule for calculation of dehydration % in cattle.

Eye ball recession	**Upper eyelid skin tent**	**Mucous membrane**	**Dehydration (%)**
Slight	Remains for 2-3 sec	Moist	Mild (6-7%)
Obviously sunken	Remains for 3-6 sec	Tacky	Moderate (8-9%)
Severely sunken into orbit	Remains indefinitely	Dry	Severe (10-12%)

3.3.2. Examination of abdominal contour

Silhouettes or contour of the abdomen of cattle were examined from a distance by viewing from behind and slightly obliquely on each side. The probable cause of distension was accessed by the patterns of distension as described by Radostits *et al.* (2007), which could be unilateral or bilateral, symmetrical or assymetrical or more prominent on the dorsal or ventral half of one side or the other.

3.3.3. Palpation of the abdominal organs

Palpation through the body wall on the left and right side was done as per description of Smith (2015).

Palpation of left hemiabdomen: palpation of the left abdominal wall was done systematically with open hands and extended fingers; clenched fists were used for deep palpation. Palpation started systemically from top of the abdominal wall just below the transverse processes of the lumbar vertebra in the paralumbar fossa and continued down to the ventral aspect of the abdominal wall.

The mass of solid ruminal contents ("rumen pack") which is normally doughy and pits on pressure, and the gaseous contents of the rumen ("gas cap") which is normally resilient and tympanic were palpated carefully through the paralumbar fossa. Any abnormalities like inability to palpate the "rumen pack" (as in medial displacement of the rumen in LDA) or "gas cap" (as in rumen collapse or pneumoperitoneum), replacement of the "gas cap" with "rumen pack" (as in ruminal impaction), or a resilient to tense distension of the left paralumbar fossa (as in ruminal tympany) were noted. Deep palpation below the costal arch was done to palpate a left displaced abomasum.

Palpation of right hemiabdomen: Systematic palpation was done on the right side behind the right coastal arch from the level of the lumbar transverse process to the ventral part of the abdominal wall. Any abnormal mass, enlargement or gas filled viscus was carefully examined and recorded. Deep palpation below the costal arch was done to detect abomasal distension, volvulus or impaction and omasal impaction.

3.3.4. Ruminal motility

It was determined by keeping a closed fist over the left paralumbar fossa to feel for the contractile waves and the contractions of rumen were evaluated for intensity, duration and frequency and recorded as number of contractions per 5 minutes

If ruminal motility was weak or not palpable, auscultation of the rumen movements was done by a stethoscope which was placed in the sublumbar fossa and directed downwards towards the rumen to auscultate the loudness, character and duration of ruminal sounds. The ruminal contraction cycles were heard as crushing sound or as crackling crescendo–decrescendo rolling thunder persisting for 5 to 8 seconds (Jackson and Cockcroft 2002). Thus number of ruminal contraction cycles heard per 5 minutes and the intensity of such contractions (weak or strong) were recorded.

3.3.5. Abdominal auscultation and percussion

Percussion and simultaneous auscultation of the abdomen were done by putting the diaphragm of the stethoscope in the area of interest while gently striking the abdominal wall nearby with a percussion hammer and listening to the ping sounds elicited by a gas filled viscus.

Left abdomen- Percussion and simultaneous auscultation was done on an area extending from 9th to 13th ribs and slightly beyond the costal arch above and below an imaginary line drawn from the point of elbow to tuber coxae in order to find the ping associated with left displacement of abomasum.

The examination was repeated on the left paralumbar fossa and the surroundings in order to find a ping as in rumen collapse, a medium pitched or high pitched tympanitic ping as in frothy bloat or free gas bloat respectively, or a large area of ping on upper third of both sides of abdomen as in pneumoperitoneum.

Right abdomen Percussion and simultaneous auscultation of the entire right abdominal wall were done from the level of 9th rib to the cranial border of the tensor fascia lata muscle and from the lumbar transverse processes to the ventral most part of the abdomen. Diligent attempt was made to detect and localize pings that may arise out of distension of several organs on the right side: unilateral pings in higher paralumbar fossa as in cecal dilatation, bilateral pings in the higher flank as in pneumoperitoneum, ping in the area from 9th to 13th rib as in RDA, or pings in the middle part of 11th to 12th intercostal space as in dilation of duodenum or ascending colon.

3.3.6. Ballotment of abdomen

The left abdomen is balloted with the closed fist over the lower one- third of the left paralumbar fossa. Ballotment alone or simultaneous ballotment and auscultation (succussion) were done to detect fluid filled viscus by hearing fluid splashing sounds. Similarly, ballotment of the right abdomen was done to detect any firm or tense mass (an impacted abomasum or intussusceptions) as they move away from the abdominal wall and then rebound back and felt by the hand. Succussion on the right was done to detect fluid filled intestines, abomasum or abnormal amounts of peritoneal fluid.

3.3.7. Examination with metal detector

All animals were examined with a metal detector to detect metallic foreign bodies in the rumenoreticulum.

3.3.8. Examination for abdominal pain

Withers pinch test – The withers pinch test was performed by grasping a fold of skin over the withers which usually caused the normal animal to dip the spine. Any abnormality i.e. reluctance to dip the spine or grunting during the test was noted and recorded.

Pole test/Bar test – A padded metal or wooden bar or bamboo pole was placed beneath the animal and held by two assistants just behind the xiphisternum. As each assistant slowly raised the bar and then lowered it quickly a stethoscope was placed over the trachea in the ventral midline of the neck for auscultation of a grunt.

3.3.9. Trans-rectal examination

Trans-rectal palpation of abdominal organs was done in all animals by wearing arm length veterinary gloves with proper lubrication in order to identify the cause of obstruction and other concurrent and palpable conditions if present. All cattle were examined in the standing position except the recumbent ones which were examined in sternal recumbency. Careful and systematic examination was carried out with minimal stress to the animal as detailed below and as described by Radostits *et al.* (2000).

Presence or absence of fecal material in the rectum was determined. If present, the colour, consistency (hard fecal balls) and amount of material present and any other observations were recorded carefully.

In all female animals, the uterus was examined for pregnancy, stage of gestation, viability of the fetus, disposition of the gravid horns and any other fetal or maternal abnormalities (retained placenta, metritis, pyometra, maceration, mummification, hydrops amni, etc).

The contents and disposition of the caudal and visceral part of rumen were palpated for obvious abnormalities e.g. ruminal collapse, medial displacement in LDA, L-shaped rumen in vagus indigestion etc. The cecum was searched and palpated for any dilation, displacement or torsion by palpating apex and palpable portion of the body of the cecum.

The accessible portion of the caudal right abdomen was searched for any sussage shaped firm mass (suggestive of intussusceptions) or for a large ingesta or gas filled viscus (suggestive of RDA). Any other obvious abnormalities found were noted.

3.4. LABORATORY EXAMINATIONS

3.4.1. Rumen fluid

Collection Collection of rumen fluid was done by introducing a lubricated probang through the mouth into the rumen and to avoid contamination with saliva, a minimum of 100 ml of ruminal fluid was collected by gentle to and fro motion of the probang as described by Garret *et al.* (1999).

If the above method failed to collect a minimum of 100 ml of ruminal fluid, samples of rumen fluid was collected from the ventral sac of the rumen by ruminocentesis by the method described by White (2004). An area at the level of the stifle joint 10-12 cm caudal to the last rib in the ventral abdominal wall was prepared, animal was adequately restrained, and 16-18 gauze needle is thrust through the skin and abdominal wall into the rumen and a small amount of rumen fluid is withdrawn (10-20 ml).

pH Ruminal fluid pH was determined immediately on the spot by wide range pH paper and the results were recorded.

Protozoa Ruminal fluid was examined for density and activity of protozoa by observing a drop of rumen fluid under the low power objective as described by Mishra *et al.* (1972) and Cockcroft and Jackson (2004). The motility was graded as sluggish, moderately active or highly active by eye estimation of the movement and concentration was graded as per table 2.

Table 2. Grading of protozoal count.

Sl no	Grading scale	Criteria
1.	1	Having 0-10 protozoa in one field.
2.	2	Having 10-20 protozoa in one field.
3.	3	Having more than 20 protozoa in one field.

Chloride: Rumen liquor was filtered through a double layer muslin cloth and then centrifuged at 3000 rpm for 5 minutes and chloride concentration was estimated using diagnostic kits (colorimetric method) with the help of an autoanalyzer.

3.4.2. Hemato-Biochemical studies

Ten mL of blood sample was collected from the jugular vein, 5 mLof blood was put in to an EDTA vial which was used for estimation of PCV, hemoglobin, differential count, and total leucocyte count. The rest 5 mLof blood was put in a serum collection tube which was kept undisturbed in slanting position and then centrifuged at 3000 rpm for five minutes to separate serum. The cleared serum was then poured into a clean vial with a stopper and was stored at 4° C in the refrigerator. The serum was used for biochemical estimation of sodium, potassium, and chloride.

Estimation of hemoglobin was done with Sahli's hemoglobinometer, packed cell volume by Wintrobe's microhematocrit method, TLC with a Neubauer's slide, and differential count done by counting WBC's on a Geimsa stained smear. Serum sodium, potassium, calcium and chloride were estimated using diagnostic kits with the help of an autoanalyzer. All the laboratory tests were performed on the day of operation (day 0), 3rd and 7th post operative days to monitor therapy and evaluate the process of recovery.

3.5. DESIGN OF STUDY

All the 16 animals in which a definitive diagnosis could not be achieved by careful examination as detailed above were subjected to exploratory laparotomy through a left ventrolateral oblique approach. The animals screened to be included in this study were divided in to two groups as per the criteria given below.

Group I: The animals in which the diagnosed surgical condition was easily approachable and correctible through the left ventrolateral oblique laparotomy approach.

Group II: The animals in which the diagnosed surgical condition was approachable and correctable with "some difficulty" or not approachable and correctable through this laparotomy approach. For the purpose of this study "with some difficulty" is defined as manipulating or depressing the incision site with hands, manipulation of the hind leg and recumbency position of the animal, or extension of the incision, and no undue tension on the affected organ or its associated mesenteric attachment.

3.6. SELECTION OF SITE

Since flank approach has limited accessibility, ventrolateral oblique incision was chosen in order to have easy approach to a larger area of the abdominal cavity. The proposed incision was given on the lower left abdomen starting from a point just above the level of the stifle and extending obliquely and cranioventrally up to the last rib (Parish *et al.*, 1995).

3.7. SURGICAL ANATOMY

The abdominal wall on the site of incision have four layers of muscles: cutaneous trunci (outermost), external abdominal oblique, internal abdominal oblique, and transverse abdominis (Figure 28). Blood supply: As the site of incision goes through the aponeurotic portion of the abdominal muscles there in no major blood vessels in the area. The cranial epigastric artery (branch of internal thoracic artery) and caudal epigastric artery (branch of external pudendal artery) supplies the area. Nerve supply is by the ventral rami of T-13, L-1, and L-2 spinal nerves (Figure 29) (Dyce *et al.*, 2010).

3.8. PREPARATION OF SITE AND ANESTHESIA

The surgical site was shaved, washed with soap and warm water, scrubbed with povidone Iodine, and draped using sterile plastic drapes. Aggressive and uncooperative animals were given xylazine @ 0.03-0.05 mg/ kg body weight intramuscularly along with local analgesia. Local analgesia was achieved by linear infiltration or paravertebral anesthesia in all the cases, and due care was taken not to exceed the toxic dose of lignocaine as recommended by Rosenberg *et al.* (2004) and Clarke *et al.* (2014).

3.9. SURGICAL EXPLORATION, DIAGNOSIS AND TREATEMENT

The animals in which no preoperative diagnosis could be made (n=16) were operated by a left ventrolateral oblique laparotomy approach for exploratory diagnosis. They were restrained on a soft bed in right lateral recumbency with the fore and hind legs tied separately in front and behind. In this technique after the skin incision, the external most cutaneous trunci muscle, and the successive layers of external, internal and transverse abdominal muscles were bluntly separated longitudinally along their fiber direction and the peritoneum was incised. On reaching the abdomen the dorsal sac of the rumen was exteriorized, brought out through the incision, fixed to the rumenotomy ring and incised. All foreign materials present within the rumen were removed and 3/4th of contents were emptied. Magnet swapping of the reticulum was done and any metallic foreign bodies present were retrieved. In the presence of omasal impaction, omasal flushing was done as per the method described by Nayak *et al.* (2000).

The cardia and reticulo omasal orifices were explored for any abnormalities like presence of abnormal masses, foreign bodies or immature amphistomes. Twenty yeast tablets were put into the rumen to balance the mocroflora and fauna. Then the ruminal incision was lavaged with copious saline and closed with No-2 chromic catgut in inverted cushing pattern. The abomasum was palpated by passing the hand between the floor of the rumen and the ventral body wall to the right side for any abnormalities which was attempted for correction by exteriorizing the abomasum.

Then the rumen was slightly deflected cranially with the greater omentum, and the small and large intestines were explored for obstruction or any other abnormality. Attempt was made to exteriorize the affected part and effect necessary surgical correction. Laparotomy wound was closed by apposing the muscle layers separately with no-2 chromic catgut as per standard procedure. Skin incision was closed routinely. The results and findings were analyzed in each group. During exploration of the gastrointestinal tract the approachability of different parts were carefully observed and recorded.

3.10. POSTOPERATIVE CARE AND MANAGEMENT

Fluid therapy: All the animals were given fluid therapy for 3 to 5 days which was modified according to the need of the patient based on laboratory findings and clinical improvement.

Drug therapy: Streptopenicillin was given intramuscularly once daily for 5-7 days and metronidazole inj @ 10 mg/kg IV once daily for 3 days. NSAID's (meloxicam @ 0.2mg/kg IM or flunixin meglumine @ 1mg/kg IV) were given daily for 3 days. In some cases, neostigmine @ 0.02 mg/ kg SC BID for 2 to 3 doses was given to promote intestinal motility.

Nursing care: Regular dressing of the wound with fly repellent cream was done till healing. A clean cloth was covered over the wound for 2 to 3 days. The owners were advised to give good nursing care and liquid diet to their animals. One to two liters rumen cud from fresh goat rumens was given to the animals that remained anorectic after evaluation of rumen pH and protozoa and it was repeated when necessary. Feeding was gradually changed from soft to coarse diet. Sling support to recumbent and weak animals was given in order to bring them to foot.

***Management of post-operative complication*:** Abscess on the suture line was treated on general principles by removing one or two sutures, draining the pus and application of topical antiseptics.

3.11. STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was used to compare the means on different days among different groups. Paired "t" test was used to compare the mean values on different days with their respective base value in each group (Snedecor and Cochran, 1994). For non-parametric observations Kruskal-Wallis one-way test was used to compare the mean between the groups on corresponding days (Siegel and Castellan, 1988).

Table 3. Patient signalment.

Group	Case no	Breed	Age	Sex	Pregnancy	Lactation	No of Calvings	Last calving since	Body weight (Kg)
I	1	CBJ	3 yr	F	P--3mo	Dry	NA	NA	300
	2	CBJ	1 yr	F	NP	NA	NA	NA	100
	3	ND	5yr	F	NP	2 L/day	2	8 mo	250
	4	CBJ	6 yr	F	NP	Dry	3	9 mo	300
	5	CBJ	7yr	F	NP	Dry	4	8 mo	200
	6	CBJ	8yr	F	NP	Dry	4	1 yr	250
	7	CBJ	4yr	F	NP	Dry	1	8 mo	250
	8	CBJ	1.5 yr	F	NP	NA	NA	NA	100
	9	ND	6yr	F	NP	Dry	2	10 mo	300
	10	CBJ	4.5 yr	F	NP	Dry	1	9 mo	300
II	1	CBJ	5 yr	F	NP	15 L/day	2	2 mo	350
	2	ND	6yr	M	NA	NA	NA	NA	400
	3	CBJ	4.5 yr	F	NP	8 L/day	2	3mo	300
	4	CBJ	6 yr	F	NP	7 L/day	3	6 mo	300
	5	CBJ	5 yr	F	NP	3 L/day	6	1 mo	350
	6	CBJ	3 yr	F	NP	2 L/day	1	15 d	200

Mean ± SE of age: 4.72 ± 0.47 yr. Mean ± SE of body weight: 265.62 ± 20.78 Kg

N.B: CBJ—Crossbred Jersery

P—Pregnant

NP—Non pregnant

mo—month, d—day

NA—Not Applicable

Table 4. Patient History.

Group	Case No	Time of onset days	Anorexia	Fecal output	Rumination	Ruminal motility X/5min	Brisket odema	Tympany
		1	2	3	4	5	6	7
I	1	15	Complete	Absent	Reduced	1	Present	No
	2	7	Complete	Absent	Absent	0	No	Recurrent
	3	7	Complete	Absent	Reduced	2	No	No
	4	0	Complete	Absent	Absent	5	No	No
	5	5	Complete	Absent	Absent	0	No	Persistent
	6	3	Complete	Absent	Absent	0	No	No
	7	2	Complete	Absent	Absent	3	No	Recurrent
	8	3	Complete	Absent	Absent	1	No	Persistent
	9	3	Complete	Scanty	Absent	0	No	Persistent
	10	15	Complete	Absent	Absent	1	No	No
II	1	10	Complete	Absent	Absent	0	No	Persistent
	2	3	Complete	Absent	Absent	0	No	No
	3	1	Partial	Scanty	Reduced	3	No	Recurrent
	4	7	Partial	Scanty	Reduced	1	No	Persistent
	5	7	Partial	Reduced	Absent	11	No	Persistent
	6	7	Partial	Reduced	Reduced	10	No	Recurrent

Table 4. Patient History continued.

Group	Case No	Feeding	Management [1]	Previous treatment [2]	Abdominal pain [2]	Posture at presentation
		8	9	10	11	12
I	1	Chopped straw, grains, restricted water	S	Y—2,3	N	Standing
	2	Dry bran, straw, restricted water	S	Y—1,3	N	Standing
	3	Chopped straw, bran, restricted water	S	Y--3	N	Standing
	4	Straw, grains	G	N	N	Standing
	5	Straw, bran	G	N	N	Recumbent
	6	Chopped, bran	G	N	N	Standing
	7	Straw, grains	G	N	N	Standing
	8	Straw, bran	G	N	N	Recumbent
	9	Straw, kitchen refuge	G	N	N	Recumbent
	10	Chopped straw, grains	S	N	N	Recumbent
II	1	Concentrates, little straw	S	Y—1,2,3	N	Standing
	2	Straw, Bran	S	Y—2,5	Y	Standing
	3	Chopped straw, grains	S	Y—2,3	N	Standing
	4	Concentrates, little straw	S	Y—1,2,4	Y	Standing
	5	Wheat bran, Straw	S	N	Y	Standing
	6	Straw, Bran	G	Y—1,3	Y	Standing

NB. [1] S-stall fed, G-grazing

[2] Y- yes, N- no: 1- relief of tympany by probang or trocarization, 2-fluid therapy, 3-oral rumenotorics or antiflatulants, 4-antibiotics or NSAIDs 5-homemade preparations.

Fig. 1: A one year old calf with gastrointestinal obstruction, case 1, group I

Fig. 2: A recumbent cow with gastrointestinal obstruction, case 5, group I.

Fig. 3: Cow with gastrointestinal obstruction showing right sided abdominal distension, case 6, group I

Fig. 4: Cow with abdominal distension, case 1, group II.

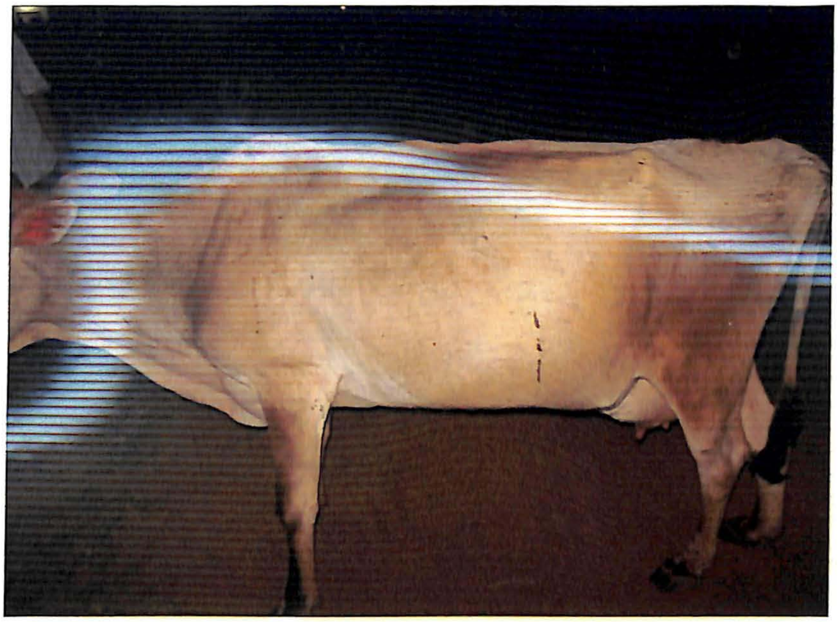


Fig. 5: Bullock with gastrointestinal obstruction showing severe dehydration and abdominal pain, case 2, group II.

Fig. 6: Cow with gastrointestinal obstruction, case 3, group II.

Fig. 7: Recording pulse by palpating the middle coccygeal artery.

Fig. 8: Examination for mucous membrane color and dehydration.

Fig. 9: Palpation of abdomen and examination for ruminal motility.

Fig. 10: Auscultation.

Fig. 11: Simultaneous auscultation and percussion.

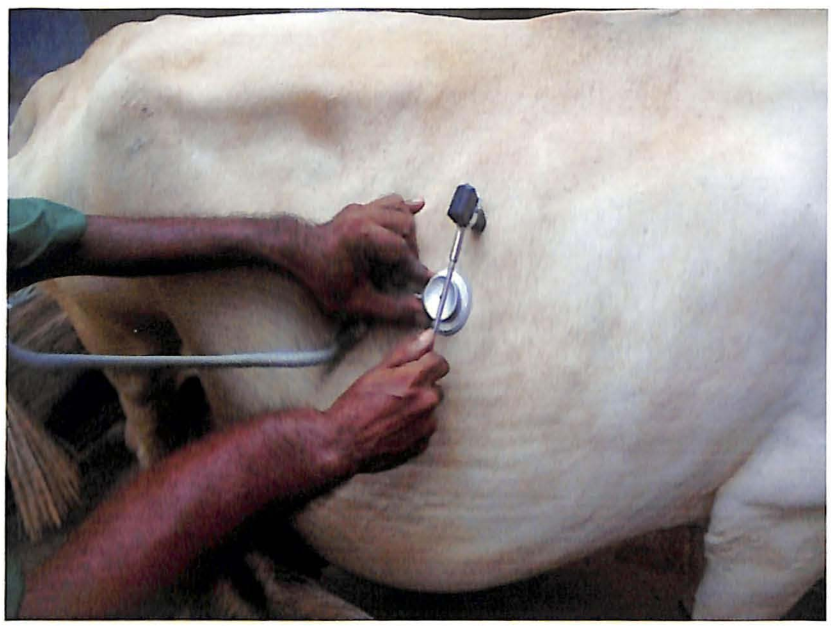


Fig. 12: Metal detector used in the study.

Fig. 13: Examination with metal detector.

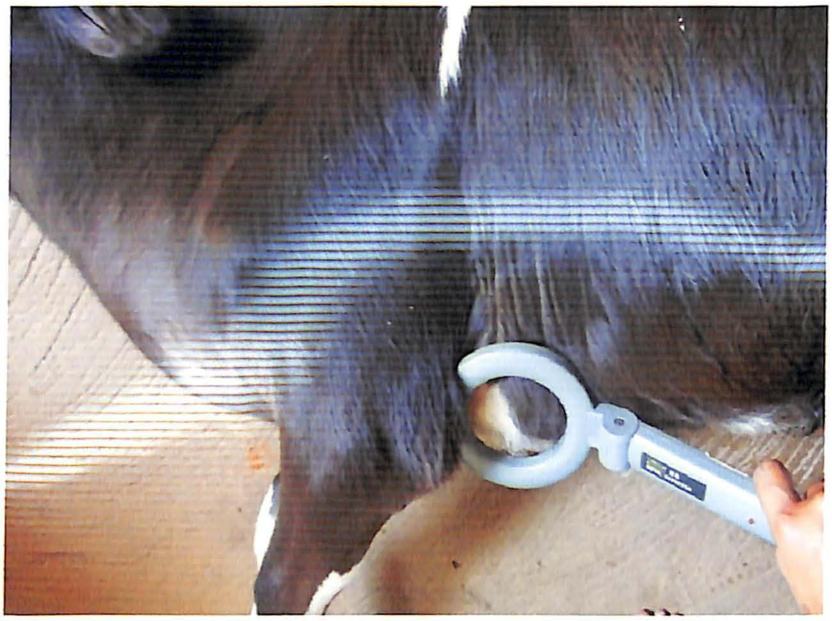


Fig. 14: Rectal examination.

Fig. 15: Positioning patient on right lateral recumbency and preparation of site for surgery.

Fig. 16: Linear infiltration anesthesia.

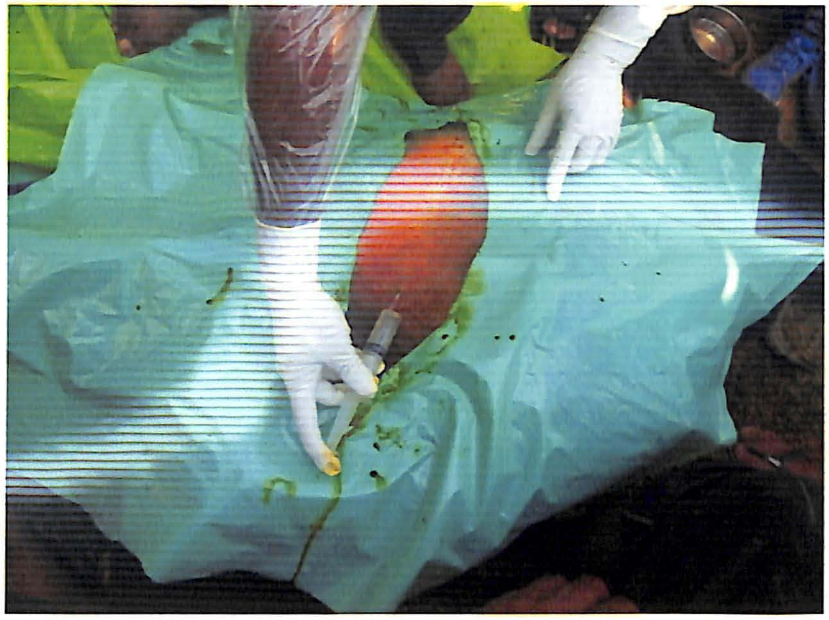


Fig. 17: Paravertebral anesthesia.

Fig. 18: Skin incision

Fig. 19: Grid technique of incision dividing individual muscles along their fiber direction.

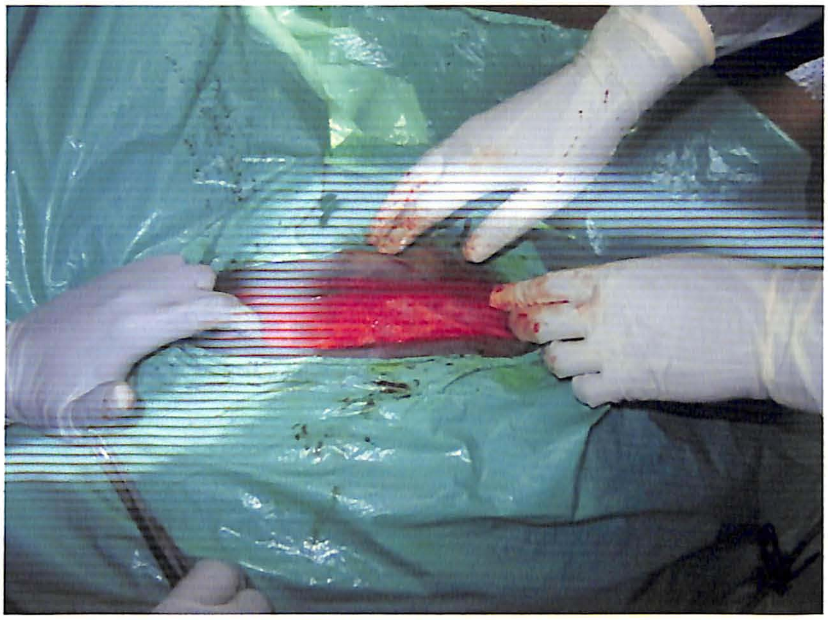


Fig. 20. Grid technique of incision dividing individual muscles along their fiber direction.

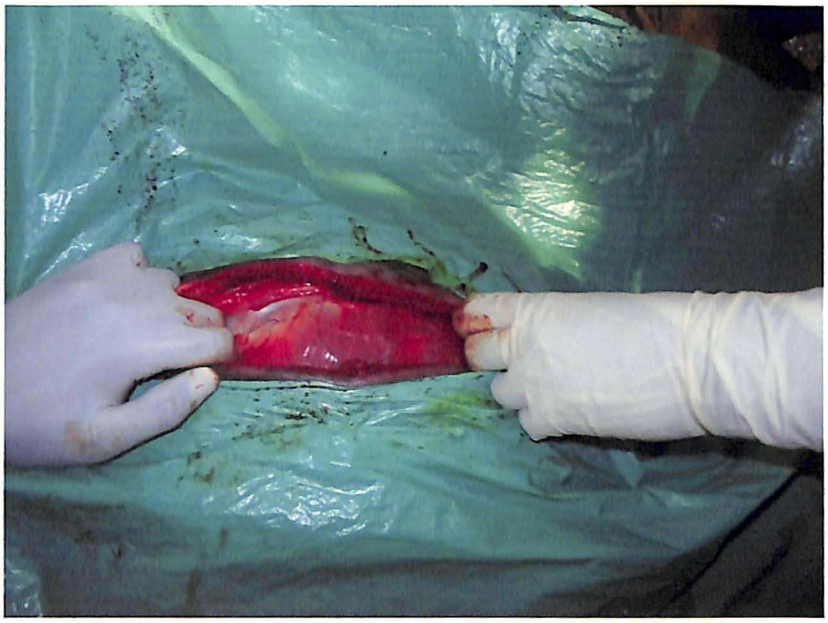


Fig. 21: Ventral sac of rumen covered with greater omentum.

Fig. 22: Exteriorization of the dorsal sac through the laparotomy site.

Fig. 23: Fixation of rumen wall to the rumenotomy ring.

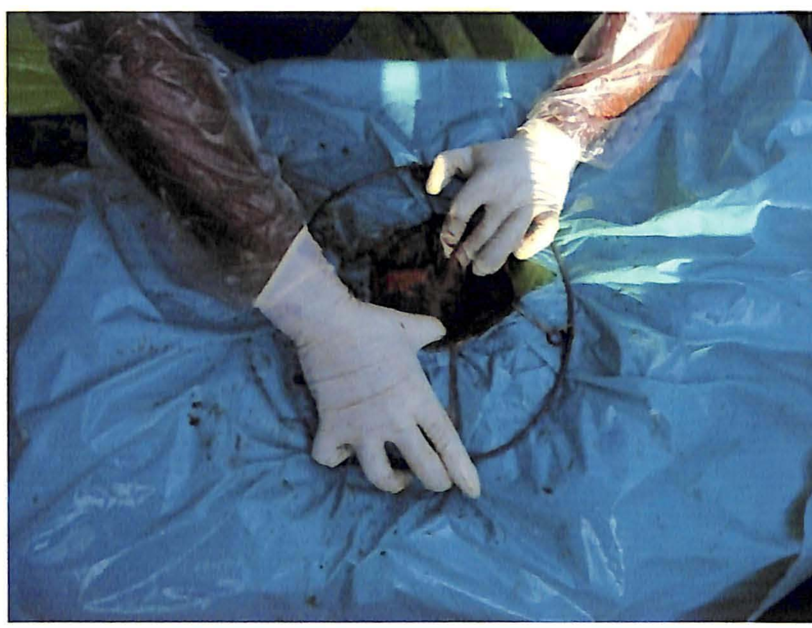


Fig. 24: Exploration of rumeno-reticulum

Fig. 25: Omasal flushing

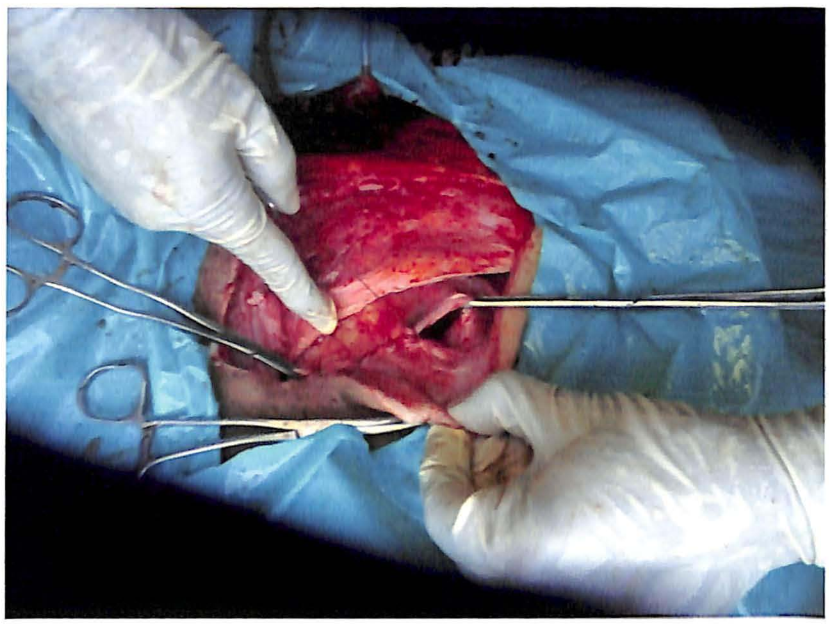


Fig. 26: Closing individual muscle layers.

Fig. 27: Skin closure.

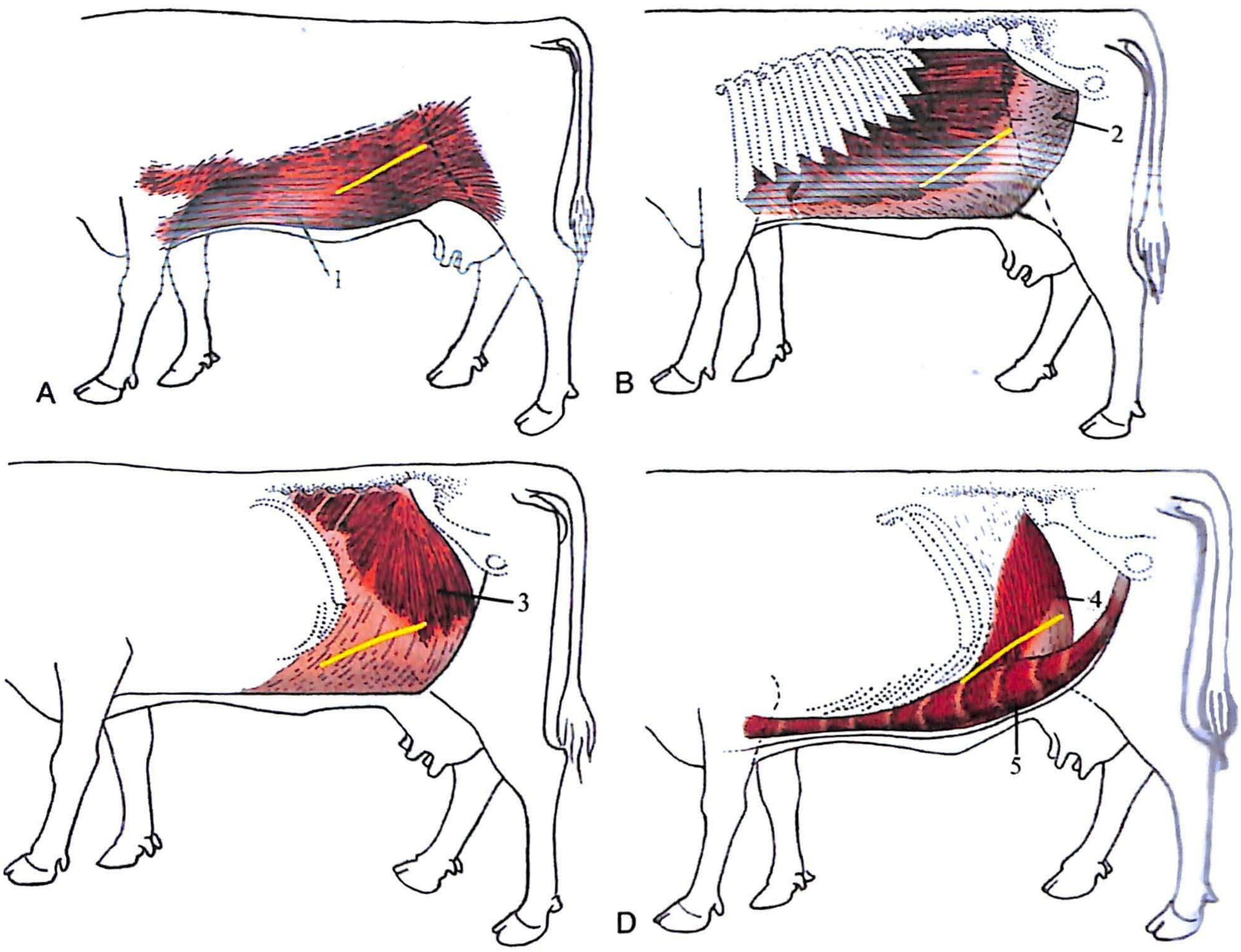


Fig. 28: Proposed site of incision.

The incision was given on the lower left abdomen starting from a point just above the level of the stifle and extending obliquely & cranioventrally up to the last rib.

1. Cutaneous trunci muscle

2. External abdominal oblique muscle

3. Internal abdominal oblique muscle

4. Transverse abdominis muscle

5. Rectus abdominis muscle

Yellow line is the site of incision

(Reproduced with modification from Dyce KM, Sack WO and Wensing CJG. 2010. Textbook of Veterinary Anatomy, 4th ed., pp-678, Saunders Elsevier, Missouri.)

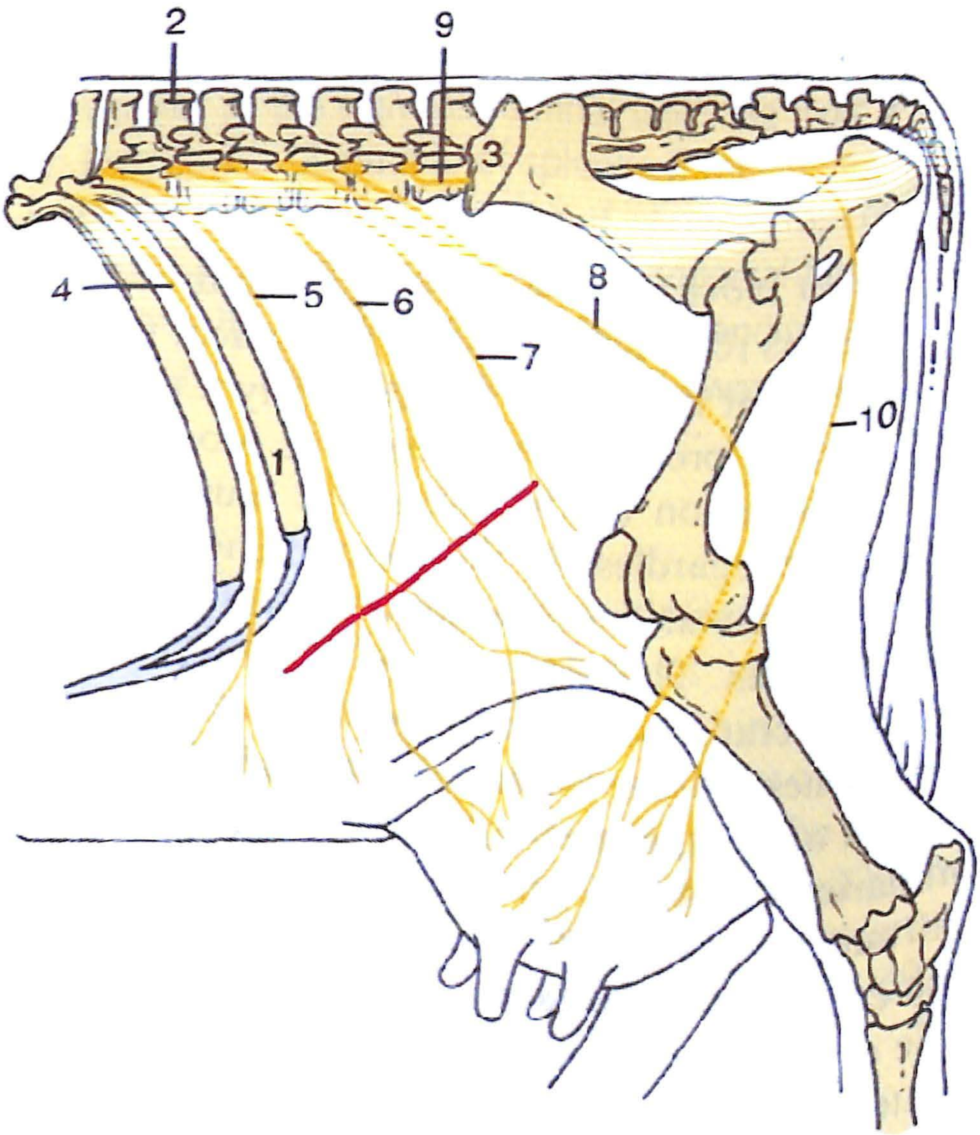


Fig. 29: Nerve supply to the site of incision (diagrammatic representation, the dorsal branches of the spinal nerves to upper parts of the flank are not shown).

1. Last rib
2. Spinous process of L2
3. Tuber coxae
4. Twelfth intercostal nerve
5, 6, 7. T 13, L1, L2 spinal nerves respectively
8. L3, L4 spinal nerve
9. Ventral perineal nerve

Red line indicates site of incision.

(Reproduced with modification from Dyce KM, Sack WO and Wensing CJG. 2010. Textbook of Veterinary Anatomy, 4th ed., pp-679, Saunders Elsevier, Missouri.)

CHAPTER-IV

RESULTS

CHAPTER-IV
RESULTS

This study included 16 undiagnosed clinical cases of suspected obstruction of the gastrointestinal tract in cattle. Although a specific preoperative diagnosis could not be made in these animals, the findings of the detailed examination were carefully recorded and analyzed.

4.1. INCIDENCE

Out of 16 presented cases 15 (94%) were females and one (6%) was a castrated male, thirteen were crossbred Jersey animals and 3 were nondescript animals. The animals aged between 1 to 8 years with a mean ± SE of 4.72 ± 0.47 years and had a mean± SE body weight of 265.62 ± 20.78 kg. Two animals were below 2 years of age and the rest 13 were adult females out of which 7 were dry, 6 were lactating and only one dry animal was pregnant. Only 3 cows were uniparous and 9 were multiparous (Table 3). Eleven animals (68.75%) in the study had diseases of the forestomachs, 2 animals (12.5%) had cecal affections, 2 animals (12.5%) had diaphragmatic hernia and 1 animal (6.25%) had intestinal volvulus (Table 6).

4.2. CLINICAL EXAMINATION

4.2.1. Vital signs

Temperature: The alterations in body temperature have been shown in table 8 and figure 30. In group I the mean ± SE of body temperature on the day of operation was 101.07±0.27 ^{0}F which significantly ($p<0.01$) increased on 1st and 2nd post operative day and decreased significantly ($p<0.01$) to normal basal value on 3rd and 7th post operative day. In group II the mean ± SE of body temperature on the day of operation was 102.13±0.18 ^{0}F which significantly ($p<0.05$) increased on 1st and 2nd post operative day and decreased significantly ($p<0.01$) to normal values on 3rd and 7th post operative day.

The body temperature of group II was significantly ($p<0.05$) higher than Group I on the day of operation and 7th post operative day but no significant difference ($p>0.05$) was observed on 1st, 2nd, and 3rd post operative days.

Pulse: The variation in pulse rates of different groups has been presented in table 9 and figure 31. In group I the mean ± SE of pulse rate was 78.6±2.01 /min on the day of operation which decreased insignificantly ($p>0.05$) on day 3 but significantly ($p<0.05$) on day 7 and the day 7 pulse rate was significantly ($p<0.05$) lower than the base value. In group II the mean ± SE of pulse rate was 83±8.54/min on the day of operation which decreased gradually but insignificantly ($p>0.05$) on day 3 and day 7. The pulse rate of group II was insignificantly higher ($p>0.05$) on day 0, but lower on day 3 and day 7 than that of group I.

Respiration: Observations of respiratory rate of different groups have been recorded in table 10. The mean ± SE of respiration rate in group I was 19.4±0.83 breaths/ minute and in group II was 18.67±2.87 breaths/minute which did not show any significant ($p>0.05$) variation on different days, and the variation between the groups on different days was also insignificant ($p>0.05$).

Examination of visible mucous membrane (VMM): In group I, the visible mucous membrane was bright in 1 animal, pale in 2 animals and pink in 7 animals, but in group II it was bright in 1 animal, pale in 2 animals and pink in 3 animals. The observations have been recorded in table 5.

Capillary Refill time (CRT): In group I, CRT was < 2 sec in two animals, 2 seconds in six animals, and 3 seconds in two animals. In group II, CRT was 2 seconds in four animals, 3 seconds in one animal and 5 seconds in one animal. The observations have been recorded in table 5.

Dehydration status: In group I, two animals had no dehydration. Six animals were mildly dehydrated (6-7%) and two animals were moderately dehydrated (8-9%). In group II, four animals were mildly dehydrated (6-7%), one animal was moderately dehydrated (8-9%), and one animal was severely dehydrated (10%). The findings are noted in table 5.

4.2.2. Examination abdominal contour

The abdominal contour could not be studied in 4 animals due to recumbency, no abdominal distension was observed in three animals. The observations of the rest of the animals are summarized in table 5.

4.2.3. Palpation of abdominal organs

Palpation of left and right abdominal wall could not be able to give much diagnostic information in these cases. In two cases deep palpation below the right costal arch resulted in pain but the source could not be identified. In one animal in Group II abdominal wall was painful to touch. In the remaining animals it did not reveal any useful diagnostic information. The observations are presented in table 5.

4.2.4. Rumen Motility

The changes in rumen motility in different groups have been recorded in table 11 and figure 32. In group I, there was a lower mean ± SE of rumen motility (1.6±0.52/ 5 min) which significantly ($p<0.05$) increased on day 3 and day 7 to normal. In group II, the basal mean ± SE of rumen motility was 4.5±2.26/ 5 min which gradually but insignificantly ($p<0.05$) increased on day 3 and day 7. The rate of rumen motility in group II was insignificantly ($p<0.05$) higher than that of group I.

4.2.5. Auscultation, percussion and Ballotement

The details of auscultation, percussion and ballotment are summarized in table 5. In one animal of group I abdominal ballotment revealed fluid splashing sound in rumen and in one animal in group II fluid splashing in rumen and intestines was audible.

4.2.6. Examination with metal detectors

In group I, three out of ten animals and in group II, four out of six animals tested positive for metals. Out of the 7 animals that tested positive for metals, two animals were diagnosed to suffer from traumatic reticulitis on exploration. In the rest five animals only blunt non potential metallic foreign bodies were recovered. The observations are noted in table 5.

4.2.7. Examination for abdominal pain

In group, I five animals were positive for both withers pinch test and pole test, three animals were negative for any of these tests, and two animals were positive for pole test but negative for withers pinch test. In group II, three animals were positive for both tests, one animal was negative for either of these tests, and two animals were positive for withers pinch test but negative for pole test. The details are recorded in table 5.

4.2.8. Rectal palpation

Rectal palpation was not possible in two animals due to their small size, and the observations in remaining animals have been summarized in table 5.

4.3. LABORATORY EXAMINATION

4.3.1. Ruminal pH

The findings on ruminal pH of different groups have been presented in table 12 and figure 33. In group I, the mean ± SE of rumen pH was 8.1±0.23 which significantly ($p<0.01$) decreased to normal values on day 3 and day 7. In group II, the mean ± SE of rumen pH was 6±0.36 which insignificantly ($p>0.05$) increased to normal values on day 3 and day 7. There was a significant difference among the two groups on day 0 ($p<0.01$) and day 3($p<0.05$), but no difference on day 7.

4.3.2. Rumen protozoa

The observations on activity of rumen protozoa in different groups have been presented in table 13 and figure 34. In group I, the basal mean ± SE of rumen protozoa count on day 0 was low which increased steadily and significantly ($p<0.01$) on day 3 and day7. In group II, the basal mean ± SE of rumen protozoa count on day 0 was also low which increased insignificantly ($p>0.05$) on day 3, but significantly ($p<0.05$) on day7. There was no significant difference ($p>0.05$) among the groups on different days.

4.3.3. Rumen Chloride content

The changes in rumen chloride content in different groups have been given in table 14 and figure 35. In group I, the mean ± SE of rumen chloride concentration was 22.9±1.04 mEq/L which decreased significantly ($p<0.01$) on day 3 and day 7. In group II, the mean ± SE of rumen chloride concentration was 32.17±2.90 mEq/L which decreased significantly ($p<0.05$) on day 3 and day 7. Comparison among the groups revealed significant difference ($p<0.05$) on different days.

4.3.4. Hematologic parameters

PCV: The variation of PCV in different groups of animals has been presented in table 15 and figure 36. In group I, the mean ± SE of PCV was 38.9±0.98% on day 0 which gradually and significantly ($p<0.01$) decreased on day 3 and day 7. In group II, the mean ± SE of PCV was 37±1.97% on day 0 which also gradually and significantly decreased on day 3 ($p<0.01$) and day 7 ($p<0.05$).No significant difference among the groups was found on comparison.

Hemoglobin: The observation on hemoglobin of different animals has been recorded in table 16 and figure 37. In group I, the mean ± SE of hemoglobin was 9.01±0.31gm% on day 0 which decreased significantly ($p<0.01$) on day 3 and day 7. In group II, the mean ± SE of hemoglobin was 8.67±0.36gm% on day 0 which slightly and insignificantly ($p>0.05$) decreased on day 3 but insignificantly ($p>0.05$) increased on day 7. No significant difference was observed between the groups on comparison.

Total Leucocyte count (TLC): The alterations in TLC have been presented in table 17 and figure 38. In group I, the mean ± SE of TLC was 10,985±1004.55/mm^3 on day 0 which slightly and insignificantly ($p>0.05$) decreased on day 3 and day 7. In group II, the mean ± SE of TLC was 14,483.33±2205.21/mm^3 on day 0 which slightly and insignificantly ($p>0.05$) decreased on day 3 and day 7. On comparison the values for group II were found to be insignificantly higher ($p>0.05$) than that of group I.

Neutrophil count: The variations in neutrophil count in different groups have been given in table 18 and figure 39. In group I, the basal mean ± SE of neutrophils was 49.3±5.84% which decreased insignificantly ($p>0.05$) on day 3 and significantly ($p<0.05$) on day 7. In group II, the basal mean ± SE of neutrophils was 62.17±7.92 % which decreased significantly ($p<0.05$) on day 3 and 7. There was no significant difference between the groups on comparison.

Lymphocyte count: The changes in lymphocytes have been presented in table 19 and figure 40. In group I, the basal mean ± SE of lymphocytes was 45.4±5.42% which increased insignificantly ($p>0.05$) on day 3 and significantly ($p<0.05$) on day 7. In group II, The basal mean ± SE of lymphocytes was 35±8.06% which increased significantly ($p<0.05$) on day 3 and 7. There was no significant difference ($p>0.05$) between the groups.

4.3.5. Serum Electrolytes

Sodium: The variations in serum sodium concentrations of different groups of animals have been summarized in table 20 and figure 41. In group I, the mean ± SE of serum sodium was 129±1.98 mmol/L on day 0 which significantly ($p<0.01$) increased on day 3 and day 7. In group II, the mean ± SE of serum sodium was 133.83±1.35 mol/L on day 0 which significantly increased on day 3 ($p<0.05$) and day 7 ($p<0.01$). Comparison revealed significant difference ($p<0.05$) between the groups on day 7, no significant difference ($p>0.05$) on day 0 and day 3.

Potassium: Observations on serum potassium concentration have been shown in table 21 and figure 42. In group I, the mean ± SE of serum potassium was 3.48±0.13 mmol/L on day 0 which significantly ($p<0.01$) increased on day 3 and day 7. In group II, the mean ± SE of serum potassium was 3.17±0.11 mmol/L on day 0 which significantly increased on day 3 ($p<0.05$) and day 7 ($p<0.01$). There was no significant difference ($p>0.05$) between the groups on different days.

Calcium: The changes in serum calcium of different groups of animals have been depicted in table 22 and figure 43. In group I, the mean ± SE of serum calcium was 8.82±0.28 mg/dL on day 0 which significantly ($p<0.01$) increased on day 3 and day 7. In group II, the mean ± SE of serum calcium was 8.67±0.27 mg/dL on day 0 which significantly ($p<0.01$) increased on day 3 and day 7. There was no significant difference ($p>0.05$) among the groups on different days.

Chloride: The alterations of serum chloride levels in various groups have been presented in table 23 and figure 44. In group I, the mean ± SE of serum chloride was 87.9±3.69 mmol/L on day 0 which significantly ($p<0.01$) increased on day 3 and day 7. In group II, the mean ± SE of serum chloride was 86.83±2.6 mmol/L on day 0 which significantly increased ($p<0.01$) on day 3 and day 7. There was no significant difference ($p>0.05$) among the groups on different days.

4.4. DIAGNOSIS

This study included 16 cases in which detailed examination as described above did not conclusively lead to a definitive diagnosis. In these animals radiography or ultrasonography was indicated for a complete diagnosis. As these facilities were not available, surgical exploration was undertaken through a left ventrolateral oblique laparotomy approach.

4.5. ANESTHESIA

Regional anesthesia was achieved either by paravertebral block (n=10) or linear infiltration (n=6). In the paravertebral technique 45 to 60 ml of 2% lidocaine was sufficient for induction of regional block. There was good analgesia of the abdominal wall including the peritoneum; however, sensation of the superficial cutaneous trunci muscle was found to be retained.

In the linear infiltration technique 30-50 ml of 2% lidocaine was adequate for desensitization of the abdominal wall. The line of anesthetic infiltration was given sufficiently above the proposed line of incision. The cutaneous trunci muscle was desensitized in all animals but sensation of the peritoneum was found to be retained. Out of sixteen animals, five required sedation with xylazine as they were uncooperative. In two animals, 0.03 mg /kg of xylazine induced sedation and in another 3 animals a slightly higher dose 0.05mg/kg was needed.

4.6. SURGICAL EXPLORATION, DIAGNOSIS AND TREATMENT

As laparotomy was done by grid technique, during blunt dissection the spinal nerves could be retracted safely without the need for transection and bleeding was minimal in all cases.

4.6.1. Laparotomy and exteriorization of rumen

Group I: A 15 to 30 cm long incision was adequate for the purpose of laparotomy and subsequent exploration. The rumen could be exteriorized easily in 6 cases. In 4 cases after carefully packing of the exteriorized part of the rumen, decompression was done by giving a small incision and releasing some of the gas after which complete exteriorization of the site of incision on dorsal sac became easy.

Group II: A 20 to 30 cm incision was adequate for laparotomy and subsequent exploration. In one case extension of the incision was required for abomasotomy for better exteriorization. In two cases the rumen was easily exteriorized and in another two cases the rumen could be exteriorized after removal of some amount of ingesta from a small incision with utmost care not to soil the peritoneal cavity with ruminal contents. In the rest two cases, some amount of frothy material was removed through a small inicision and then the dorsal sac was easily exteriorized.

4.6.2. Exploratory diagnosis and treatment

Since a preoperative diagnosis could not be achieved in these 16 cases under study, abdominal exploration through a left ventrolateral oblique incision formed the basis for diagnosis and discussed below. The results of exploratory diagnosis and treatment have been summarized in table 6.

Group I. In group I, 10 animals were placed in which the diagnosed surgical condition was easily approached and corrected.

In one animal (case no 1) the reticulo-omasal orifice was found to be obstructed with a large phytobezoar (15X6 inches). The rumen contents of this animal were mushy and 3/4th of it could be removed easily. As the phytobezoar was firmly lodged in the reticulo-omasal orifice, considerable difficulty was encountered in dislodging it by gently shaking and rocking.

In 2 animals (case no 2 and 3), trans-ruminal palpation following rumenotomy revealed the omasum to be excessively hard like a football and the abomasum to be empty confirming omasal impaction. The rumen contents in these two animals consisted principally of fibrous materials and small amount of fluid.

Following ruminal emptying, three fingers of left hand inserted into the omasum through the reticulo-omasal orifice revealed hard fibrous impacted feed material some of which could be removed. Then a 3 meter long polythene pipe of 2.5 cm diameter was introduced in to the reticulo omasal orifice through the laparorumenotomy and luke warm water was flushed through the pipe into the omasum. Five minutes of flushing and gentle digital manipulation of the impacted feed materials was successful in breaking the impacted mass and the omasum became soft. On gradual flushing, fluid was felt to be passing in to the abomasum. As soon as the patency of the omaso-abomasal orifice was established by feeling the filling abomsum, flushing was stopped. The excess fluid in the rumen could easily be drained through the laparotomy incision and the rumen was closed.

In 2 animals (case no 4 & 5), exploration of forestomachs revealed ruminoreticular foreign bodies. In one case 80 kg and in another one 70 kg of polythene materials were obtained. Considerable difficulty was faced in removing these polythene materials. In one case after removal of the polythene magnet swapping of the reticulum revealed a large no of blunt non potential metallic foreign bodies.

In 2 animals (case no 6 & 7), on exploration traumatic reticulitis was diagnosed. Considerable amount of polythene materials were removed from the rumen. Magnet swapping retrieved sharp nails from the reticulum. In one case 11 sharp nails were removed which penetrated and lodged in the reticular wall. They were detected by magnets and removed by gentle manipulation with fingers. Fortunately none of these nails penetrated through the full thickness of the reticulum in to the peritoneum or diaphragm and no adhesion was detected in the reticular area. However the reticulum was thickened at the points of penetration of the nails but no reticular abscess was detected. In another case one large nail was removed that penetrated the full thickness of the reticular wall. There was also adhesion of the reticulum with the diaphragm which was not disturbed.

In 3 animals (case no 8, 9 & 10), ruminoreticular foreign bodies with omasal impaction was diagnosed. Fifteen, 40 & 60 kgs of polythene were removed from the three cases respectively. Omasal flushing with luke warm water and digital manipulation of the reticulo-omasal orifice for 5-7 minutes broke down the impacted mass and loosened the contents; the omasum became palpably soft and relatively empty. The patency of omaso-abomasal orifice was established and the rumenotomy incision was closed.

Group II. This group included 6 animals in which the diagnosed surgical cause of obstruction was exteriorized and surgically corrected with "some difficulty" or could not be corrected.

In one animal (case no 1) rumen was emptied of fibrous feed material, some polythene and sand, which were obviously not the cause of obstruction. Exploration of the right side after closing the rumen revealed a dilated and ventrally displaced cecum. With gentle manipulation sufficient length of cecum was exteriorized to perform a typhlotomy. The cecal apex was incised and the contents of the exposed portion of the cecum were evacuated. Then the intra-abdominal portion of the dilated cecum was gently milked out and the entire contents were evacuated. About 5 litres of black putrefied contents and gas were removed. The cecum was closed with two layers of inverting sutures and reposited into the abdomen.

In one animal (case no 2), rumenotomy and exploration of forestomachs yielded fibrous feed materials and some non potential metallic foreign bodies. Exploration of the intestines revealed a volvulus affecting a loop of jejunum in its distal flange. The affected jejunal segment was necrosed and had ruptured spilling intestinal contents all over the peritoneal cavity. There was evidence of severe peritonitis with highly congested serosal surfaces and patchy hemorrhages at many places. The volvulus was reduced, the gangrenous portion of the jejunum and associated mesentery were resected and anastomosis was done with No 0 chromic catgut in inverting cushing pattern. Peritoneal lavage was done using 10 litres of warm normal saline and as much debris as possible were removed.

In one animal (case no 3), the undigested packed feed materials along with some non potential metallic foreign bodies were removed from the rumeno-reticulum. Trans-ruminal palpation revealed a moderately filled hard abomasum. The rumen incision was closed and abomasum was exteriorized. Extension of incision helped to exteriorize the abomasum and hard materials were palpated inside it. Abomasotomy yielded 3 phytobezoars after which the incision was closed in three layers.

In one animal (case no 4), rumen contents, some polythene and non potential metallic foreign bodies were recovered. Exploration of right side revealed dilation of the cecum with ventroflexion. The cecal apex was exteriorized and incised; the contents were removed and the incision was closed with double layer inverting sutures. Close inspection revealed that cecal wall to be devitalized and total typhlectomy from the level of ileocolic orifice was planned. However the proposed site of incision could not be exteriorized, hence a right flank approach was used for cecal ablation on the next day.

In two animals (case no 5 & 6), frothy materials exploded out from the incision on entering the rumen. Ruminal exploration in both cases revealed clear diaphragmatic hernias. The laparotomy was closed and the treatment options for diaphragmatic hernia were explained to the respective owners. Both the owners declined to undertake further treatment and hence a rumenostomy was performed and standard postoperative care was given.

4.7. POSTOPERATIVE CARE

4.7.1. Fluid therapy

All 15 animals received fluid therapy for 1st 3 days that consisted of physiologic saline and 5% dextrose in physiologic saline. Additionally, ten animals with hypocalcemia received calcium borogluconate @ 50-200 ml IV daily. Three animals needed an additional infusion of calcium on 4th day. Based on the serum electrolyte levels fluid was discontinued on 3rd day in 8 animals. Seven animals having electrolyte deficiency or anorexia were given fluid therapy for 2 more days. Four animals were found to be hypokalemic on 3rd postoperative day and were given potassium chloride @ 5-10 gm/ animal orally for 5 days.

4.7.2. Drug therapy

Five days of antibiotic administration was adequate for 13 animals; in 2 animals it was extended for 2 more days. In addition, all animals received metronidazole IV for 3 days to combat anaerobic infection.

Meloxicam was given @ 0.2mg/kg IM for 3 days to 13 animals and Flunixin meglumine @ 1 mg/kg IV for 3 days was given to two animals. Four animals were given neostigmine @ 0.02mg/kg SC twice daily for 2 days to promote intestinal motility under close supervision.

4.7.3. Rumen cud transplantation

On the 3rd postoperative day, 6 animals remained anorectic with low viable protozoal count. One of them had ruminal pH 8 which was corrected by administering 0.5 L of vinegar orally into the rumen. All other animals had normal or slightly acidic pH. All these 6 animals were given 2 liters of rumen cud from fresh goat rumens brought from slaughter house twice on 3rd and 5th day. All animals showed dramatic improvement in appetite and rumination following cud transplantation.

4.7.4. Suture removal

In 12 animals, sutures were removed on 10th day and there was uncomplicated healing of the skin wound. Three animals developed abscesses on the suture line which was treated by draining pus with removal of one or two sutures and then with povidone Iodine dressing. Sutures were removed in these animals on 15th day.

4.8. POSTOPERATIVE FINDINGS

The postoperative findings in different animals have been summarized in table 7.

4.8.1. Appetite

Group I: Eight animals out of 10 started taking water on 2nd day and the rest two on 3rd day. Six animals started taking liquid food when they were offered it first on 3rd day. The rest four refused to take food on 3rd day but slowly started taking it from 5th day onwards following rumen cud transplantation and supportive therapy.

Group II: One animal died on 3rd day. Three started drinking on 2nd day and two on 3rd day. One animal started feeding on 3rd day, two animals on 5th day, but the two animals with diaphragmatic hernia regained appetite partially.

4.8.2. Rumination

Following surgery, 5 animals in group I started ruminating from 2nd post operative day, one on 3rd day, 2 on 4th day and two on 5th day. In group II, three started rumination on 2nd day and two on 5th day.

4.8.3. Fecal output

In group I, Six animals started voiding small amount of feces on 2nd day, 2 animals on 4th day and 2 animals on 5th day. In group II, two animals voided feces on 2nd day and three animals on 3rd day.

4.8.4. Brisket edema

Brisket edema was observed in one animal of group I that was affected with obstruction of the reticulo-omasal orifice with a large phytobezoar. In none of the rest 15 animals— not even in the two animals diagnosed with traumatic reticulitis— this symptom was present. Following surgery and removal of the large phytobezoar, brisket edema disappeared gradually on 4th post operative day.

4.8.5. Ruminal tympany

Postoperatively, 6 animals (4 in group I and 2 in group II) developed ruminal tympany which was relieved by a probang twice daily. It gradually abated with return of ruminal motility and voiding of feces following attempts to promote intestinal motility with intravenous administration of calcium, subcutaneous administration of neostigmine or correction of electrolyte imbalance. In one animal of group I, a temporary rumenostomy was done as the tympany was severe.

4.8.6. Recumbency

Eleven animals in the study got to their feet within 6 hours of surgery; radial paralysis or any other complication was not observed. The 4 animals those were preoperatively recumbent (table 4) remained recumbent after surgery. Out of these 4 animals, one stood with sling support and could bear weight on its own on the 5th day, one stood on its own on the 2nd postoperative day, but the rest two cases did not respond despite all efforts.

4.8.7. Post-operative survival

One animal in group II (case 2) died on 3rd day after surgery. Two animals in group I (case 9 & 10) showed improvement in appetite, fecal output, ruminal motility, and wound healing. But they remained recumbent despite all efforts (medical therapy and sling support). After 7 days they showed deterioration and died on 9th and 11th post operative day. Diaphragmatic herniorrhaphy of two animals in group II was declined by the owners.

4.9. APPROACHABILITY OF DIFFERENT PARTS OF GASTOINTESTINAL TRACT FROM LEFT VENTROLATERAL OBLIQUE LAPAROTOMY SITE

As this study was conducted on undiagnosed cases of gastrointestinal obstruction in cattle using left ventrolateral oblique laparotomy approach, a systematic exploration of the forestomachs and the small and large intestines were done in every case to establish a diagnosis. During exploration, the approachability of the gastrointestinal tract was carefully observed and noted.

Parts of the gastrointestinal tract palpable and exteriorizable

Rumen (reticulum and reticulo-omasal orifice accessible from rumenotomy site)

Abomasum

Jejunum— except a small proximal portion.

Cecum— 2/3rd of its length from the blind end.

Parts of the gastrointestinal tract palpable but not exteriorizable

Ascending duodenum from caudal flexure to the beginning of jejunum

Proximal portion of jejunum

Ileum

Cecum—1/3rd of its length from ileocecocolic junction.

Colon- proximal loop and spiral loop

Descending colon

Peritoneal part of rectum

Parts of the gastrointestinal tract not palpable and not exteriorizable

Descending duodenum up to caudal flexure

Colon- distal loop and transverse colon

Table 5. Summary of clinical examination.

Group	Case No	Abdominal contour	Palpation	Auscultaion	Auscultation and percussion
		1	2	3	4
I	1	Lower L part distended	NAD	NAD	NAD
	2	L upper, R lower part distended	NAD	NAD	Tympanitic resonance on left upper flank
	3	Bilateral lower part distended	Pain on deep palpation R side	NAD	NAD
	4	No distension	NAD	NAD	NAD
	5	Recumbent, not examined	NAD	No intestinal sounds	NAD
	6	R lower quadrant distended	Rumen doughy	NAD	NAD
	7	No distension	Rumen doughy	NAD	NAD
	8	Recumbent, not examined	Rumen doughy	NAD	Tympanitis resonance on left upper flank
	9	Recumbent, not examined	Rumen doughy	No intestinal sounds	Tympanitis resonance on left upper flank
	10	Recumbent, not examined	Pain on deep palpation R side	No intestinal sounds	NAD
II	1	Bilateral lower part distended	NAD	No intestinal sounds	Tympanitis resonance on both flanks
	2	Bilateral lower part distended	Painful to touch	NAD	NAD
	3	Bilateral Lower part & L upper part distended	Rumen doughy	NAD	Tympanitis resonance on left upper flank
	4	Bilateral lower and L upper part distended	Gas filled rumen	No intestinal sounds	Tympanitis resonance on both flanks.
	5	L upper part distended	NAD	rumen sounds not audible	Tympanitic resonance
	6	L upper part distended	NAD	rumen sounds not audible	Tympanitic resonance

Table 5. Summary of clinical examination...contd...

Goroup	Case No	Ballotment	Rectal palpation	Exam with metal detector	Withers pinch test	Pole test	VMM	CRT in sec	Dehydration %
		5	6	7	8	9	10	11	12
I	1	Fluid splashing rumen	No fecal material	- ve	- ve	+ ve	Pale	2	6
	2	NAD	Not possible	- ve	+ ve	+ ve	Pink	2	6
	3	NAD	Few hard beads of feces in empty rectum	- ve	- ve	+ ve	Pink	2	6
	4	NAD	Rectum empty	- ve	- ve	- ve	Pink	<2	0
	5	NAD	Small amount of hard fecal balls in rectum	+ ve	+ ve	+ ve	Pale	2	6
	6	NAD	Rectum empty	+ ve	+ ve	+ ve	Pink	3	8
	7	NAD	Rectum empty	+ ve	- ve	- ve	Pink	<2	0
	8	NAD	Not possible	- ve	- ve	- ve	Pink	3	8
	9	NAD	Empty rectum, dilated rumen	- ve	+ ve	+ ve	Pink	2	6
	10	NAD	Empty rectum	- ve	+ ve	+ ve	Brigh t	2	6
II	1	Fluid splashing rumen and intestines	Rumen distended, dilated intestines felt	- ve	+ ve	- ve	Pink	3	8
	2	NAD	Empty rectum with mucous	+ ve	+ ve	+ ve	Pale	5	10
	3	NAD	Enlarged rumen, empty rectum	+ ve	- ve	- ve	Pale	2	6
	4	NAD	Empty mucoid material	+ ve	+ ve	- ve	Pink	2	6
	5	NAD	Distended rumen, soft scanty fecal material	+ ve	+ ve	+ ve	Brigh t	2	6
	6	NAD	Distended rument soft scanty fecal material	- ve	+ ve	+ ve	Pink	2	6

CRT- Capillary Refill Time, VMM-Visible Mucous Membrane, NAD- No Abnormality Detected, L- Left, R- Right.

Table 6. Result of exploration.

Group	Case No.	Exploratory Diagnosis	Surgery performed
I	1	Obstruction of reticulo-omasal orifice with phytobezoar	Rumenotomy and removal of the phytobezoar
	2	Omasal impaction	Rumenotomy and omasal flushing
	3	Omasal impaction	Rumenotomy and omasal flushing
	4	Rumenoreticular foreign bodies	Rumenotomy and removal of polythene and metallic foreign bodies
	5	Rumenoreticular foreign bodies	Rumenotomy and removal of polythene and metallic foreign bodies
	6	Traumatic Reticulitis	Rumenotomy and removal of polythene & nails
	7	Traumatic Reticulo-peritonitis (localized)	Rumenotomy and removal of polythene & nails
	8	Rumenoreticular foreign bodies with omasal impaction	Rumenotomy and removal of foreign bodies and omasal flushing
	9	Rumenoreticular foreign bodies with omasal impaction	Rumenotomy and removal of foreign bodies and omasal flushing
	10	Rumenoreticular foreign bodies with omasal impaction	Rumenotomy and removal of foreign bodies and omasal flushing
II	1	Cecal dilation and displacement	Typhlotomy
	2	Intestinal volvulus	Resection and anastomosis
	3	Pyloric obstruction with phytobezoar	Abomasotomy
	4	Cecal dilation, ventroflexion & necrosis	Total typhlectomy*
	5	Diaphragmatic hernia	Herniorrhaphy declined
	6	Diaphragmatic hernia	Herniorrhaphy declined

*Total typhlectomy was done by a second right flank approach as ileo-ceco-colic orifice was not exteriorizable from the left ventrolateral oblique site.

Table 7. Post-operative findings.

Group	Case no	Water intake #	Feeding#	Rumination#	Fecal output#	Post operative tympany	Post operative survival
I	1	2	3	2	2	No	Recovered
	2	2	5	4	3	Yes	Recovered
	3	2	3	3	2	No	Recovered
	4	2	3	2	2	No	Recovered
	5	2	3	2	2	No	Recovered
	6	2	5	4	3	Yes	Recovered
	7	2	3	2	2	No	Recovered
	8	2	3	2	2	No	Recovered
	9	3	5	5	5	Yes	Died on 9th day
	10	3	5	5	5	Yes	Died on 11th day
II	1	3	5	5	3	Yes	Recovered
	2	--	--	--	--	--	Died on 3rd day
	3	2	3	2	2	No	Recovered
	4	3	5	5	3	Yes	Recovered
	5	2	3	2	2	Rumenostomy	**
	6	2	3	2	2	Rumenostomy	**

The figures indicate the corresponding post-operative day on which feeding, drinkin, etc started, day 0 being the day of operation.

**Specific treatment declined by owners, the animals lived with rumenostomy.

Table 8. Mean ± SE values of temperature (^{0}F) in the animals of different groups

Groups	Day 0	Day 1	Day 2	Day 3	Day 7
Group I	101.07 ±0.27a	102.45 ±0.17b**	102.4 ±0.14b**	101.15 ±0.18a	100.81 ±0.16a
Group II	102.13 ±0.18b	102.58 ±0.17c*	102.32 ±0.13c*	101.6 ±0.24a**	101.46 ±0.07a**

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 9. Mean ± SE values of pulse rate/min in the animals of different groups

Groups	Day 0	Day 3	Day 7
Group I	78.6±2.01b	77±1.46b	75±1.19a*
Group II	83±8.54	74.6±6.33	70.2±4.61

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 10. Mean ± SE values of respiration (breaths/ minute) in different groups

Groups	Day 0	Day 3	Day 7
Group I	19.4±0.83	18.3±0.68	18.2±0.66
Group II	18.67±2.87	16.8±2.87	17.4±2.87

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 11. Mean ± SE values of rumen motility (contractions/5 min) in different groups

Groups	Day 0	Day 3	Day 7
Group I	1.6±0.52a	3.4±0.73b**	6.5±0.34c**
Group II	4.5±2.26	6.4±1.69	8±1.05

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 12. Mean ± SE values of rumen pH in the animals of different groups

Groups	Day 0	Day 3	Day 7
Group I	8.1±0.23b	7.1±0.1a**	7±0a**
Group II	6±0.36	6.6±0.24	7±0

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 13. Mean ± SE values of rumen protozoan count in different groups

Groups	Day 0	Day 3	Day 7
Group I	0.8±0.25a	1.7±0.21b**	2.5±0.17c**
Group II	1±0.36a	1.6±0.24	2.2±0.2b*

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 14. Mean ± SE values of rumen chloride (mEq/L) in different groups.

Groups	Day 0	Day 3	Day 7
Group I	22.9±1.04b	18±0.47a**	18.7±0.33a**
Group II	32.17±2.90b	20±0.55a*	20.2±0.37a*

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 15. Mean ± SE values of PCV (%) in the animals of different groups

Groups	Day 0	Day 3	Day 7
Group I	38.9±0.98b	37.7±1.03a**	37.5±0.98a**
Group II	37±1.97b	34.4±1.54a**	34.6±1.43a*

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 16. Mean ± SE values of Hemoglobin (gm %) in different groups

Groups	Day 0	Day 3	Day 7
Group I	9.01±0.31b	8.79±0.29a**	8.79±0.29a**
Group II	8.67±0.36	8.46±0.41	8.66±0.38

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 17. Mean ± SE values of TLC in the animals of different groups

Groups	Day 0	Day 3	Day 7
Group I	10985±1004.55	10475±694.95	10055±578.43
Group II	14483.333±2205.21	12200±1589.65	11200±1156.29

* Significantly different from the base value (Day 0) (P<0.05)** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 18. Mean ± SE values of Neutrophil count (%) in different groups

Groups	Day 0	Day 3	Day 7
Group I	49.3±5.84b	44.2±3.57	40.1±1.89a*
Group II	62.17±7.92b	47.6±5.77a*	39.4±2.56a*

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 19. Mean ± SE values of Lymphocyte count (%) in different groups

Groups	Day 0	Day 3	Day 7
Group I	45.4±5.42a	51±3.02a	56.2±1.67b*
Group II	35±8.06a	47.8±5.95b*	52.2±5.40b*

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 20. Mean ± SE values of serum sodium (mmol/L) in different groups.

Groups	Day 0	Day 3	Day 7
Group I	129±1.98a	134.4±0.97b**	136.4±0.37b**
Group II	133.83±1.35a	136±1.87b*	138.8±1.39c**

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 21. Mean ± SE of serum potassium (mmol/L) values in different groups.

Groups	Day 0	Day 3	Day 7
Group I	3.48±0.13a	3.89±0.11b**	4.17±0.06c**
GroupII	3.17±0.11a	3.62±0.17b*	4.26±0.06c**

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 22. Mean ± SE values of Serum calcium (mg/dL) in different groups.

Groups	Day 0	Day 3	Day 7
Group I	8.82±0.28a	9.56±0.19b**	9.96±0.07c**
Group II	8.67±0.27a	9.78±0.30b**	10.16±0.30b**

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

Table 23. Mean ± SE values of Serum chloride (mmol/L) in different groups.

Groups	Day 0	Day 3	Day 7
Group I	87.9±3.69a	96.9±1.46b**	100±0.60c**
Group II	86.83±2.6a	94±2.66b**	98.2±0.92b**

* Significantly different from the base value (Day 0) (P<0.05) ** (P<0.01)
Values with different subscripts in a row differ significantly.

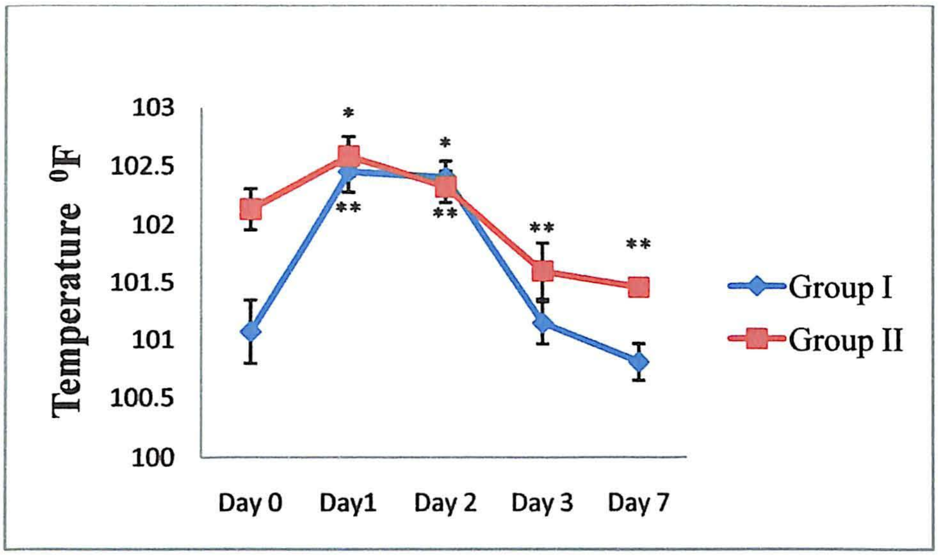


Fig. 30: Mean ± SE values of temperature (^{0}F).

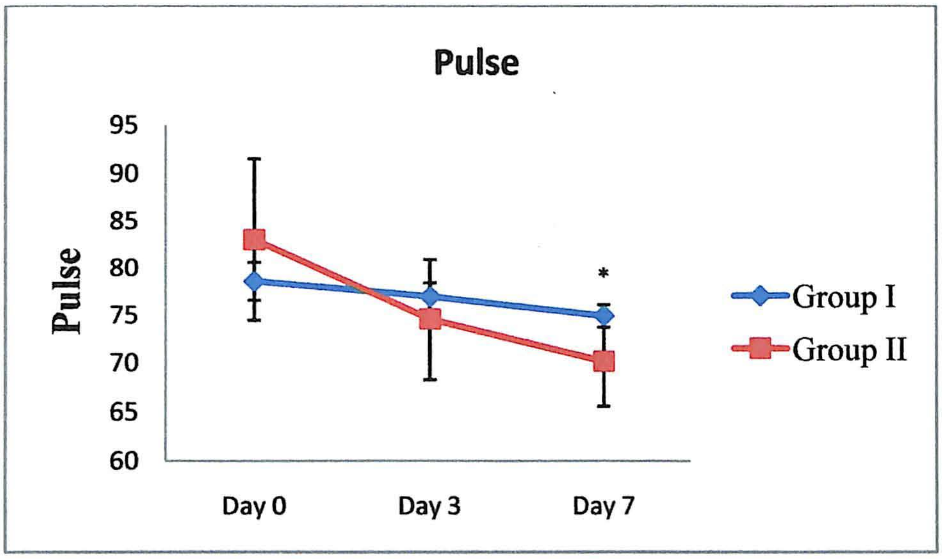


Fig. 31: Mean ± SE values of pulse /minute.

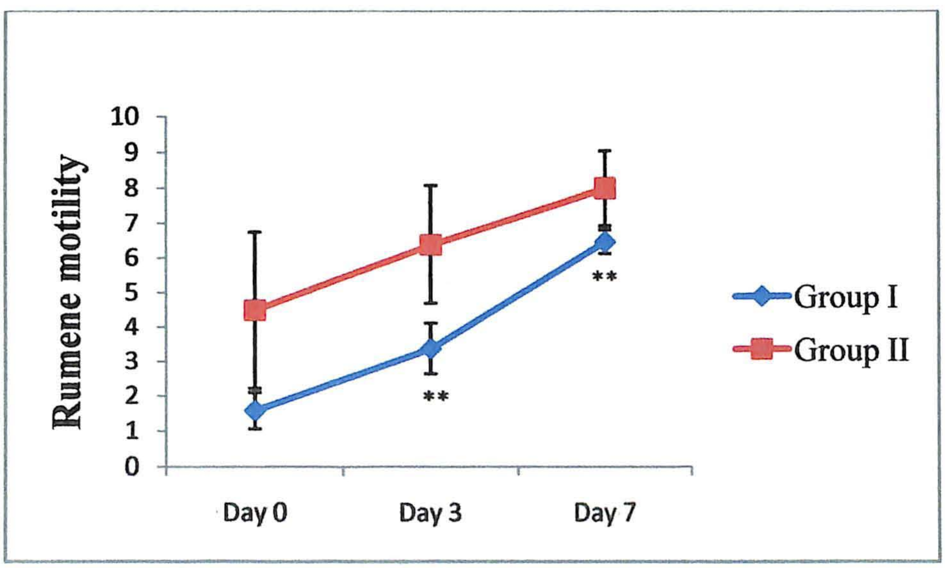


Fig. 32: Mean ± SE values of rumen motility (contractions/5min).

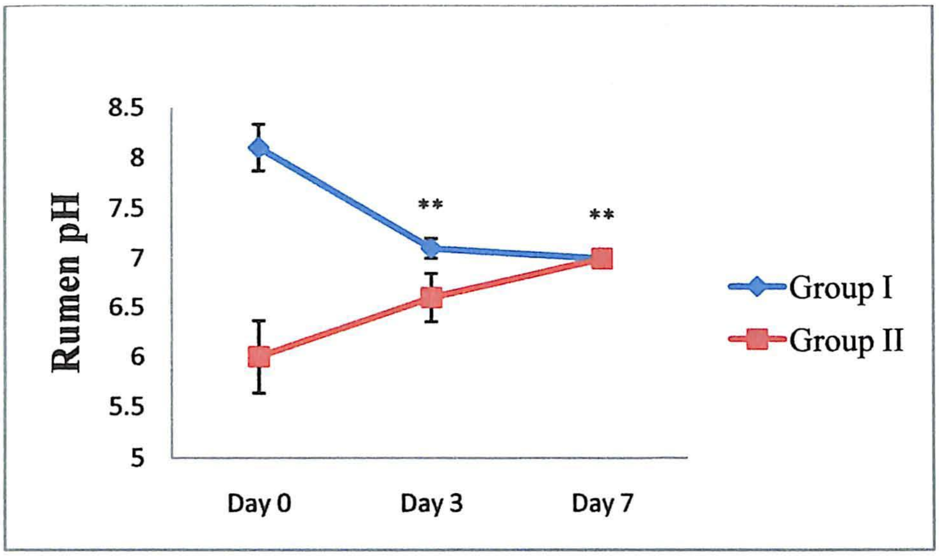


Fig. 33: Mean ± SE values of rumen pH.

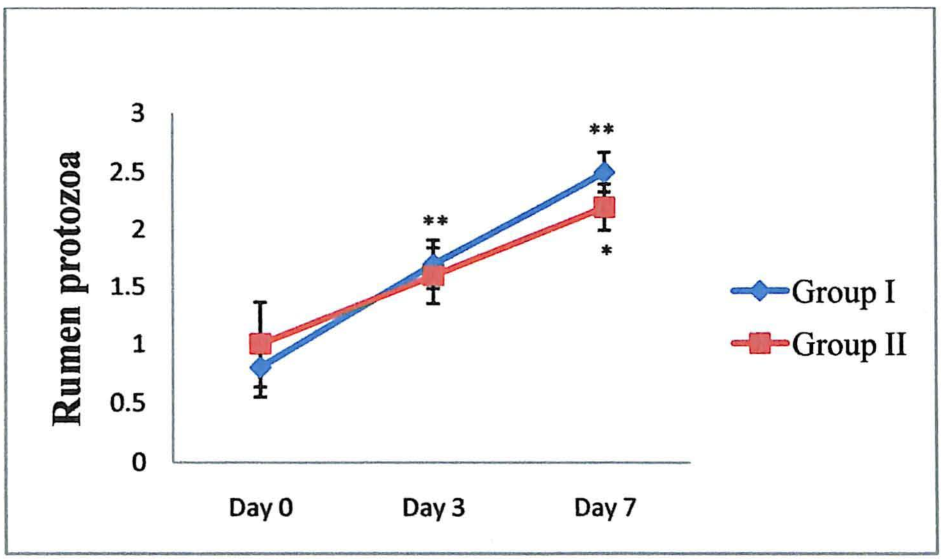


Fig.34: Mean ± SE values of rumen protozoan count.

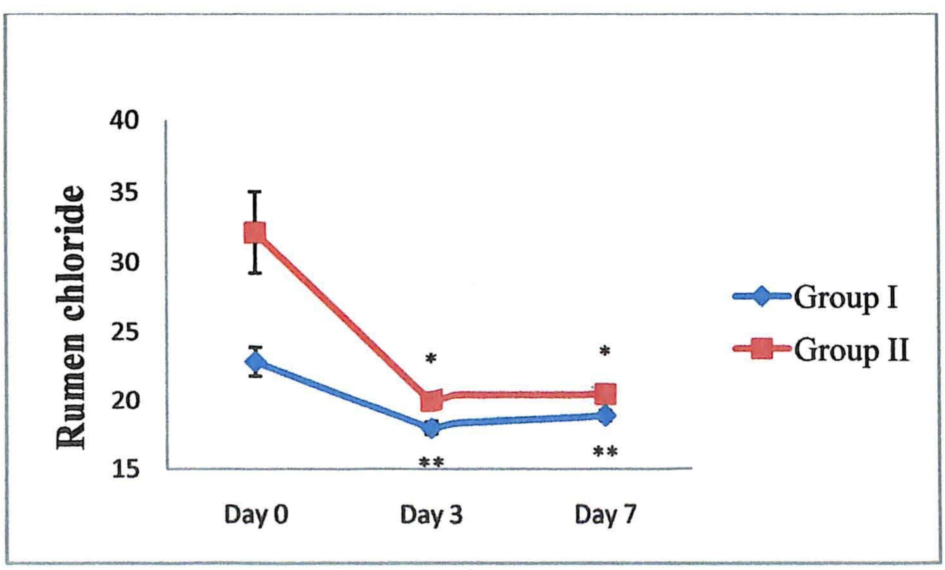


Fig.35: Mean ± SE values of rumen chloride (mEq/L).

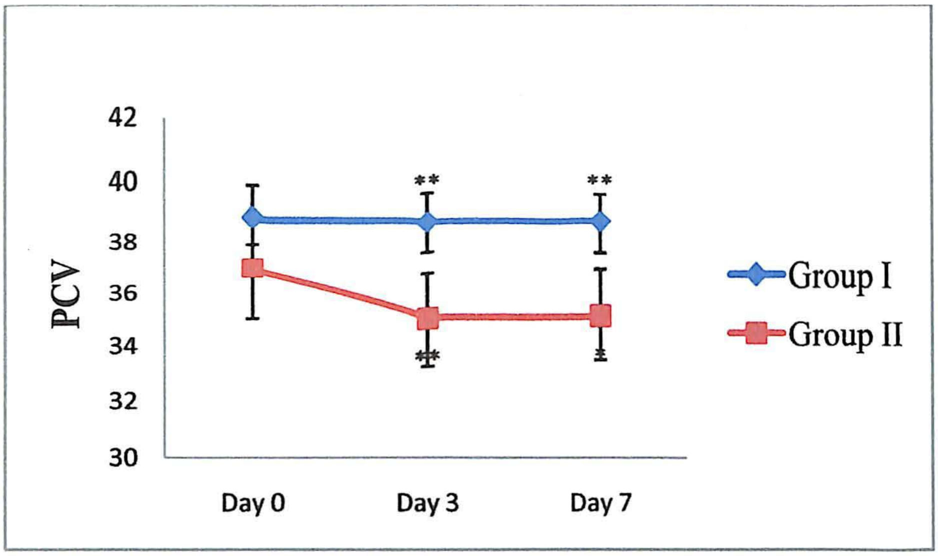


Fig. 36: Mean ± SE values of PCV (%).

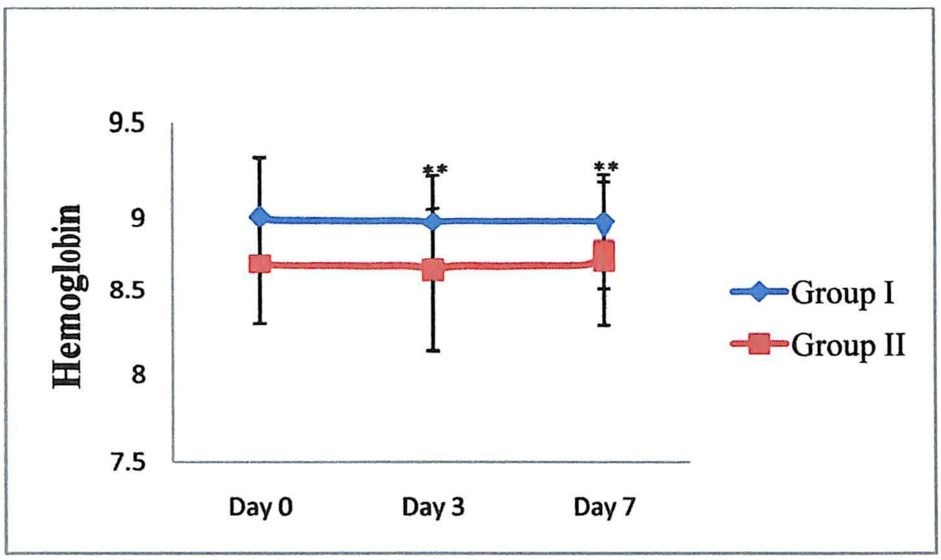


Fig. 37: Mean ± SE values of Hemoglobin gm%.

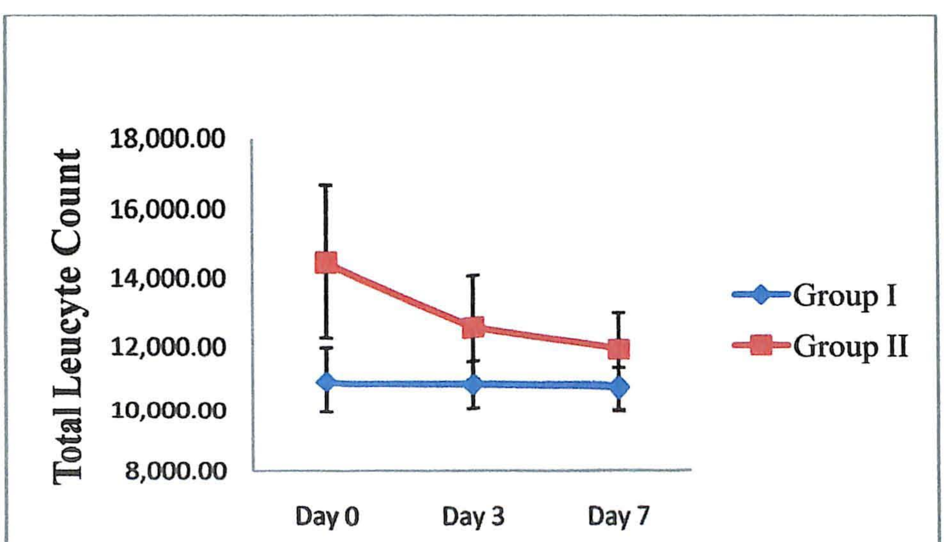


Fig. 38: Mean ± SE values of TLC.

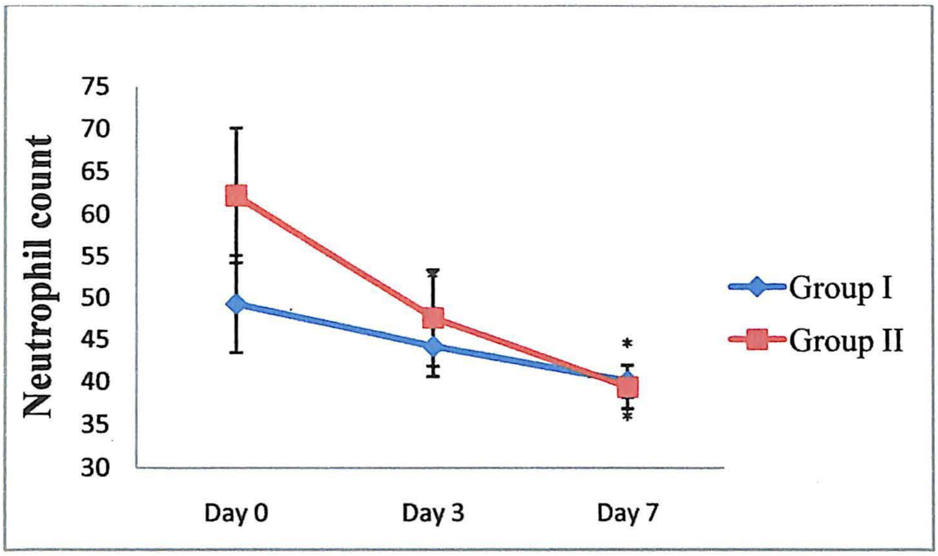


Fig. 39: Mean ± SE values of Neutrophil count (%).

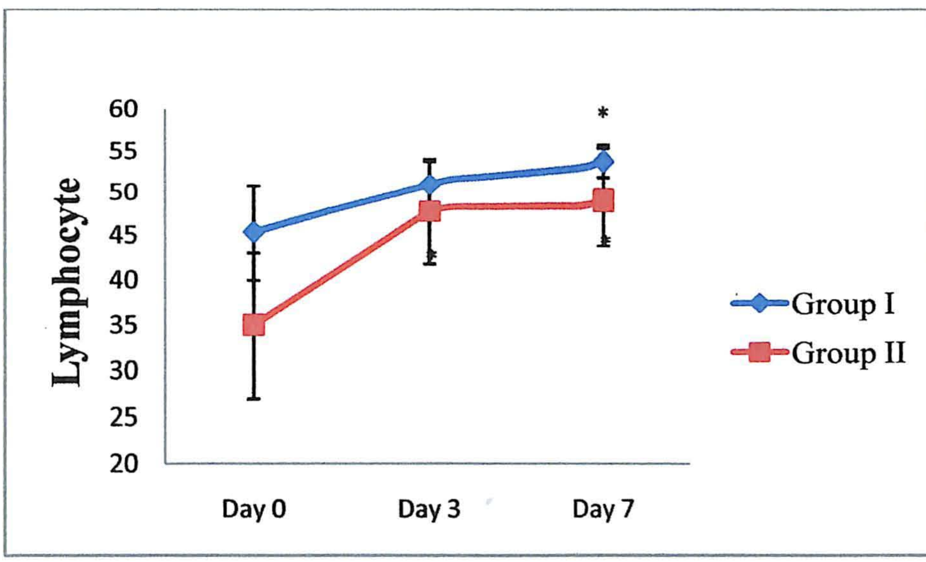


Fig. 40: Mean ± SE values of Lymphocytes count (%).

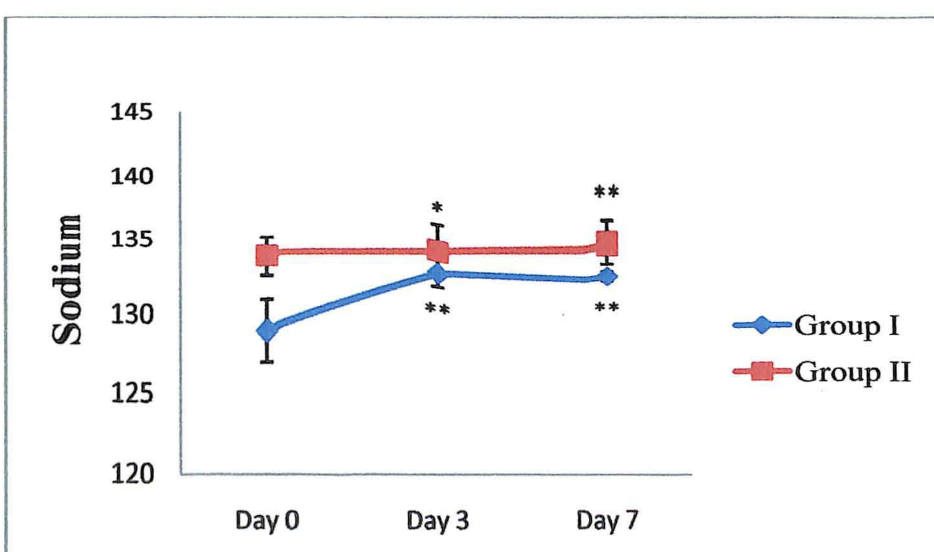


Fig. 41: Mean ± SE values of serum sodium (mmol/L).

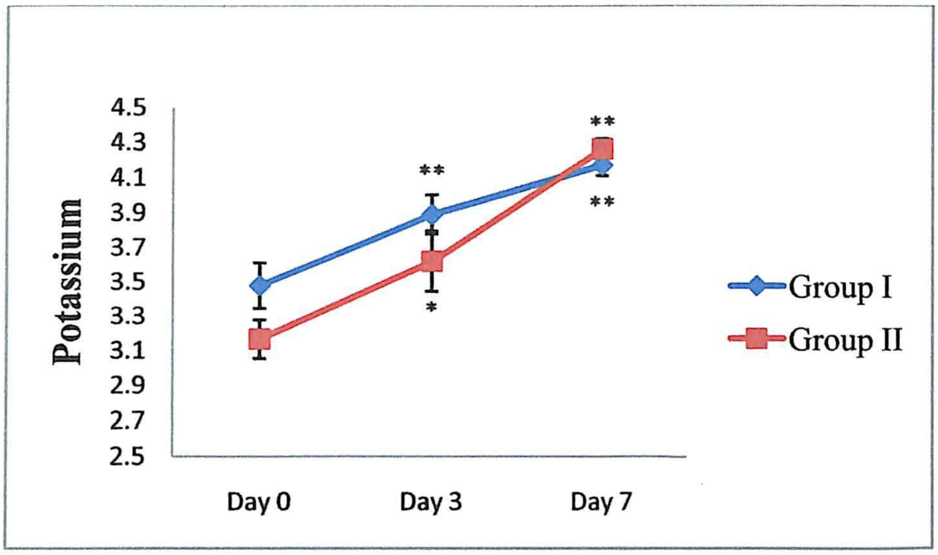


Fig. 42: Mean ± SE of serum potassium (mmol/L).

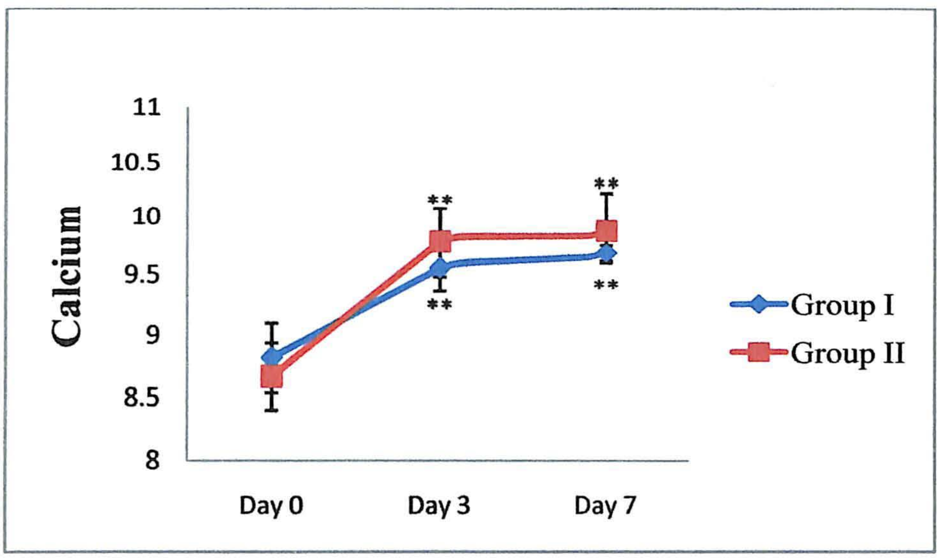


Fig. 43: Mean ± SE values of Serum calcium (mmol/L).

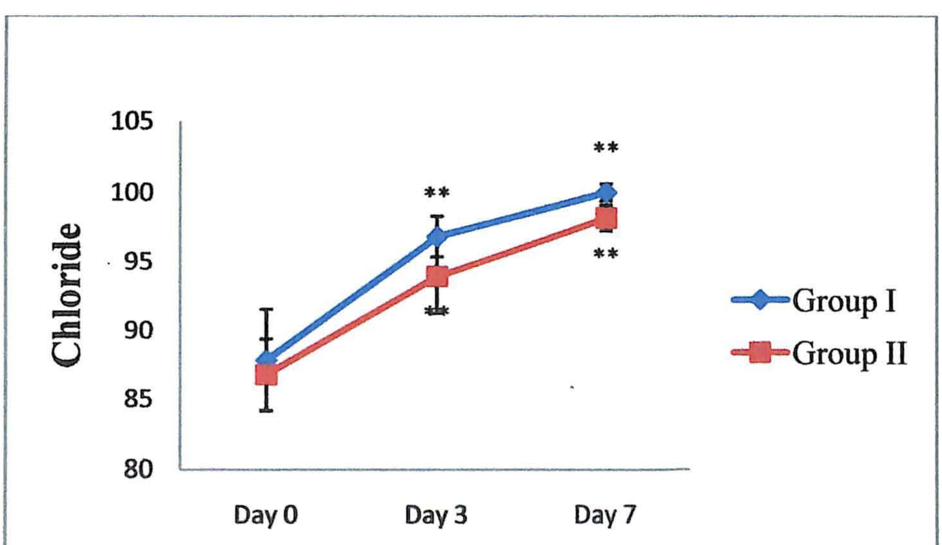


Fig. 44: Mean ± SE values of Serum chloride (mmol/L).

Fig. 45: Large phytobezoar (15X6 inches) retrieved from rumen, case 1, group I.

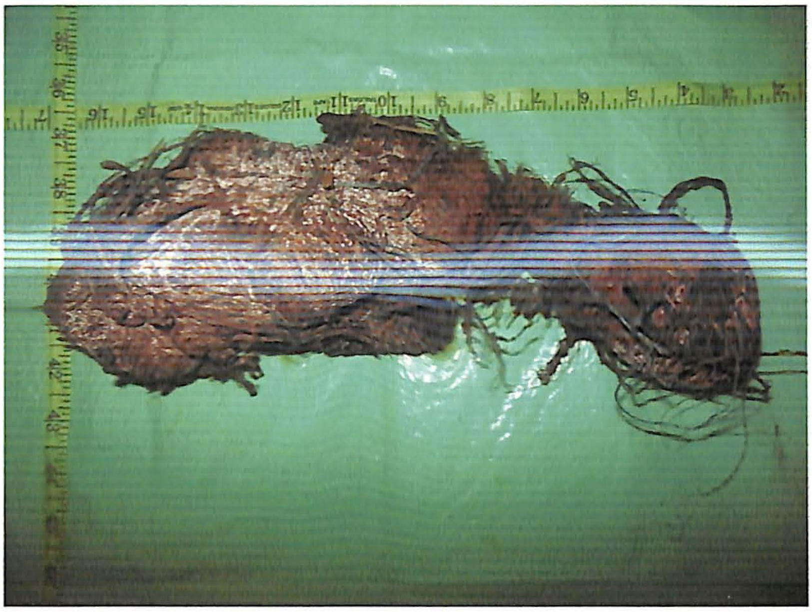


Fig. 46: Polythene recovered from rumen.

Fig. 47: Polythene recovered from rumen.

Fig. 48: Sand recovered from rumen, case 1, group II.

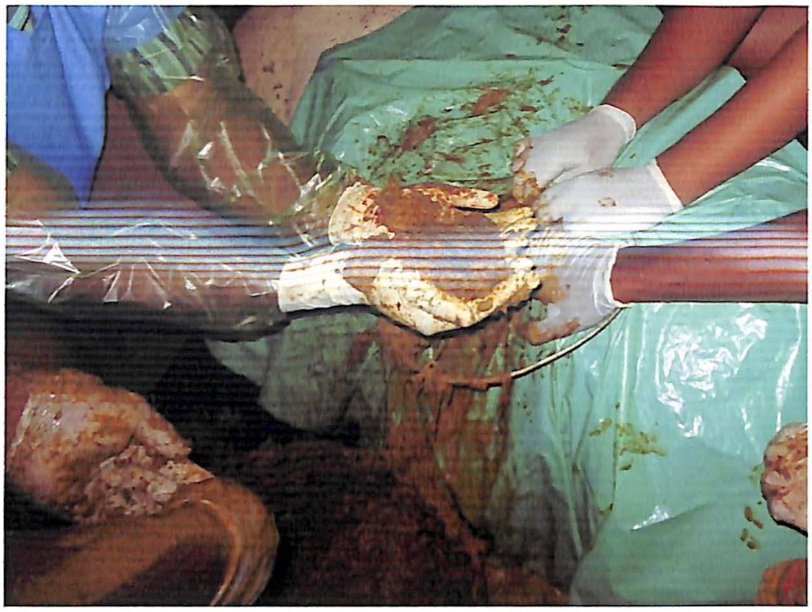


Fig. 49: Sharp nails recovered from reticulum, case 6, group I.

Fig. 50: Non potential metallic foreign bodies obtained from rumen by magnet swapping.

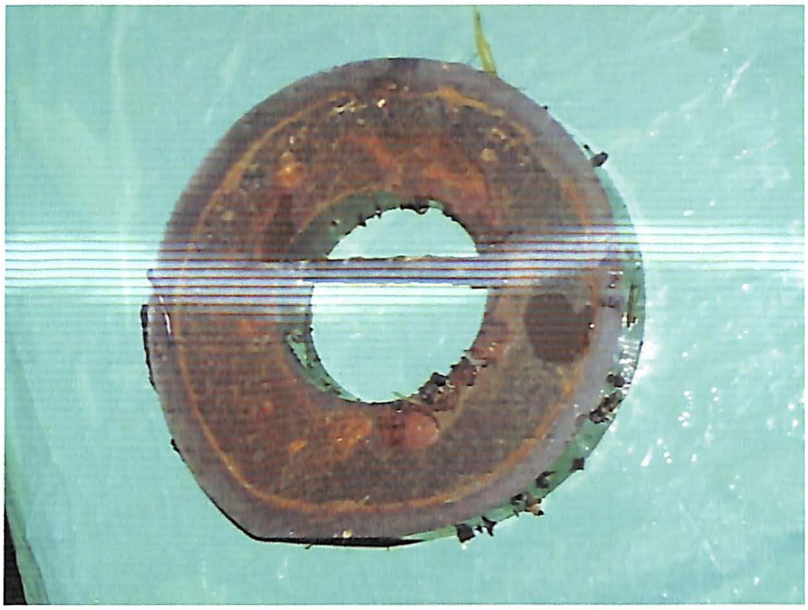


Fig. 51: A sharp nail recovered from reticulum, case 7, group I.

Fig. 52: Typhlotomy and drainage of contents from dilated cecum, case 1, group II.

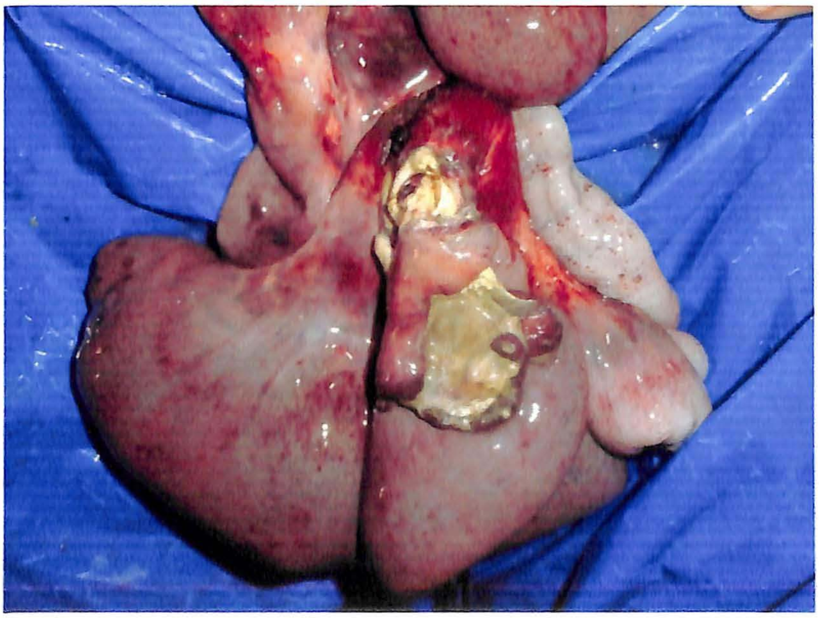


Fig. 53: Jejunal volvulus with necrosis, case 2, group II.

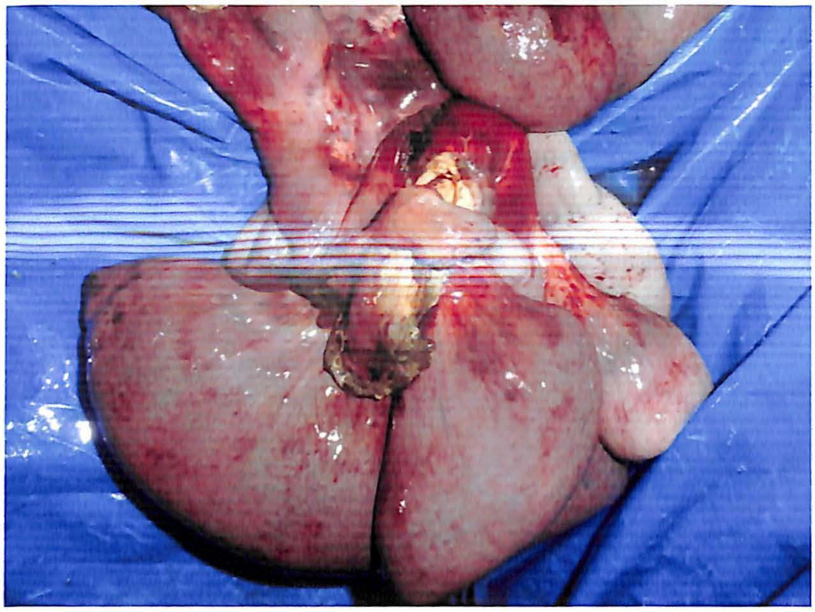


Fig. 54: Rupture of jejunal wall, case 2, group II.

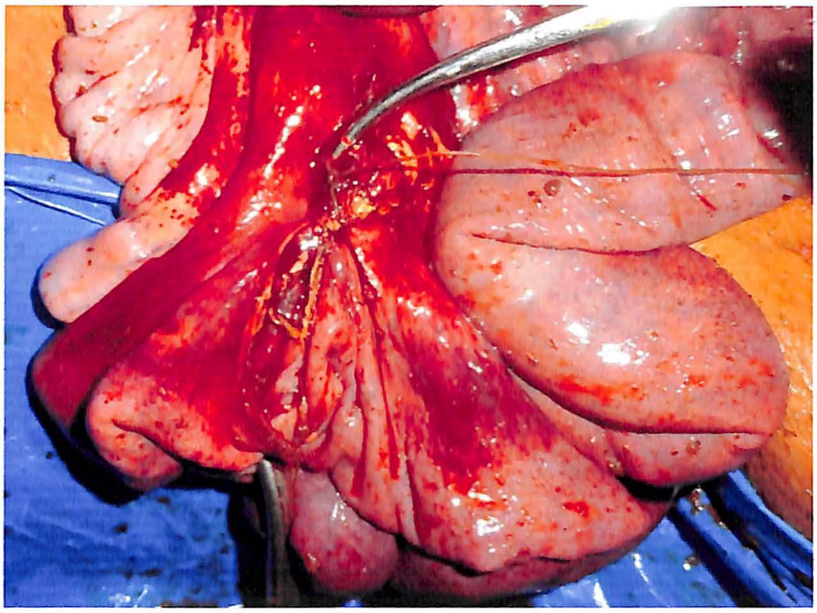


Fig. 55: Resection and anastomosis of the necrosed jejunum, case 2, group II.

Fig. 56: Distended and injected abomasum, case 3, group II.

Fig. 57: Three phytobezoars removed from the abomasum, case 3, group II.

Fig. 58: Cecal dilatation with devitalization of its wall, case 4, group II.

Fig. 59: Frothy exudates exploding out from the rumen, case 6, group II.

Fig. 60: Case 2, group I, one month after surgery.

Fig. 61: Case 7, group I, one month after surgery.

Fig. 62: Case 8, group I, one month after surgery.

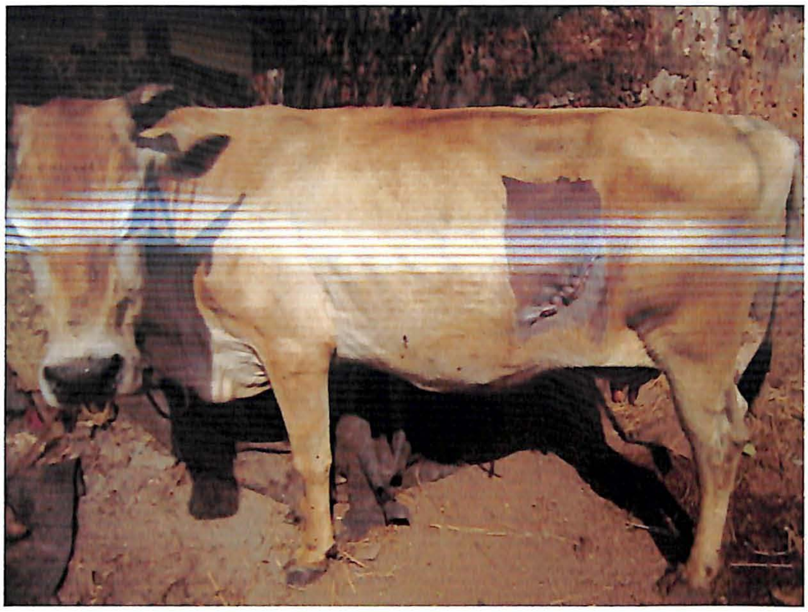


Fig .63: Case 1, group II, 10 days after surgery.

Fig. 64: Case 3, group II, 10 days after surgery.

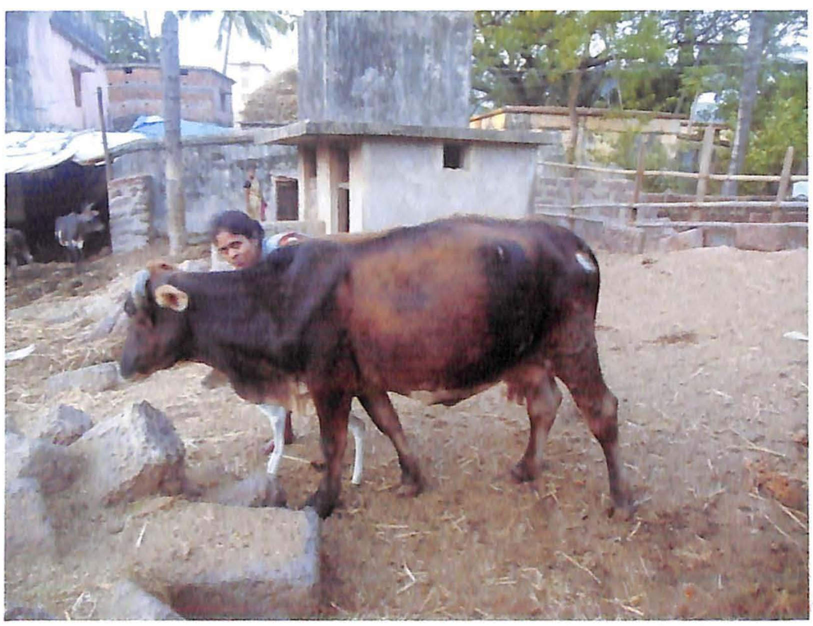


Fig. 65: Case 5, group II, one month after surgery.

Fig.66: Exteriorization of jejunum

Fig. 67: Exteriorization of jejunum

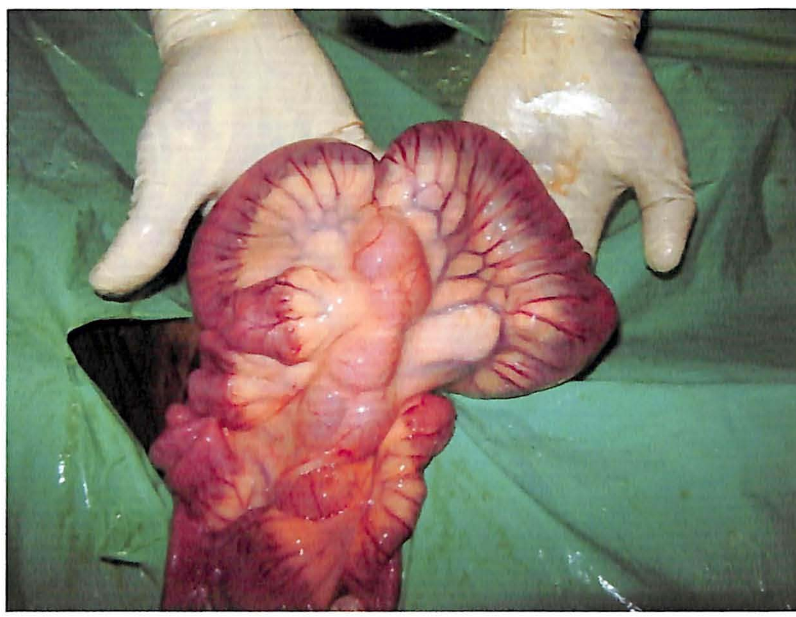


Fig.68: Exteriorization of jejunum

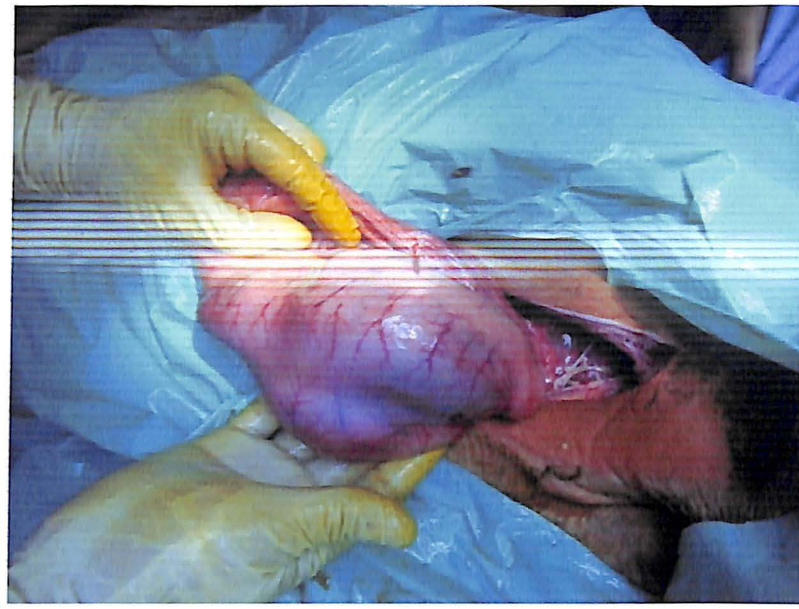


Fig.69: Exteriorization of abomasum

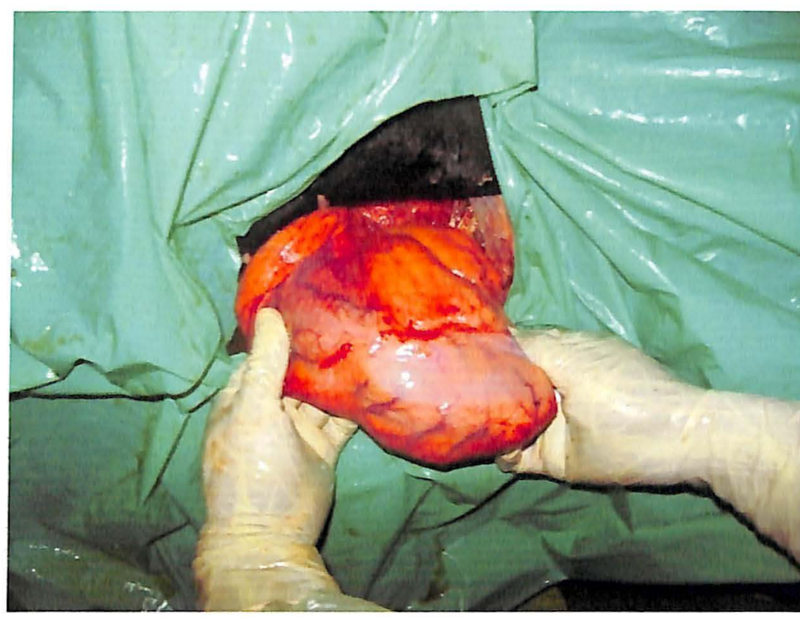


Fig.70: Exteriorization of abomasum

Fig.71: Exteriorization of abomasum.

Fig. 72: Exteriorization of cecum.

Fig.73: Exteriorization of cecum.

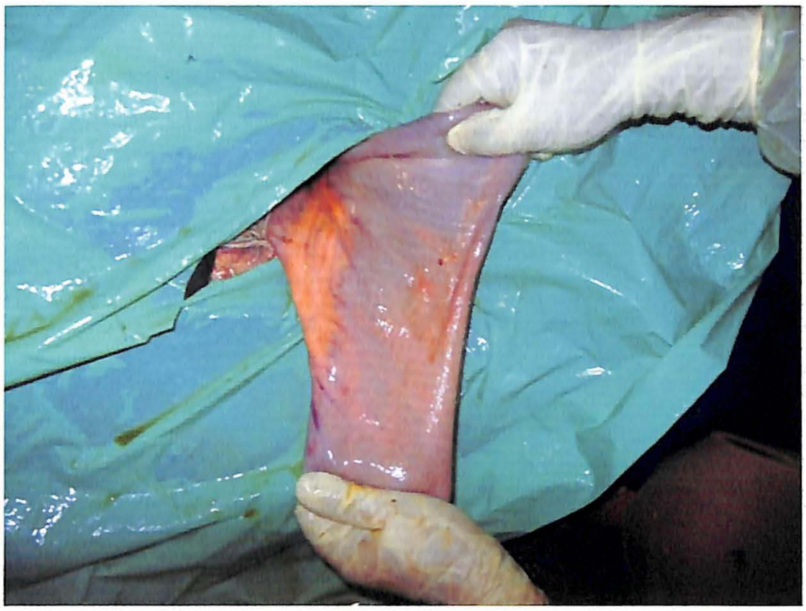
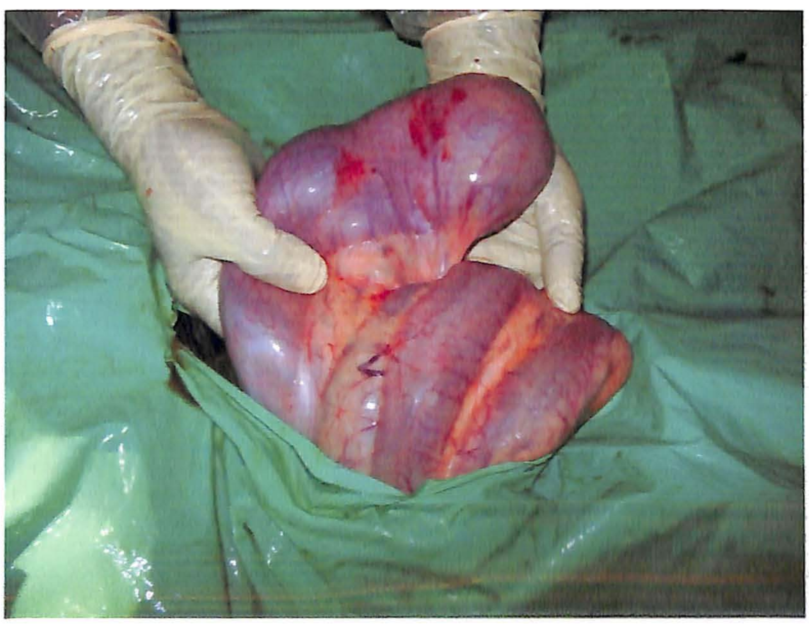


Fig.74: Exteriorization of cecum.



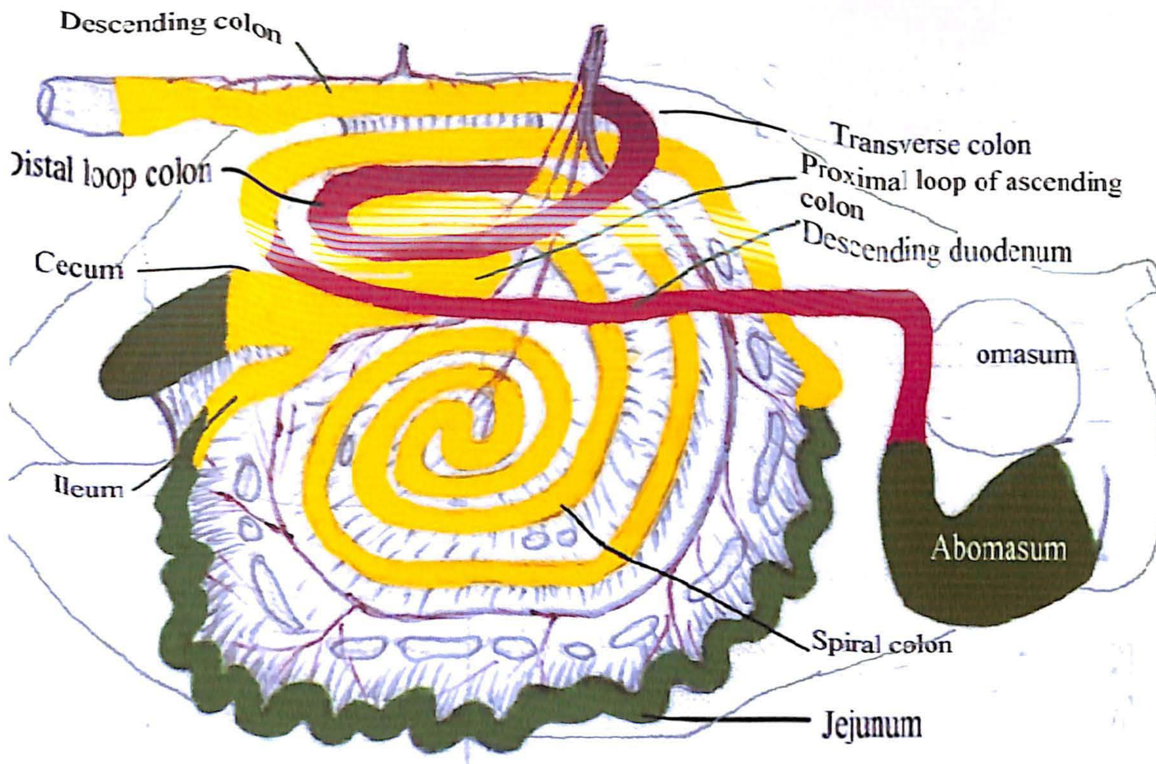


Fig.75: Diagrammatic representation for approachability of different parts of the gastrointestinal system from ventrolateral oblique laparotomy site.

Parts of the gastrointestinal tract exteriorizable

Rumen (reticulum and reticulo-omasal orifice accessible from the rumenotomy site).

Abomasum.

Jejunum—except a small proximal portion.

Cecum – 2/3rd of its length from the blind end.

Parts of the gastrointestinal tract palpable but not exteriorizable

Ascending duodenum from caudal flexure to the beginning of jejunum.

Proximal portion of jejunum.

Ileum.

Cecum- 1/3rd of its length from ileocecocolic junction.

Colon- proximal loop and spiral loop.

Descending colon.

Peritoneal part of rectum.

Parts of the gastrointestinal tract not palpable and not exteriorizable

Descending duodenum up to caudal flexure.

Colon- distal loop and transverse colon.

CHAPTER-V

DISCUSSION

CHAPTER-V

DISCUSSION

This study included sixteen out of a total forty seven animals showing obstructive symptoms of the GI tract in which a definitive preoperative diagnosis could not be achieved. Failure to achieve a preoperative diagnosis in 34% cases was principally due to the unavailability of imaging tools—radiography and ultrasonography. The use of these tools would definitely have improved diagnosis in these animals. Braun *et al.* (2012), in a study of 461 cases of cecal dilation in cattle, could diagnose the condition in 405 (88%) cases by clinical examination alone and in rest 56 (12%) cases used ultrasonography, exploratory laparotomy or postmortem examination for the diagnosis. Imran *et al.* (2011c) could tentatively diagnose intestinal obstruction in 4 (67%) out of 6 cases by clinical examination alone, and failed to diagnose it in 2 (33%) cases for which they used transrectal ultrasonography for diagnosis. Constable *et al.* (1997) reported that intussusception was palpable in only 23% of affected adult cattle and dilated intestines were palpable only in 50% of affected cattle and found use of ultrasonograpy or exploratory laparotomy to be useful in confirming the diagnosis.

5.1. INCIDENCE

The reporting of 94% females in this study is mainly due to over representation of female animals and partly due to increased incidence of gastrointestinal obstruction in females. Due to mechanization of agriculture, rearing of bullocks has been greatly reduced; and in the young age group, farmers are biased to provide healthcare more to the females than the males. This could have been the reason for over representation of female animals in this study. Although abomasal displacement and cecal dilatation have been reported with increasing frequency in females, the same conditions have also been recorded in male animals (Singh *et al.*, 1993; Fubini and Ducharme, 2004; Divers and Peek, 2008). Increased number of crossbred Jersey cows in this study reflects the wide spread use of cross breeding in the state for high milk production. Although young calves are reported to be affected with physical obstruction of the intestines due to intussusceptions (Constable *et al.*, 1997) or trichobezoars (Smith, 2015), animals below 1 year of age has not been recorded by this study probably due to small sample size. TRP has been recorded in two adult cattle and is in accordance with the findings of Radostits *et al.* (2007). Spotaneous jejunal volvulus has been recorded in a bullock in the absence of predisposing factors like rolling for correction of abdominal disorder as suggested by Singh *et al.* (1993), and its location in the distal flange of the jejunum is consistent with the findings of Fubini and Ducharme (2004).

5.2. CLINICAL EXAMINATION

5.2.1. Vital signs

Temperature: As most of the conditions in group I were localized without systemic involvement, no significant alteration of body temperature was noted. Group II animals had obstruction with systemic involvement like peritonitis or cecal necrosis and hence the temperature was significantly ($p<0.05$) higher which is in agreement with the findings of Divers and Peek (2008) and Smith (2015). The elevation of body temperature of both groups on day 1 and 2 following surgery could be due to surgical infection and inflammation. After treatment with antibiotics and anti-inflammatory drugs, the body temperature gradually receded on day 3 and day 7 to normal values due to control of infection and inflammation. The significant difference in body temperature between the groups on day 7 may be due to the fact that group II animals had more severe inflammatory conditions and had higher basal body temperature which required time to resolve and lead to a slower decline than group I animals.

Pulse: The insignificantly higher pulse rate in group II on day 0 and day 3 was probably due to more severe toxemia and dehydration. This observation is supported by the findings of Smith (2015), who has stated that abdominal pain, decreased plasma volume, and endotoxemia often result in persistent tachycardia. The insignificantly lower pulse rate in group II on day 7 was probably due to bradycardia of two untreated cases with diaphragmatic hernia that was probably due to increased vagal tone and is consistent with the observations of Singh *et al.* (1996) and Radostits *et al.* (2007). The significant reduction in pulse rate in group I on day 7 and insignificant reduction in group II was probably due to relief of pain and suffering following treatment.

Examination of visible mucous membrane (VMM): Change in visible mucous membrane color can sometimes be spectacular (blue in cyanosis or yellow in jaundice) and can often give valuable clues to diagnosis (Smith, 2015). However in all cases, its color indicates the status of hemoglobin and can suggest the presence of anemia (Radostits *et al.*, 2000). Dryness of mucous membranes can suggest presence of dehydration in the animal (Fecteau, 2015). The pale mucous membrane in 2 animals in group I and 2 animals in group II were an indication of presence of anemia.

Capillary Refill time and Dehydration status: Capillary refill time (CRT) is a useful indicator of peripheral circulation, cardiovascular function and hydration status (Radostits *et al.*, 2000). Higher CRT in most of the patients was due to reduced perfusion of peripheral tissues due to hypovolemia and dehydration. Group II animals had peripheral perfusion compromised to a greater extent and more profound dehydration than group I animals due to the systemic nature of some conditions (peritonitis, cecal necrosis).

5.2.2. Abdominal contour

Distension patterns of bovine abdomen have long been used as a clinical tool in the diagnosis of abdominal disorders in cattle. However in the present study this was a source of confusion and sometimes misled the diagnosis. Braun *et al.* (2012) have found similar difficulties; in a retrospective study of 461 cattle with cecal affection, they observed only 42 animals (9%) to have classical distension of the right flank and hence they did not find abdominal distension as a reliable diagnostic sign.

5.2.3. Palpation of abdominal organs

Palpation of the right and left abdominal wall in some of the animals either revealed a gas filled or doughy rumen which yielded limited diagnostic information in the present study. The source of pain on deep palpation below right coastal arch could not be interpreted as the involvement of omasum, abomasum or liver was possible and ultrasonographic study was warranted for differential diagnosis (Braun, 2005).

5.2.4. Rumen motility

Obstruction of the gastrointestinal tract is usually associated with acid base and electrolytes imbalance that leads to general atony of gastrointestinal tract resulting in tympany and abdominal distension (Divers and Peek, 2008). The ruminal motility in group II was slightly and insignificantly higher than group I due to the presence of hypermotility in two animals with diaphragmatic hernia and is in accordance with the findings of Radostits *et al.* (2007). Following surgical treatment, correction of pH and with medication, ruminal motility gradually returned to normal in both the groups.

5.2.5. Auscultation and percussion

An inaudible intestinal sound is an indication of paralytic ileus (Radostits *et al.* 2000) which was seen in six animals that developed intestinal atony secondary to the obstructive gastrointestinal disease. In two animals of group II, ruminal motility was not audible on auscultation although ruminal hypermotility could be palpated. As these animals had frothy bloat, the movement of rumen contents failed to produce the characteristic sound detectable by a stethoscope. In the same two animals bradycardia with a muffled heart sound was audible, but reticular sounds in the thoracic area could not be heard. In the opinion of Radostits *et al.* (2007), reticular sounds near the heart are audible in many normal animals and are not significantly increased in diaphragmatic hernia.

Simultaneous auscultation and percussion revealed tympanitic ping over the left paralumbar fossa in 8 animals with tympany, but yielded little diagnostic information as tympany was clearly visible and palpable. A slow tympanitic ping was audible on the right parlumbar fossa in two animals, but the source could not be interpreted correctly as right sided ping can arise out of distension of several organs like cecum, colon, duodenum, abomasum or intestines (Radostits *et al.*, 2000; Jackson and Cockcroft, 2002) and ultrasonograhic study is warranted to determine the organ involved (Braun, 2005; Braun, 2009). Hence in the present study, simultaneous percussion and auscultation were not of much diagnostic value.

5.2.6. Examination with metal detectors

Metal detectors can detect presence of metals in the rumenoreticulum, however it cannot distinguish between potential (sharp) and non-potential (blunt) metallic foreign bodies. Hence testing positive on a metal detector does not conclusively indicate the presence of traumatic reticulo-peritonitis (Jackson and

Cockcroft, 2002) and further radiographic examination of the reticular area is required for definitive diagnosis (Fubini and Ducharme, 2004). That is why only two animals had traumatic reticulitis out of seven that tested positive for metal detectors.

5.2.7. Examination for abdominal pain

Spontaneous manifestation of symptoms of abdominal pain has not been observed preoperatively in any animals of group I and reported by the owners in case of four animals of group II (Table 4). Two of these animals had cecal dilatation and exhibited visceral pain due to stretching and bending of the cecum (Belknap and Navarre, 2000). The rest two animals had diaphragmatic hernia and symptoms of pain observed were due to pressure of the herniated reticulum on the thorax (Singh *et al.*, 1993).

In group I, although no animals showed spontaneous pain, the seven animals that tested positive for pole and/or withers pinch test had either traumatic reticulitis, omasal impaction or rumenoreticular foreign bodies that was the source of pain in the anterior abdomen. In group II, five animals inclusive all the four animals that had a history of spontaneous abdominal pain tested positive for pole and/or withers pinch test. Out of them two animals had cecal dilatation, two had diaphragmatic hernia, and two had intestinal volvulus which caused pain in the abdomen. The animals having cecal dilatation (n=2) were positive for withers pinch test but negative for pole test because anterior absomen was painless but the animals felt pain during dipping of spine due to dilated cecum in the caudal abdomen.

The withers pinch test and the pole test detects abdominal pain in response to external pressure on the abdominal wall (Cockcroft and Jackson, 2004) and is mainly helpful in detection of reticular pain caused by penetration of sharp nails (TRP), pain from omasal impaction or pain from other rare conditions of cranial abdomen (reticular or hepatic abscess) (Radostits *et al.,* 2000). Hence radiographic examination of the cranial abdomen is needed to distinguish these conditions.

5.2.8. Rectal palpation

In all animals affected with gastrointestinal obstruction the fecal output is absent or reduced (Oeheme and Prier, 1974). Hence in almost all cases the rectum was found to be empty with mucous or hard fecal balls which was consistent with the findings of Constable *et al.* (1997), Braun *et al.* (2012) and Hussain *et al.* (2013). Additionally, rectal palpation can detect obstructions in small and large intestines in the caudal abdomen. Rectal examination failed to detect cecal dilation in two animals as there was ventroflexion and the blind end of the cecum was directed away from the pelvic inlet that supports the observations of Divers and Peek (2008) and Braun *et al.* (2012). Rectal palpation could not give any other diagnostic information in the present series of cases.

5.3. LABORATORY EXAMINATION

5.3.1. Ruminal pH

Ruminal pH in cattle is usually maintained between 6.2 and 7.2 (Radostits *et al.*, 2007), and is the result of a delicate balance between the fermentative activity of cellulolytic and amylolytic ruminal flora and the action of alkaline saliva (Smith, 2015).

In group I, the ruminal pH was found to be alkaline on day 0. The rumen pH probably turned alkaline, due to obstruction at the level of reticulo-omasal orifice that prevented onward transport of ingesta, lack of food intake that made substrates unavailable for microbial fermentation and consequent acid production, and continuous ingestion of alkaline saliva (Cockcroft and Jackson, 2004). On the contrary, Hussain *et al.* (2013), in 11 cattle and buffaloes affected with omasal impaction, observed the pH to be maintained in the normal range. In group II, the ruminal pH was found to be acidic. As many animals in this group had obstructions at the level of the pylorus or caudal to it, the abomasal secretion was probably refluxed in to the rumen causing an acidic ruminal pH (Braun *et al.*, 2011). Following relief of the obstruction and after taking the relevant corrective measures the rumen pH gradually returned to normal in both the groups.

5.3.2. Rumen protozoa

The rumen functions as a fermentation vat where efficient digestion of plant materials is brought about by the rumen microbes that operate in a state of dynamic equilibrium in a complex ecosystem, and hence rumen microbial health is of paramount importance in maintaining dairy cow health (White, 2004). Rumen protozoan activity is a rapid and valuable indicator of overall ruminal microbial health, and is closely related with a good appetite and wellbeing (Mishra *et al.*, 1972). Both groups of animals had lower protozoa count on the day of operation because of change in rumen pH (Radostits *et al.*, 2007) which increased steadily and significantly following surgical correction of the condition. Improvement in protozoa count and appetite was due to putting of yeast tablets in the rumen while closing rumenotmy incision, correction of rumen pH and rumen cud transplantation in the postoperative period.

5.3.3. Rumen Chloride content

Group I animals had normal basal ruminal chloride which slightly but significantly decreased on day 3 and day 7 probably due to emptying of ruminal contents and correction of obstruction. In group II, the animals had a slightly higher ruminal chloride content which also decreased significantly to normal values on day 3 and day 7 of operation. As many animals in group II had obstruction at the level of pylorus or caudal to it, there was sequestration of gastric acid in the lumen, and its reflux in to the rumen probably lowered the ruminal pH and elevated ruminal chloride (Braun *et al.*, 2011; Braun *et al.*, 2012). However, in some cases under this study the owners reported to have fed common salt in homemade remedies which could be responsible for elevated ruminal chloride that caused confusion in interpretation of this result.

5.3.4. Hematologic parameters

PCV: The PCV values were in the higher side of normal range on day 0 in both the groups which gradually but significantly decreased till the day 7 of operation. The mildly elevated PCV on the day of the operation was due to the varying degrees of dehydration present in the animals. As the animals' appetite resumed following surgery and the dehydration was corrected by fluid therapy the PCV decreased gradually.

Hemoglobin: The hemoglobin values were in lower normal ranges on the day of operation in both Groups. The significant decrease in group I and slight but insignificant decrease in group II on the day 3 and day 7 of operation was mainly due to restoration of body fluid deficits and could be partially due to intra-operative hemorrhages. The lower normal basal levels of hemoglobin in both groups were unrelated to the primary disease, and reflected the suboptimal level of nutrition in the animals prior to the development of the gastrointestinal obstruction.

Total Leucocyte count (TLC) and differential count: The earliest manifestation of inflammation is leucocytosis with neutrophilia, and neutrophilia is clearly visible in inflmamatory conditions of cattle as lyphpocyte is the dominant leucocyte (Smith, 2015). In group II there was leucocytosis with neutrophilia due to inflammatory conditions involved. The leukogram in group I was almost normal with subtle changes in some animals suggesting minimal inflammatory changes. Therapy with antibiotics and anti-inflammatory drugs resolved inflammation and there was gradual reduction in TLC and neutrophil count in both groups. As the neutrophil number reduced there was a consequent rise in lymphocyte percentage in both groups suggesting a favorable change in the leukogram towards normalcy.

5.3.5. Serum Electrolytes

Sodium: Serum sodium levels were not found to be significantly affected in 11 cases of omasal impaction by Hussain *et al.* (2013); a mild hyponatremia was seen in 57 cattle affected with intussusception by Constable *et al.* (1997). Peshin *et al.* (1993) have found no abnormalities in serum sodium in cases of LDA because sodium continues to be absorbed from the gut, but Fubini and Ducharme (2004) observed mild to severe hyponatremia in RDA and duodenal outflow obstruction.

A mild hyponatremia found in group I animals in this study may be due to lack of intake and absorption of sodium from the gastrointestinal tract. However, with continued fluid and electrolyte therapy serum levels gradually but significantly increased to normal values in both the groups. The significant difference between the groups on day 7 might be due to the aggressive fluid and electrolyte therapy done in group II animals to correct severe dehydration that lead to a swifter rise in serum sodium in group II than in group I.

Potassium: Anorexia in ruminants for any reason leads to development of moderate and clinically occult hypokalemia due to reduced intake, and administration of oral postassium chloride has been recommended as a supportive therapy (Divers and Peek, 2008). All the animals in this study had varying degrees of anorexia and consequent reduced intake of potassium contributed mostly to the development of hypokalemia in both groups. Sequestration of gastric acid in the gastrointestinal lumen in some animals might have contributed to the development of hypokalemia (Horne 1991; Fubini and Ducharme, 2004; Radostits *et al.*, 2007). Fluid and electrolyte therapy in both groups lead to significant improvement of serum potassium and restoration of normal levels in both groups.

Calcium: Both groups of animals in this study had a mild hypocalcemia which is consistent with the finding of Constable *et al.* (1997), Imran *et al.* (2011c), Braun *et al.* (2012), and Hussain *et al.* (2013). Lack of intake and interference in absorption of calcium have led to development of hypocalcemia in all animals (Peshin *et al.*, 1993). Additionally, drainage of calcium in milk in the lactating animals in this study contributed further to the development of hypocalcemia. As per Braun *et al.* (2012), intestinal obstruction initially leads to increased myoelectric activity of the intestine which consumes calcium and lowers serum levels. Although a profound hypocalcemia (serum calcium levels < 5 mg/dL) is required for recumbency in cattle, a mild to moderate degree of hypocalcemia leads to depression of muscle tone and GI motility and aggravates the ileus developing in physical obstruction (Smith, 2015). Intravenous administration of calcium led to significant improvement in serum levels to normal in both groups and hastened recovery.

Chloride: In both groups of animals there was a mild hypochloremia which is consistent with the observations of (Karapinar and Kom, 2007). In obstructive diseases of the gastrointestinal system, ruminants develop a hypokalemic and hypochloremic alkalosis and the more proximal the lesion, more rapid is the development of this biochemical abnormality (Horne, 1991). Sequestration of hydrochloric in gastrointestinal lumen in case of gastrointestinal obstruction was probably the principal cause of hypochloremia in these animals (Fubini and Ducharme, 2004; Radostits *et al.*, 2007).

5.4. DIAGNOSIS

Most of the cases in this study were referral cases which were treated unsuccessfully for variable lengths of time. While previous treatments like periodic removal of ruminal gas kept the animal living, it delayed specific treatment and the primary disease progressed further. As a definitive diagnosis could not be made surgical exploration was done.

5.5. ANESTHESIA

Paravertebral anesthesia achieves complete desensitization of the abdominal muscles including the peritoneum as the nerves are blocked from the point of origin (Kumar and Chouhan, 1993). The cutaneous trunci muscle is not anesthetized by parvertebral block as the muscle is supplied by branches from the brachial plexus (Dyce *et al.*, 2010; Schummer *et al.*, 1981), that is why the animals operated under paravertebral anesthesia (n=10) retained sensation in cutaneous trunci muscle layer. Linear infiltration anesthesia achieves analgesia of the cutaneous trunci muscle and all the abdominal muscles but fails to block the deeper branches of the ventral spinal nerves (Tranquilli *et al.*, 2007), and hence the animals (n=6) operated under linear infiltration retained sensation in the peritoneum. Linear infiltration was done sufficiently above the line of incision to avoid possible edema formation, and interference with healing as recommended by Clarke *et al.* (2014).

5.6. SURGICAL EXPLORATION, DIAGNOSIS AND TREATMENT

As the individual muscle layers were divided along their fiber direction, they produced a valve like action at the laparotomy site, post-operative healing was accelerated, and chances of postoperative hernia was reduced. However a comparatively longer incision than muscle transection technique was required and constant retraction of the laparotomy site was needed. Though transection of two spinal nerves have been reported to produce no significant abnormality (Fubini and Ducharme, 2004), the nerves could be retracted safely and none needed to be transected.

5.6.1. Laparotomy and exteriorization of rumen.

Since the study used a ventrolateral oblique approach, upon entering the abdomen the ventral sac of the rumen covered with greater omentum was encountered first. But rumenotomy incision could not be given at that site. The dorsal sac of the rumen had to be exteriorized and the incision should be in the dorsal sac sufficiently above the longitudinal groove in an avascular area between the coronary groove and the dorsal transverse groove. For this reason the dorsal sac of the rumen had to be pulled out through the incision which was easily accomplished in 8 cases. In the rest of the cases decompression of the rumen was required to exteriorize the dorsal sac. Incision on the dorsal sac was required because the fluid line needed to be below the incision to prevent leaking of ingesta and to accelerate healing.

5.6.2. Exploratory diagnosis and treatment

Group I

Obstruction of the reticulo-omasal orifice with a phytobezoar (in case 1) led to complete obstruction of rumino-reticular outflow. Continued secretion of saliva and intermittent drinking of water kept the ruminal contents mushy. Anorexia with a lack of carbohydrate substrate in the rumen for fermentation and ingestion of saliva made the contents alkaline which is consistent with the finding of (Cockcroft and Jackson, 2004). Presence of eructation reflex aided in expulsion of gases and prevented tympany but led to development of other clinical symptoms of obstruction.

Two animal (case 2 & 3) developed omasal impaction and another three (case 8, 9 & 10) had omasal impaction concurrent with rumenoreticular foreign bodies. Four animals out of these five were fed manually chopped paddy straw (Table 4). The remaining one was a one year female calf that was fed dry wheat bran and paddy straw. None of these five animals were given adequate drinking water.

Chopping of straw into small pieces inhibits the reflex contraction of the rumen that leads to regurgitation and chewing of cud (Thomas, 2009), and they accumulate in the forestomachs particularly between the omasal leaves and lead to impaction (Toor and Saini, 2008). Paddy straw has high fiber content with low energy and low DCP, hence it is poorly digested, and when given as the sole forage in the diet cause impaction (Imran *et al.*, 2011b). Thus feeding of finely chopped paddy straw as the staple forage and restriction of drinking water contributed to the development of omasal impaction in these four animals, and it is consistent with the observations of Hussain *et al.* (2013).

Omasal flushing in all the animals yielded satisfactory results and it was easier to approach the reticulo-omasal orifice from ventrolateral oblique laparotomy site (than from higher left flank incision in a standing animal) particularly in large sized animals. Fubini and Ducharme (2004) has suggested to place the incision as close to the ribs as possible in the left flank of a standing animal and explained that a few centimeters gained would be of great help in approaching the reticulo omasal orifice. This difficulty was completely overcome in the left ventrolateral oblique laparotomy approach.

Four animals (case 4, 5, 6 & 7) had ruminoreticular foreign bodies, two of which had traumatic reticulitis. Three animals had rumenoreticular foreign bodies along with omasal impaction. All of the seven animals were allowed to graze (Table 4) and a variety of metallic and a large amount of non metallic foreign bodies were recovered from the rumen. This finding contradicts the observation of Radostits *et al.* (2007) who maintained that rumenoreticular foreign bodies and TRP are more common in cattle fed on prepared feed and almost unknown in cattle fed entirely on pasture. Due to lack of pasture land, high population density and irresponsible use and disposal of polythene bags, roaming cattle feed on market or domestic waste and easily engulf polythene and metallic foreign bodies.

The problem is so acute in urban and semi-urban areas of our state that Bose (1990) advised not to leave the animals to graze. Churning action of the rumen causes staking and entwining of this polythene leading to a closely compacted mass (Singh *et al.* 1993) that becomes difficult to remove during operation. Ruminoreticular motility along with weight of the metallic bodies propels them to the reticulum where they accumulate harmlessly or cause TRP (Fubini and Ducharme, 2004).

Group II

Two animals (case 1 & 4) diagnosed of cecal dilation were maintained exclusively on concentrates (Table 4). High concentrates in the diet probably led to excess volatile fatty acids in the cecum that caused cecal atony and distension which is consistent with the findings of Braun *et al.* (2012), Smith (2015) and Divers and Peek (2008). Engel *et al.* (2006) demonstrated a lower population of serotonoergic receptors in the large intestine of cows affected with cecal dilatation and suggested a genetic predisposition for the condition. The incidence of cecal affections under Indian condition is low due to the roughage based ration (Singh *et al.*, 1993). One case was treated with typhlotomy which was possible from the left ventrolateral laparotomy site, but another case needed total typhlotomy which was done by a second surgery by the right flank approach as exteriorization of ileocolic orifice was not possible from this site. In both cases the dilated cecum was not palpable per rectum due to displacement of the cecal apex which is consistent with the findings of Fubini and Ducharme (2004).

The presence of sand particles in the rumen and reticulum of one animal (case-1) was probably due to adulteration of food stuff with sand. Hussain *et al.* (2013) and Erickson and Hendrick (2011) have made similar observations.

Jejunal volvulus was diagnosed in a bullock (case 2) which is a rare condition in the bovine. Delayed presentation led to gangrene and rupture of the affected segment leading to severe peritonitis which is in accordance with the findings of Smith (1985b).

Abomasal impaction with fibrous feed (Ashcroft, 1983), sand (Erickson and Hendrick, 2011) and phytobezoars (Tschuor *et al.*, 2010) have been reported. In case 3, partial outflow obstruction of the abomasum was observed with three phytobezoars. As the pylorus was partially obstructed the patient exhibited slow progression of clinical signs, electrolyte abnormalities were not pronounced and the outcome after surgery was favourable.

Diaphragmatic hernia has been extensively reported in buffaloes and infrequently reported in cattle (Singh *et al.*, 2006). Thinning of the diaphragm by trauma from reticular foreign bodies, congenital weakening of the diaphragm and increased intra-abdominal pressure due to any reason (ruminal tympany, violent fall, advanced pregnancy, parturition process, chronic cough, and straining due to any reason) has been described as major predisposing factors leading to diaphragmatic hernia (Athar *et al.*, 2010). The two cows (case 5 & 6) diagnosed to have diaphragmatic hernia in this study did not have TRP and could have acquired the disease due to a thin diaphragm that developed a rent during parturition.

5.7. POSTOPERATIVE CARE

Post operative care plays a vital role in successful outcome of surgical treatment. Specifically in obstructive diseases of the gastrointestinal tract, there is considerable fluid and electrolyte imbalance which need to be corrected for a good outcome (Fubini and Ducharme, 2004). Meticulous fluid and electrolyte therapy, antibiotic and analgesic medications and good nursing care resulted in successful outcome in the patients under study.

5.8. POSTOPERATIVE FINDINGS

5.8.1. Appetite

Anorexia is the initial and principal manifestation of gastrointestinal disorders which is also present in many other systemic or metabolic diseases (Thomas, 2009). Here all animals showed variable degrees of anorexia, and a detailed examination revealed involvement of the digestive system. An obstruction of the digestive system causes cessation of onward movement of food materials, distension of the bowel cranial to the obstruction, manifestation of visceral pain, alteration in rumen ecology and disturbances of electrolyte balance which lead to anorexia and other characteristic symptoms (Divers and Peek, 2008).

Preoperatively 12 animals had complete anorexia and 4 had partial anorexia. (Table 4). Surgical correction of obstruction in the animals, fluid therapy and restoration of rumen ecology led to marked improvement of appetite in all animals. However in group II, two animals with cecal affections showed slow improvement in appetite probably due to marked alteration of rumen ecology and acid base imbalances. Two animals with diaphragmatic hernia remained partially anorectic as the primary condition was not treated.

5.8.2. Rumination

A cow normally spends 8 to 10 hours daily for chewing her cud which helps in complete chewing of fibrous feed, stimulates secretion of saliva and aids in digestion of coarse feed materials (Thomas, 2009). Cows ruminate while resting and relaxed, and rumination is a symptom of good health and wellbeing. The usual causes of reduction or absence of rumination are reticulorumen hypomotility or atony, central nervous system affection (excitement, pain), a lack of fiber in the diet, or mechanical injury to the reticulum (reticuloperitonitis) (Radostits *et al.*, 2007). Preoperatively, eleven animals had complete lack of rumination and 5 had reduced ruminations (Table 4). Following surgical correction of the primary cause of obstructions and supportive therapy to restore rumen ecology, electrolyte balance and gastrointestinal motility, most animals started ruminating from 2nd day and by 5th day all the animals were ruminating. It was a good sign of convalescence and lack of post operative pain.

5.8.3. Fecal output

Preoperatively, complete absence of fecal output was seen in 10 animals, scanty fecal output in 4 animals and reduced manure production in 2 animals (Table 4). Surgical correction of the obstruction and drug therapy lead to defecation in all animals in the first five days following surgery and was considered as a good sign of proceeding to recovery.

Adult cattle generally pass manure 10 to 12 times in a 24-hour period and produce about 30-50 kg of dung in a day (Thomas, 2009). Reduced manure production is the initial indication of a physical obstruction of the GI tract. However any condition that alter or affect the motility or peristalsis may lead to reduced fecal output (Smith, 2015), hence careful evaluation is required for diagnosis of a physical obstruction. Complete absence of fecal output is indicative of more severe obstruction and, if associated with strangulation, can be rapidly fatal due to devitalization and necrosis of the affected segment (Fubini and Ducharme, 2004).

5.8.4. Brisket edema

Brisket edema is basically suggestive of congestive cardiac failure. Perforation of the thoracic cavity with a metallic foreign body from the reticulum leads to pericarditis and accumulation of inflammatory fluid in the pericardium which leads to congestive heart failure due to a temponade effect. There is inadequate return of peripheral blood to the heart and development of edema in the dependant parts leading to engorgement of the jugular veins, edema of the brisket and ventral abdominal wall (Radostits *et al.*, 2007).

In the present case, probably a large phytobezoar lodged in the reticulo-omasal orifice put pressure on the heart and development of edema was due to a direct temponade effect. Nayak *et al.* (2000) have also reported that development of brisket edema may not be always due to TRP. In the opinion of Radostits *et al.* (2007), approximately 8% of the animals affected with traumatic reticulo peritonitis will develop pericarditis. Absence of brisket edema or jugular pulse in two cases of TRP in the present study may be due to the fact that the nails had not punctured the diaphragm and there was no traumatic pericarditis.

5.8.5. Ruminal tympany

Fermentation of feedstuff in the rumen leads to production of gas which is usually removed by eructation or belching (Thomas, 2009). Tympany is the result of abnormal production of gas in the rumen, excessive frothiness of the ruminal gas or impairment of eructation (Smith, 2015). Failure of eructation may be due to depression of ruminal motility, physical obstruction of the cardia, or due to excessive frothiness of the ruminal contents.

At presentation, 7 animals had persistent tympany, four animals had recurrent tympany and five animals had no history of tympany (Table 4). The five animals in this study that did not show bloat preoperatively despite a physical obstruction of the GI tract had probably a patent cardia and intact eructation reflex with some degree of ruminal motility.

Frothiness of the ruminal contents in the two animals of group II with diaphragmatic hernia was due to constant churning of the ingesta by a hyper motile rumen and is consistent with the observations of Divers and Peek (2008); consequent failure of eructation lead to frothy bloat in these animals. Additionally, both these animals had ruminal pH 6 that helped stabilize the froth in the absence of ingestion of surface tension lowering agents which is in accordance with the findings of Radostits *et al.* (2007).

Following surgery, only six animals developed tympany that was managed effectively and they gradually recovered. Occurrence of bloat in these animals was due to a combination of atony of the gastrointestinal tract and absence of forward passage of ingesta down the alimentary tract, which was initially relieved manually and disappeared as ruminal motility returned to normal.

5.8.6. Recumbency

Those four animals that were recumbent preoperatively (Table-4) were found to have hypokalemia, hypocalcemia and hypochloremia. Lack of food intake due to gastrointestinal obstruction and electrolyte abnormalities probably caused weakness and recumbency in these animals which could be revived only in two animals following surgery.

5.8.7. Post-operative survival

Two animals of group I died on 9th and 11th day. Both had rumeno-reticular foreign bodies with excessively firm, highly distended and impacted omasums which were considered as poor prognostic indicators by Hussain *et al.* (2013). Both animals also had profound hypokalemia and hypochloremia and one has an inflammatory leukogram which are also associated with poor prognosis according to Smith (1978) and Hussain *et al.* (2013). Hence a severe impaction of omasum and intense hemato-biochemical alterations along with a preoperative recumbency for variable periods in these animals were associated with poor survival following surgery.

One animal in group II, had a jejunal volvulus, and due to compromise in vascular supply gangrene set in rapidly (Smith, 1985b). With subsequent rupture of the intestine and seeding of peritoneum with intestinal contents severe peritonitis ensued. The bullock did not improve despite surgical correction of the condition and medical therapy, and succumbed on the 3rd post operative day. Treatment in this case was delayed that lead to peritonitis and death of the animal. As suggested by Oehme and Prier (1974), an early intervention could have been extremely beneficial to save the animal. In this study 2 animals were declined treatment and 14 animals were treated surgically for the obstruction, out of which 3 animals died and 11 survived. Hence post-operative survival rate of this study was 78.6%.

5.9. APPROACHABILITY OF DIFFERENT PARTS OF GASTROINTESTINAL TRACT FROM LEFT VENTROLATERAL OBLIQUE LAPAROTOMY SITE

It was observed from this study that the rumen, abomasum, cecum and jejunum were exteriorized from a left ventrolateral oblique laparotomy site. Hence surgical conditions of the rumen, reticulum, omasum, abomasum, jejunum, and cecum can be rectified from this site. Typhlotomy and partial typhlectomy can be done by this approach but ileo-colic anstomosis is not possible as the ileocecocolic junction is not exteriorizable from this site. Based on the knowledge gained by approaching different organs in the present study, some additional surgical procedures can be reasonably performed from this approach. They include abomasopexy in left displaced abomasum, intussusceptions of the jejunum, torsion of the mesenteric root, and decompression of strangulation in gut-tie.

Since most of the parts of the gastrointestinal tract was palpable (except portions of duodenum and colon), this site was found to be adequate for exploration of the obstructive conditions of the alimentary tract.

CHAPTER-VI

SUMMARY AND CONCLUSION

CHAPTER-VI
SUMMARY AND CONCLUSION

For the purpose of this study, 47 presented clinical cases of cattle showing symptoms of gastrointestinal obstruction like lack of or scanty fecal output, tympany, anorexia, abdominal distension and/or abdominal pain for a period of one year were screened. They were subjected to a detailed clinical examination which included examination for vital signs (temperature, pulse, respiration, heart rate, capillary refill time, dehydration, and mucous membrane colour), auscultation, palpation, percussion, ballotment, and hematobiochemical studies. Radiographic or ultrasonographic examinations were not done as facilities were not available.

Based on history, clinical signs and clinical examination, a definitive diagnosis was possible in 31 (66%) patients, and they were excluded from this study. In the remaining 16 (34%) animals a preoperative diagnosis could not be made and formed the subjects of this study. Due to the limitations of left flank laparorumenotomy or right flank laparotomy, a left vetrolateral oblique laparotomy approach was evaluated for its usefulness and efficiency in diagnosing and correcting the obstruction.

All animals were operated under paravertebral (n=10) or linear infiltration (n=6) anesthesia but some (n=5) needed additional sedation with xylazine. Following surgical preparation of the site and skin incision, the muscles were divided bluntly along their fiber direction, the spinal nerves were deflected and access to the peritoneal cavity was gained. Rumenotomy was conducted by exteriorizing the dorsal sac of the rumen and emptying 3/4th of the contents. The reticulo-rumen was explored for any abnormality which was corrected before closing the rumen wall. Then the rumen along with the greater omentum was deflected anteriorly and the different parts of the gastro-intestinal tract were explored for any other abnormality which was also attempted for correction from the same site.

In all the 16 cases, an exploratory diagnosis was possible through this laparotomy approach and hence the diagnostic efficiency of this approach was found to be 100%. Based on the approachability and correctibility of the diagnosed condition the animals were divided into two groups.

Group I included animals in which the diagnosed surgical condition was approachable and correctible easily through this laparotomy approach. A total of 10 animals were placed in this group: one was diagnosed with complete obstruction of the reticulo-omasal orifice with a large pytobezoar which was retrieved through the rumenotomy incision; two animals were diagnosed with omasal impaction which was treated by omasal flushing; two animals were diagnosed with rumino-reticular foreign bodies which were evacuated carefully; two animals were diagnosed with traumatic reticulitis where the nails were retrieved manually by magnet swapping; three animals were diagnosed with omasal impaction with ruminoreticular foreign bodies which was treated with omasal flushing and foreign body removal.

Group II included animals in which the diagnosed surgical condition was approachable and correctible "with some difficulty" and the animals in which the condition was impossible to approach and correct. For the purpose of the study "with some difficulty" is defined as manipulation or depression of the incision site with hands, manipulation of the hind leg and recumbency position of the animal, or extension of the incision, and no undue tension on the affected organ or its associated mesenteric attachment. One animal in this group was diagnosed to have cecal dilation and displacement which was treated by typhlotomy and draining the contents of the cecum. The second animal was diagnosed with a jejunal volvulus with gangrene and rupture of the intestine leading to peritonitis which was treated with resection and anatomosis and peritoneal lavage. The third animal in this group was diagnosed to have a distended abomasum with a hard mass in which abomasotomy retrieved three phytobezoars. The fourth animal was diagnosed to have cecal dilation, ventroflexion and necrosis which was treated by total typhlectomy by right flank approach as the illeocecocolic junction was not approachable from the left ventro-lateral oblique laparotomy site. The rest two animals in this group were diagnosed to have diaphragmatic hernia which was not correctable from this site. The treatment options were discussed with the respective owners but both declined further treatment.

Group I animals showed an alkaline rumen pH, lower rumen motility, normal leukogram and mild hyponatremia. Group II animals showed an acidic rumen pH, higher rumen motility, higher body temperature, inflammatory leukogram with neutrophilia, normonatremia and mildly elevated rumen chloride concentration. Both groups showed hypokalemia, hypochloremia and hypocalcemia. Pulse, respiration, hemoglobin and PCV were in normal ranges in both groups. Hematobiochemical findings were extremely useful in guiding post-operative treatment but did not provide significant diagnostic information in the present study.

Out of 14 animals treated surgically, one animal in group II died on the 3rd day and two animals of group I died on the 9th and 11th postoperative day. Eleven animals out of 13 that had undergone surgical treatment survived giving a post-operative survival rate of 78.6%.

During systematic exploration, the approachability of the different parts of the gastrointestinal tract from left ventrolateral oblique laparotomy site was studied. The descending duodenum up to its caudal flexure, the distal loop of colon and the transverse colon were neither palpable nor exteriorizable. The caudal flexure of duodenum, ascending duodenum, a small portion of the proximal jejunum, ileum, 1/3rd of the cecum towards ileocecocolic junction, proximal loop of ascending colon, spiral colon, descending colon and peritoneal part of rectum in the pelvic cavity were palpable but not exteriorizable. The rumen, reticulum and omasum are easily accessed from this laparotomy site. The abomasum was approachable and exteriorizable. In addition, the entire jejunum (except a small proximal portion) and the cecum upto 2/3rd of its length were also exteriorizable.

On the basis of the findings of the present study, the following conclusions are drawn:

1. Since most parts of the gastrointestinal tract (except the ascending duodenum and small part of colon) can be explored from a left ventrolateral oblique laparotomy site, this approach leads to a confident and nearly complete exploration of both parts of the abdomen in undiagnosed cases of gastrointestinal obstruction in cattle.

2. As obstructive diseases of the forestomachs, cecum and jejunum are most common and these organs are easily accessed from this site, a left ventrolateral oblique laparotomy approach can be adopted as a working solution for abdominal exploration and surgical correction of commonly found gastrointestinal obstructions where a confirmatory diagnosis is not possible.

3. Omasal flushing for treatment of omasal impaction is easier from a left ventrolateral oblique laparotomy site than from higher left flank incision in standing position particularly in large sized animals as long hands are required to reach the reticulo-omasal orifice in case of the latter approach.

4. This approach can also be used in cattle diagnosed with multiple and concurrent obstructive conditions of the forestomachs, jejunum and/or cecum for effective surgical management from a common site.

CHAPTER-VII

RECOMMENDATIONS

CHAPTER-VII
RECOMMENDATION

1. As this study was conducted in 16 clinical cases, further investigation is required for validation of this technique in more number of animals.
2. Ultrasonography and radiography facilities should be made available in the College and in selected Veterinary Hospitals of the state so as to improve diagnosis and reduce no of abdominal explorations.

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