# DIAGNOSTIC LAPAROSCOPY IN LARGE ANIMALS

**THESIS**

**By**

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**(V-2014-30-009)**

***Submitted to***

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## CERTIFICATE – I

This is to certify that the thesis entitled " **Diagnostic laparoscopy in large animals**" submitted in partial fulfilment of the requirements for the award of the degree of **Master of Veterinary Science** in the discipline of **Veterinary Surgery and Radiology** of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out by **Priyanka Thakur (V-2014-30-009)** daughter of Sh. Nihal Singh Thakur and Smt. Meena Thakur under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

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

**(Prof. Adarsh Kumar)**
**Major Advisor**

**Place: Palampur**
**Date: .....................**

## CERTIFICATE – II

This is to certify that thesis entitled **"Diagnostic laparoscopy in large animals"** submitted by **Priyanka Thakur (V-2014-30-009)** daughter of Shri Nihal Singh to the CSK Himachal Pradesh Krishi Vishvavidyalya, Palampur in partial fulfilment of the requirements of the degree of **Master of Veterinary Science** in the discipline of **Veterinary Surgery and Radiology** has been approved by the Advisory committee after an oral examination of the student in collaboration with an External Examiner.

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Dean Post Graduate Studies

*Affectionately*

*Dedicated*

*To*

*My Beloved Parents*

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*Place: Palampur*

*Date:* *(Priyanka Thakur)*

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# ABBREVIATIONS

| Abbreviation | Meaning |
|---|---|
| **%** | **Per cent** |
| **Kg** | **Kilogram** |
| **b.wt.** | **Body weight** |
| **Inj.** | **Injection** |
| **mm** | **Millimeter** |
| **cm** | **Centimeter** |
| **D cr** | **Dorso cranial** |
| **D cd** | **Dorso caudal** |
| **V cr** | **Ventro cranial** |
| **V cd** | **Ventro caudal** |
| **Cen** | **Central** |
| **Tr** | **Trocar cannula** |
| **$CO_2$** | **Carbon dioxide** |
| **Li** | **Liver** |
| **cd LLi** | **Caudate lobe of liver** |
| **R LLi** | **Right lobe of liver** |
| **PF** | **Peritoneal fluid** |
| **W** | **Abdominal Wall** |
| **cD** | **Cranial part of duodenum** |
| **dD** | **Descending duodenum** |
| **Rk** | **Right kidney** |
| **Lk** | **Left kidney** |
| **UB** | **Urinary bladder** |
| **OF** | **Omental fold** |
| **Mv** | **Mesovarium** |
| **Ov** | **Ovary** |
| **Rec** | **Rectum** |
| **Ut** | **Uterus** |

| | |
|---|---|
| **Co** | **Colon** |
| **Ce** | **Cecum** |
| **Ru** | **Rumen** |
| **Sp** | **Spleen** |
| **Cy** | **Cyst** |
| **GF** | **Grasping forceps** |
| **TRP** | **Traumatic reticulo peritonitis** |
| **BF** | **Biopsy forceps** |

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**CHAPTER -1**

# INTRODUCTION

Abdominal affections are one of the major clinical problems in large animal practice. It is often difficult to differentiate whether the condition requires medicinal or surgical treatment or both. Therefore, it is very important for a surgeon dealing with these types of conditions to have a fundamental knowledge of anatomy and physiology of the systems. Proper history taking, complete physical examination, clinical examination, laboratory examination and diagnostic imaging make the complete rationale to deal with a clinical case presented for any surgical disorders. Out of which, lab examination and diagnostic imaging are emerging very fast in developing countries due to the influx of resources and more spending power of large animal owners due to the commercialization of dairy industry. Diagnostic imaging consists of many invasive and non-invasive techniques used routinely in human as well as companion animal medicine. But in large animals, its use is still limited specialty in third world countries. Generally, radiography, ultrasonography along with exploratory laparotomies is commonly used for diagnosis of various surgical conditions in large animals.

Since antiquity, practitioners have striven to visually examine the internal anatomy of their patients. Laparoscopy is a minimally invasive surgical technique for viewing the internal structures of the abdominal cavity by means of a telescope through a small incision made in the abdominal wall. Direct visualization of the organ with a token invasive method helps the clinicians to imply an assiduous control over the technique without invasive exploratory surgery and proves its superiority over other non invasive diagnostic techniques like X - ray, ultrasound, MRI etc. Moreover, laparoscopy requires minor surgical intervention and it provides one of the only available practical means of making repeated direct visualization of abdominal viscera (Twedt 1999). Limited abdominal keyhole exploration for laparoscope guided organ examination permits precise and accurate site localization of the various internal organs (Fantinatti *et al.* 2003; Lew *et al.* 2003). It is also helpful when excision biopsy is indicated to ascertain a correct diagnosis, specific therapy and accurate prognosis (Tams 1990).

Laparoscopic procedures allow excellent observation, minimal incision, lower complication rates, rapid postoperative recovery, lower pain scores and improved patient convalescence compared with open surgical procedures (Davidson et al. 2004; Babkine and

Desrochers 2005; Hendrickson 2008; Jimenez Pelaez et al. 2008; Dupre et al. 2009). The development of laparoscopy in veterinary science was dependent mainly on the advances in imaging. Laparoscopy is a constantly evolving field within large animal surgery. It was originally considered a surgical technique only practiced in academic hospitals by surgeons with advanced training. Laparoscopic surgery is now considered, however, an important aspect of general large animal surgery. Although veterinary laparoscopy has become increasingly popular during the past 20 years, minimally invasive surgery lags behind the human medical field. The reason for this discrepancy between human and veterinary laparoscopy is decreased access to appropriate training and instrumentation. It is also a fact that without such advances the large animal standing surgery lacks potential for forward progress. Although novel standing techniques continue to be published, the addition of minimally invasive laparoscopic techniques adds an entirely new dimension and provides an abundance of opportunities to surgeons practicing large animal standing surgery (Yanmaz *et al.* 2007).

Laparoscopy allows visualization of many structures not seen in standard celiotomy approach. Accurate knowledge of normal visceral anatomy is essential for performing diagnostic and therapeutic laparoscopic procedures and allows more accurate diagnosis of pathologic conditions and precise decisions for surgical intervention (Galuppo *et al.* 1995; Galuppo 2002). Laparoscopy in cattle is a promising tool for clinical diagnosis and treatment, along with the lower cost of the equipment these days and it does not entail more costs than an exploratory laparotomy (Babkine and Desrochers 2005).

Laparoscopy has a potential for wide spread use in the diagnosis of disorders of several body systems in large animals viz. gastrointestinal and urogenital. Para lumbar fossa laparoscopy can be used to view a variety of viscera. In bovines, on right side the descending duodenum, caudate and right lobes of the liver, right kidney, peristaltic movements, female urogenital tract, descending colon, cecum, urinary bladder can be visualized cranially, whereas caudomedial aspect of rumen’s dorsal sac, cranial mesenteric root and on left side, dorsal sac of rumen, spleen, kidney and portions of small intestine caudomedial to rumen can be visualised caudally. Likewise, in equines, various abdominal organs can also be explored (Fischer 2002). Other current applications are a serial renal biopsy, abomasal displacement, and ovarian tumours etc.

Diagnostic laparoscopy is a minimally invasive surgical procedure that allows the visual examination of intra abdominal organs in order to detect pathology. It is a procedure that allows a practitioner to look directly at the contents of a patient's abdomen or pelvis, including the fallopian tubes, ovaries, uterus, small bowel, large bowel, liver, and gallbladder (Almeida *et al.* 1995). The purpose of this examination is to actually see if a problem exists that has not been found with non invasive tests (Boyd and Nord 2000). Diagnostic laparoscopy is indicated in any situation when inspection of the abdomen will help establish a diagnosis and to define subsequent treatment. A number of important considerations should be taken into account before performing the diagnostic laparoscopy. The surgeon must be familiar with laparoscopic anatomy, laparoscopic techniques, limitations of the technique, and possible complications. As an example, the portal choice for laparoscope insertion into the abdominal cavity can make the difference between a successful examination and a failed one. It is very important to know what is expected with the examination.

Keeping in view the referral practice of large animals especially bovines in teaching veterinary clinical complex of the university, the present study was undertaken. The study was designed mainly explore its diagnostic utility in large animal practice and to delineate the landmarks for laparoscopy and to obtain a normal laparoscopic anatomy of the abdomen for clinical application. Therefore the basic objectives of the present study were

1. To standardize the laparoscopic technique for visualizing different organs in large animals.
2. To apply the laparoscopic visualization as a diagnostic aid in large animals.

**CHAPTER -2**

# REVIEW OF LITERATURE

There are many modalities used as diagnostic aids in veterinary sciences such as radiography, ultrasonography, but nowadays laparoscopy is getting popularity as a valuable and complimentary diagnostic technique because it offers tremendous advantage of direct visualization of abdominal and pelvic organs. The documentation is very scanty in the field of bovine abdominal laparoscopy.

## 2.1 History and instrumentation of laparoscopy

Spaner and Warnock (1997) gave a brief history of endoscopy, laparoscopy, and laparoscopic surgery. The ideas that form the framework for laparoscopic surgery were initially reported over a century ago. However, the introduction of the technique into the field of general surgery has been a relatively recent development. Laparoscopic surgery owes much of its history to the development of endoscopic technique.

Laparoscopy was a response to the curiosity to observe directly the interior of the living bodies. Light instruments were invented to fulfil illumination problems in the body cavities, like the 'Lichtleiter' by Philip Bozzini in 1804 which had a system of tubes and mirrors reflecting a candle light. Unfortunately, as a result of contemptuous reviews of his invention by his contemporaries, the innovation went largely unrecognized by the medical community (Rathert *et al.* 1974).

The first endoscope with an internal light source was the invention of a German dentist, Julius Bruck, in 1867 (Rosin 1993). The light source was an electrically heated platinum wire, which provided improved illumination but generated considerable heat. The potential for tissue burns induced by the instrument was reduced with the addition of a circulating water jacket. Maximilian Nitze, a German urologist, and his colleagues are generally credited with the development of the first rigid telescope in 1879, an instrument equipped with a series of lenses and alight source based on the design of Bruck (Nitze 1879).

Priority for “true” laparoscopic examination of the abdomen is afforded the German surgeon Georg Kelling, who used a Nitze - style cystoscope to examine the peritoneal cavity of dogs in 1901. Kelling created pneumoperitoneum with filtered air and called the technique “koelioskopie” (Kelling 1902; Rosin 1993). Jacobaeus (1911) examined the abdomen and the thorax of humans, deschbing hepatic diseases (cirrhosis, tuberculosis, metastatic tumours, and syphilis), gastric cancer, and 'chronic peritonitis'. Unlike Kelling, Jacobaeus did not use abdominal insufflation; however, many of his patients had ascites, which afforded working space. From here on several reports started to appear. Bernheim (1911) reported an 'Organoscopy' using an ordinary proctoscope or cystoscope, with illumination from an electric headlight.

The first time use of $CO_2$ as an insufflation gas was introduced (Zollikofer 1924), and the first operative laparoscopy is attributed to the German laparoscopist Carl Fervers, who conducted laparoscopic liver biopsies and lysed abdominal adhesions under direct observation (Gotz *et al*. 1993).

The hepatologist Heinz Kalk, introduced oblique - viewing telescopes (Kalk 1929) and a variety of hand instruments and devised the use of a second operative (instrument) portal as early as 1929, which opened the way to operative laparoscopic procedures; In 1938, Janos Veres, a Hungarian physician, improved on existing pneumoperitoneum needles by inventing one equipped with a spring loaded obturator to reduce injuries to abdominal viscera when establishing pneumoperitoneum (Veres 1938).

The contribution of Fourestier and his colleagues, combined with the development of a more robust and optically muchimproved rod lens system by the English physicist Harold Hopkins, opened new vistas in endoscopy and laparoscopy (Hopkins and Kapany 1954).

Among the greatest innovators in the development of modern laparoscopy was the German engineer and surgeon Kurt Semm. Indeed, his contributions are largely responsible for the current trend for minimally invasive surgery (Spaner and Warnock 1997). The development of the automatic insufflator, the morcellator, a variety of hand instruments, the ligating loop, and techniques for extracorporeal knot tying and intracorporeal suturing are all attributable to Dr. Semm. Additional contributions include advancing surgical techniques for tumour staging, adhesiolysis, and applications for bipolar electrocautery. He also invented a laparoscopic training device, the “pelvitrainer” Semm published extensively and a number of his gynaecologic procedures appear in a surgical atlas on “pelvicoscopy” in a number of languages (Semm 1992).

## 2.2 Effect of capnoperitoneum

The effects of $CO_2$ pneumoperitoneum have been studied extensively in human medicine. The cardiovascular effects of $CO_2$-insufflation started to be described by Smith *et al.* (1970) in a study of 13 human patients, in which the authors found an increase of the heart rate and blood pressure on the order of 10% with insufflation, in addition to an increase of the central nervous and intrathoracic pressures, as well as some other alterations.

Two years later, Kelman *et al*. (1972) went further and reported, in horizontal patients, a slight increase of $PaO_2$, and progressive increases of $PaCO_2$, even after disufflation, as well as an increase in the heart rate and arterial blood pressures. Soon studies started to appear comparing the influences of insufflation within $CO_2$ and $N_2O$.

The cardiovascular effects of intraperitoneal insufflation with these two gases were studied by Ivankovich *et al*. (1975) in dogs ventilated with 100% oxygen. Increased arterial blood pressures, heart rate, $PaCO_2$, and decreased pH and $PaO_2$ were found in $CO_2$-insufflation at high pressures (> 20 mmHg). In $N_2O$-insufflation, the same haemodynamic changes occur, but $PaO_2$, $PaCO_2$, and pH suffered no significant variations.

Luiz *et al.* (1992) utilised 11 human patients undergoing laparoscopic cholecystectomy, with controlled ventilation, to study ventilatory alterations. The results showed a significant increase in mean arterial pressure from the beginning of insufflation, which lasted until the end of the procedure and an increase up to 38% of the respiratory, carbon dioxide output, 60 minutes after the onset of the pneumoperitoneum; therefore, the minute volume had to be increased by approximately 30-40% to maintain normocapnia.

Blobner *et al.* (1994) concluded that there is no significant resorption of $CO_2$ from the abdominal cavity later than 30 min after releasing the KP. Up to this time, any $CO_2$ remaining in the abdominal cavity after careful emptying by the surgeon has been resorbed and exhaled. An increased $PCO_2$ as late as 30 to 90 min postoperatively should rather be considered a consequence of residual anaesthetics and narcotics than of $CO_2$ resorption.

Specific cardiovascular and neuroendocrine and metabolic effects were described by Cuschieri (1999), which consisted of a reduction in the cardiac output, increase in the systemic and pulmonary vascular resistance, preload, and diminished hepatic, splanchnic and renal flow, the release of renin and aldosterone, sympathicomimetic response, and renal vasoconstriction.

The animals were by this time used as models in order to investigate the deleterious effects of laparoscopic insufflation.

In 1992, Ho *et al.* performed a trial in eight adult pigs with a constant pressure of 15 mmHg of $CO_2$ pneumoperitoneum during laparoscopic cholecystectomy. The results revealed an increase of the $PaCO_2$ and a concomitant decrease of the arterial pH, as well as an increase in the heart rate and systemic and pulmonary pressures. The authors concluded that $CO_2$-insufflation resulted in significant trans-peritoneal $CO_2$ absorption, with secondary hypercapnia and acidemia. The accumulation of $CO_2$ was also associated with an increase in systemic and pulmonary arterial pressure, and a compensatory tachycardia.

Williams and Murr (1993) used a dog model, in which the authors found a decrease in the mean cardiac output in less than 80% of the baseline, and a significant increase in the mean arterial $PaCO_2$ and mean peak airway pressure. Hyperkalaemia was associated with the prolonged insufflation of carbon dioxide into the peritoneal cavity in an experimental study with pigs (Pearson and Sander 1994).

Furthermore, in the area of veterinary medicine, several experimental and clinical studies were conducted. Hahn *et al.* (1997) utilised 32 pigs for experimental partial colon resections, 27 by laparoscopy and 6 by laparotomy, and studied the problems during laparoscopy by using $CO_2$ pneumoperitoneum or capnoperitoneum. The results showed an increase of $PaCO_2$ and decrease of the pH in the first phase of capnoperitoneum. There were no significant changes in $HCO_3$. The heart rate was elevated from the IV phase until the end of the trial.

In 1999 Tung and Smith revealed an exaggerated interleukin- 6 response in the serum and intestinal mucosa after the exposure of the abdominal cavity to ambient air compared with that of carbon dioxide. According to Tung and Smith cytokine measurements may be a good indication of the response to the stress of surgeries and concluded that the beneficial effects of laparoscopy might be the exclusion of ambient air from the peritoneal cavity.

In small ruminants, the effects of pneumoperitoneum have not been clarified. There are some studies in pregnant ewes as experimental models in order to study the Influences of abdominal insufflation in the pregnant patient and foetus. Cruz *et al.* (1996) utilised nine pregnant ewes in order to investigate the maternal heart rate, mean arterial pressure and blood gases, and foetus vital parameters. No significant differences were found between the insufflation and control groups regarding the haemodynamic parameters. Maternal $PaO_2$

decreased significantly and $PaCO_2$ increased in the initial 60 minutes of the study, but not significantly. No changes were appreciable in either group with respect to the acid-base status.

Curet *et al.* (1996) also utilised these models and recorded the parameters from the ewe (heart rate, blood pressure, blood gases, and others) and from the foetus. The authors found an increase of the maternal heart rate in the beginning of Insufflation at 10 mmHg and continuing on throughout the study. There was no significant difference in the maternal blood pressure between the groups, even after insufflation at 15 mmHg.

Curet *et al.* (2001) studied the effects of helium pneumoperitoneum in pregnant ewes, compared to $CO_2$ pneumoperitoneum, since the second gas showed a risk of acidosis for the mother and foetus in the authors' previous study. The results showed that helium insufflations led to an increase of the maternal heart rate, but no significant changes in $PaCO_2$ and pH.

In 2004, Neuhaus and Watson suggested that the use of carbon dioxide in creating a pneumoperitoneum during laparoscopy possibly could cause ultrastructural, metabolic, and immunologic alterations at the peritoneal surface. These alterations could favour tumour implantation in the peritoneal cavity and would affect its capacity to eliminate peritoneal infections.

Anderson *et al.* (1993) suggested that insufflation in cattle should be done when all organs are sufficiently separated, without exceeding a pressure of 20 mm Hg. Similar recommendations were suggested by Babkine and Desrochers (2005) in their study on laparoscopic surgery in adult cattle.

## 2.3 Laparoscopy in large animals

### 2.3.1 Bovines

Laparoscopy in ruminants started to be a complementary diagnostic tool. Wishart and Snowball (1973) observed the ovary of the cow *in situ*, and Naoi *et al*. (1985) described the method to biopsy the kidney in bovine species; however it was steadily increasing as a therapeutic resource.

Diagnostic laparoscopy can be performed in the standing cow and sheep, where the normal laparoscopic abdominal anatomy is already described from the right and left paralumbar fossa (Anderson *et al.* 1993; Leber 2001), as well as in dorsal recumbent calves, from a cranioventral midline approach, as described by Fuhrmann (1991). It has also good indications for patients with the suspicion of an abdominal disease (Franz 1998) or to exclude such diagnoses and biopsy internal organs such as the spleen.

In 1985, Naoi *et al.* did laparoscopic guided organ biopsy for the first time in cattle. The organ involved was a kidney. In this technique, the laparoscope was introduced in the middle of the right paralumbar fossa after the site had been surgically prepared (local anaesthesia and a 2-cm cutaneous incision). A Franklin-Silverman biopsy needle was used and introduced 5 cm below the transverse processes, behind the last rib. The biopsy was completed using the sharp part of the needle. It allowed one to take a biopsy specimen that was on average 1.5mmin diameter and 16mmin length.

In 2002, Klein *et al.* described a method to biopsy the small intestine of calves and sheep, placed under general anaesthesia in dorsal recumbency, under laparoscopic control. In 8 of the 9 cadavers, it was possible to perform the biopsy. The intestine was held with forceps and removed from the abdomen and the biopsy was performed as open surgery. In 4 (all sheep) of the 14 animals, it was impossible to carry out the sampling.

Rao *et al*. (2013) performed laparoscopic biopsy technique of liver and spleen in buffalo calves. The advantages of the use of laparoscopy-guided biopsy techniques are the direct visualization of the target organ and the selection of the exact biopsy site. In this way, obtaining biopsy specimens of the wrong organ is avoided, and possible haemorrhages are identified and controlled.

In 1984, Wilson and Ferguson performed the study to examine the use of a flexible fiberoptic colonoscope as a diagnostic aid in cattle. They reported that it was possible to diagnose a traumatic reticuloperitonitis in a cow that showed clinical signs of the disease with the help of a colonoscope inserted through the left flank. Consequently, these lesions were detected and characterized in all cases. Examinations were carried out on a group of normal animals and the effects of laparoscopy on haematological parameters measured. The use of laparoscopy in the diagnosis of left displacement of the abomasum and traumatic reticuloperitonitis was assessed in two separate groups of patients.

In 1993, Anderson *et al.* also stated that biochemical analyses and peritoneal fluid likewise were unaltered before and 72 hours after the laparoscopic examination. Three laparoscopic procedures were performed on each of 6 adult Jersey cows in the first trimester of gestation to describe the normal laparoscopic anatomy of the bovine abdomen. Also, a technique for laparoscopy of the cranioventral portion of the abdomen was described. Right paralumbar fossa, left paralumbar fossa, and cranioventral midline laparoscopy was performed 72 hours apart of each cow. It was performed without complication in all cows. Adverse effects of laparoscopy, individually or serially, were not observed. Significant differences were not found between CBC, serum biochemical, and peritoneal fluid variables are taken before and 72 hours after surgery.

In 1993, Anderson *et al.* reported that pancreas always can be identified in right flank laparoscopy and he said, the bladder occasionally is identifiable on the left side (one case out of six), and the left lobe of the pancreas is seen situated cranially to the left kidney, near the rumen's attachment to the dorsal abdominal wall (one case out of six).

In 1984, Bernard *et al.* used laparoscopy to observe ovulation in heifers. In 1985, Sirard and Lambert did *in vitro* fertilization of bovine follicular oocytes which were obtained by laparoscopy. In 1986 Lambert *et al*. did in vitro fertilization of bovine oocytes which were matured in vitro and were collected at laparoscopy. In 1989, Schellander *et al.* did *in vitro* fertilization of bovine follicular oocytes recovered by laparoscopy and Fayrer-Hosken *et al*. (1989) laparoscopically transferred in vitro matured and in vitro fertilized bovine oocytes into the oviduct. In 1994, Reichenbach *et al.* did laparoscopy through the vaginal fornix of the cow so that repeated aspiration of follicular oocytes can be done.

Steiner and Zulauf (1999) described the technique of laparoscopy in cows. The laparoscopic anatomy of healthy cows was described with the laparoscope introduced through the left and right flank in the standing animal and through the ventral aspect of the abdomen with the animal positioned in dorsal recumbency.

The laparoscopic examination was carried out in 49 cattle suspected of abdominal diseases by Franz *et al.* (2000). Laparoscopy successfully diagnosed peritonitis of the cranial parts of the abdomen, caused by foreign bodies or laparotomy, and left abomasal displacement. Laparoscopy was not suitable for examining the ventral abdomen or for diagnosing non-inflammatory intestinal diseases. It was concluded that laparoscopy should be carried out in every suspicious case of the abdominal disease to support clinical diagnosis and to decide on further measures.

Konig *et al.* (2000) described the physiological and anatomical appearance of the organs after insufflation of the abdominal cavity with the help of carbon dioxide. Laparoscopy in the region of fossa paralumbalisdextra was carried out in 42 cattle. The peritoneum perforation was difficult in obese animals. Insufflation of carbon dioxide was needed in most cases to create sufficient space for visualizing internal organs. 35 litres of $CO_2$ gas was insufflated into the peritoneal cavity at a rate of 3 litres/minute. Abdominal organs were then photographed, and physiological and anatomical appearance of the organs were described.

In 2005, Babkine and Desrochers studied laparoscopic surgery in adult cattle. They described that laparoscopy in cattle is a promising tool for clinical diagnosis and treatment. The lower cost of the materials available in addition to the possibility of an intervention on an animal that was sedated did not entail more costs than an exploratory laparotomy. The application of this tool during abdominal explorations and biopsies allowed the avoidance of invasive and often useless surgical interventions and even with the diagnosis and prognosis of certain conditions. Surgical techniques currently were limited to abomasopexies, however, never-ceasing progress and improvements in human surgery were expected to affect the future of bovine surgery. With the advancements in the multimedia technology used by universities, the use of laparoscopy as a pedagogic tool definitely has a promising future. Endoscopic exploration of the thorax is possible using the same material as for laparoscopy. In addition, diagnostic and biopsy applications are useful. The use of the laparoscope in different body cavities and for different applications would make the purchase of the required materials more cost-effective.

In 2006 Babkine *et al.* described ventral laparoscopic abomasopexy in adult cows. The objectives of this study were to describe a safe and reliable abomasopexy technique by laparoscopy and to assess postoperative adhesion formation. A ventral laparoscopic abomasopexy was performed on 10 adult dry cows. Displacement of the abomasum is frequently diagnosed by veterinarians in bovine practice and numerous surgical techniques have been developed to treat and prevent this condition. Complications secondary to those techniques are related to their degree of invasiveness and the development of postoperative wound infections. The objectives of this study were to describe a safe and reliable abomasopexy technique by laparoscopy and to assess postoperative adhesion formation. A ventral laparoscopic abomasopexy was performed on 10 adult dry cows. The abomasum was fixed with 4 simple interrupted sutures using USP 2 polydioxanone suture material. No major complications were encountered during the surgery. Abomasal adhesions were visually evaluated by laparoscopy three months postoperatively. This technique proved to be simple and safe, and it provided adequate abomasum fixation in healthy dry cows. It could be used to surgically correct left displaced abomasum.

Franz *et al.* (2006) studied two different techniques for ruminoscopy in nine calves, concluding that the ruminoscopy via a ruminal fistula was well tolerated by all the animals, enabling direct visualisation and the evaluation of the mucosa and contractions of the rumen and reticulum. The ruminoscopy via the oral approach could not be performed in three non-cooperative calves, but guaranteed the good visualisation of the caudal rumen, none from the reticular groove and inconstant visualisation of the reticulum, with the advantage of being less invasive than the previous technique.

Laparoscopy is also used for therapeutic reasons in ruminants. Laparoscopic-guided abomasopexy was used as a method for the reposition and fixation of the abomasum after displacement (Janowitz *et al*. 1998) and then was studied in comparison to omentopexy via the right flank laparotomy in dairy cows (Seeger *et al.* 2006; Roy *et al.* 2008).

Ovariectomies can be performed by laparoscopy with the cow in the standing position, via the left flank approach with minimal invasion and optimal visualisation (Bleul *et al.* 2005).The main objective of this study was to evaluate laparoscopic ovariectomy and to develop an optimal surgical technique for this procedure in standing cattle. Eight cows underwent laparoscopic ovariectomy. In two cows, a bilateral flank approach was used and in six cows, both ovaries were removed via a left flank approach. An important prerequisite for ensuring sufficient intrabdominal space for instrumentation, optimal endoscopic orientation and easy access to the ovaries and uterus was withholding feed for at least 36 hour prior to surgery. The portal for the laparoscope was at the ventral angle of the left paralumbar fossa, approximately 10 cm cranioventral to the tuber coxae. The instruments were inserted through two portals approximately20 cm and 30 cm ventral to the tuber coxae. After abdominal insufflation with carbon dioxide, the left ovary was grasped and local anaesthetic was injected into the mesovarium and mesosalpinx. The mesovarium was transected using bipolar cauterization and the ovary removed through an extended instrument portal. The right ovary was removed in the same way. The incisions were closed with single interrupted absorbable sutures in the musculature and single interrupted non-absorbable sutures in the skin. The procedure lasted 120–150 minute. Bilateral laparoscopic ovariectomy via left flank approach in standing cows is feasible. This procedure involves special instrumentation, but is minimally invasive and allows optimal visualization of the ovaries and uterus.

Beierer and Burgess (2009) stated that laparoscopy is a minimally invasive technique for exploration and manipulation of the internal structures and wall of the peritoneal cavity. The minimally invasive nature of the procedure, diagnostic accuracy, reduction in surgical stress, reduced patient morbidity, and post-operative pain contribute to making this procedure a definite alternative to open surgical approaches in small animals. Laparoscopy represents a major advancement in veterinary science and demonstrates a forward thinking approach to patient care.

Surgery always causes great trauma and stress on the animal's body. Many efforts have been made to reduce this drawback of conventional surgical procedures, and laparoscopy is one of them (Zade *et al.* 2007). The modern laparoscopic procedure involves instruments like cameras, light source, different hand instruments, visualization screen, etc. that helps in better visualization of internal organs. Laparoscopy is performed by creating a space on the abdominal cavity, i.e. pneumoperitonium (8-10 mmHg) and inserting fibre optic cables carrying light inside the cavity. The success and good results of this technique have made this procedure very popular among veterinarians. The future of laparoscopy is great in veterinary practice. In the future, new techniques like remote handling technology will overcome the manipulative restriction of the current instruments.

Laparoscopic cryptorchidectomy without insufflation was applied in 10 standing bulls aged 3 to 15 months. (Kaneko *et al*. 2015) Nine bulls were preoperatively pointed out intra-abdominal testes by computed tomography. Preoperative fasting for a minimum of 24 hr provided laparoscopic visualization of the intra-abdominal area from the kidney to the inguinal region. The surgical procedure was interrupted by intra-abdominal fat and testis size.

In 2006 Seeger *et al.* did a comparison of laparoscopic-guided abomasopexy versus omentopexy via right flank laparotomy for the treatment of left abomasal displacement in dairy cows. In a prospective clinical trial, cows were randomly allocated to the abomasopexy group (laparoscopy-assisted abomasopexy) or to the control group (omentopexy via right flank). 59 of 60 cows in the abomasopexy group and all 60 cows in the control group were treated successfully. Five cows in the abomasopexy group had wound complications and 2 had LDA relapses, compared with 2 wound complications and no relapses in the control group.

Experimental laparoscopic intervention in umbilical structures, in calves dorsally positioned, was attempted by Boure *et al*. (2001), where the apex of the bladder and umbilical structures were resected by the use of an endoscopic suturing device. Boure *et al.* (2005) then compared two laparoscopic suture patterns for the repair of experimentally ruptured urinary bladders in normal neonatal calves.

Fransson (2014) stated that laparoscopic surgery minimizes tissue trauma and speeds recovery, but its uptake into veterinary clinical practice has been slow. Because laparoscopy is distinctly different from traditional open surgery and a reduced working area and loss of depth perception are among the challenges that the surgeon must get to grips with. Indeed, it is often lack of the necessary skills, rather than the cost of equipment, that presents the greatest obstacle.

Romussi and Gualtieri (1994) performed a laparoscopy for diagnosis of left abomasal displacement in 13 cases of cows. According to their results laparoscopy might be considered a successful method in detecting ping negative LDA and all cows in which LDA is suspected.

**2.3.2 Equines**

The first published reports of 'peritoneoscopy" in animals came from Witherspoon and Talbot (1970), related to an exploratory laparoscopy as a gynaecologist tool to observe the ovaries in the mare.

Some years later, the laparoscopic anatomy of the abdomen was described in standing horses by Fischer *et al.* (1986), in the dorsally recumbent animal by Galuppo *et al.* (1995), and in foals positioned in dorsal recumbency by Boure *et al.* (1997).

Nowadays, the endoscopic surgery of the abdomen is a common procedure in horses. Laparoscopic colopexy can be successfully performed with minimal abdominal invasion (Trostle *et al.* 1998), as well as mesenteric rent repair (Sutter and Hardy 2004), nephrosplenic space closure in standing horses (Marien *et al.* 2001; Rocken *et al.* 2005), adhesiolysis (Boure *et al.* 2002; Lansdowne *et al.* 2004), and inguinal hernia repair (Fischer *et al*. 1995; Rossignol *et al.* 2007).

An experimental study performed by Fischer (1999) described a technique for laparoscopicassisted resection of the umbilical structures in foals in the dorsal position.

Related to the urinary system, Edwards *et al.* (1995) reported a case of the diagnosis of a bladder rupture and surgical treatment by using laparoscopy with good results, Walesby *et al.* (2002) repaired laparoscopically a ruptured urinary bladder in a stallion that was discharged from the hospital 5 days after surgery and showed no signs of urological disease in the subsequent 2 years. Laparoscopic-assisted cystostomy and urolith removal in geldings with cystic calculi were also described by Ragle (2002).

Rijkenhuizen *et al.* (2008) did a laparoscopic repair of a ruptured bladder in an adult mare. It was concluded that a laparoscopic approach in the recumbent mare proved suitable for the repair of a bladder rupture in a mare. However, a laparoscopic approach in the standing horse might improve the surgical access to a ruptured bladder further, and would certainly reduce the anaesthetic risks. On the other hand, it might prove a technical challenge for the surgeon, who would need to be adept at intracorporeal suturing.

Lund *et al.* (2013) did Laparoscopic removal of a bladder urolith in a standing horse. The laparoscopic technique provided excellent viewing and access to the bladder, permitting extraction of the urolith and secure closure of the cystotomy with minimal tension and tissue trauma to the bladder.

Rocken *et al.* (2007) performed successfully left and right sided laparoscopic assisted nephrectomy in standing horses with unilateral renal disease and concluded that to avoid risks associated with general anaesthesia and to reduce surgical trauma, laparoscopic assisted nephrectomy can be performed in the standing sedated horses using a two portal technique and a mini laparotomy.

Rossignol *et al.* (2007) concluded that laparoscopic hernioplasty on a recumbent horse is feasible by closing the vaginal ring with a peritoneal flap and opined that this technique was efficient to prevent recurrence of strangulated inguinal hernia and reduced inflammation and irritation of the spermatic cord, which could otherwise jeopardise the animal’s breeding career.

Bracamonte *et al.* (2008) performed evaluation of a laparoscopic technique for collection of serial full thickness small intestinal biopsy specimen in standing 13 sedated horses by ex vivo and in vivo study and concluded that laparoscopic collection of serial full thickness small intestinal biopsy specimens with a 45 mm ELS may be an effective and safe technique for use in healthy adult experimental horses.

Penide (2008) did unilateral ovariectomy by laparoscopy in mares. The laparoscopic method used in this case has advantages in that it is a relatively simple, non-invasive and low cost procedure that does not require general anaesthesia.

Smith and Mair (2008) did unilateral and bilateral laparoscopic ovariectomy of mares by electrocautery. Alsafy *et al.* (2013) described the laparoscopic anatomy of the abdomen and laparoscopic ligating loops, electrocoagulation, and a novel modified electroligation ovariectomy in standing mare.

Holak *et al.* (2013) did diagnostic laparoscopy for small intestinal intussusception in a horse. In 2014 Stewart *et al.* did Hand-assisted laparoscopic repair of a grade IV rectal tear in a post-parturient mare.

Caron and Mehler (2009) performed laparoscopic mesh incisional hernioplasty in five horses with a ventral medial abdominal incisional hernia. Successful placement of the prostheses was achieved without major intra or post operative complications. Repairs were intact in all horses without evidence of adhesion formation. Cosmetic results compared favourably with those typically achieved using conventional, open hernioplasty techniques and concluded that incisional hernia repair in horses can be successfully achieved with a laparoscopic intaperitoneal mesh onlay technique.

Kassem *et al.* (2014) described Gasless laparoscopic anatomy and renal biopsy of the kidney in the Standing Mare. They provided the topography and renal biopsy of the standing mare kidneys by laparoscopy without $CO_2$ insufflation and to compare between the use of biopsy needle and forceps. The gasless laparoscopic renal biopsy appeared simple, safe, reliable, minimally invasive, timesaving and economical technique. The parallel biopsy portals provided easy and accessible biopsy procedure than dorsal or ventral portals. The biopsies taken from the lateral surface were less haemorrhagic than those taken from the caudal pole.

CHAPTER-3

# MATERIALS AND METHODS

The study was conducted in the Department of Veterinary Surgery and Radiology, Dr. G.C. Negi College of Veterinary and Animal Sciences, CSKHPKV, Palampur, Himachal Pradesh.

## 3.1 Animals

Client owned bovine patients presented to the Teaching Veterinary Clinical Complex of the College were the subjects of the study. A total of 20 female patients referred for exploratory laparotomy/ diagnostic abdominal explorations were included in the study.

As per diagnostic indication, the study is executed by allocating the animals in two groups namely right flank laparoscopy and left flank laparoscopy.

## 3.2 Materials /Instrumentation for general laparoscopy and biopsy procurement

**Table 1. General laparoscopy and biopsy procurement instruments**

| No. | Description of instrumentation and other materials |
|---|---|
| 1. | Supplies for anaesthesia (Inj. Xylazine , Inj. Lignocaine hydrochloride) |
| 2. | Supplies for skin incision and skin closure |
| 3. | Veress needle |
| 4. | Laparoscope cannula (sleeve) with trocar<br>Trocar cannula with multifunctional valve<br>Trocar cannula with threads with multifunctional valve |
| 5. | Rigid Laparoscope<br>Straight forward telescope 0 degree, 10 mm diameter and 57 cm length |

| | |
|---|---|
| | Straight forward telescope 0 degree, 10 mm diameter and 31 cm length |
| 6. | Telepack vet X (Karl storzendoskope) |
| 7. | Accessory Insertion cannula with trocar (5 mm and 10 mm in diameter) |
| 8. | Palpation probe. |
| 9. | Muscle retraction Hook |
| 10. | Grasping forceps |
| 11. | Mechanical insufflators (Ackermann) |
| 12. | Gas insufflation tubing |
| 13. | Electrocautery |
| 14. | Fiberoptic endoscope |

Plate 1 – Complete assembly for laparoscopy

### 3.2.1 Components of laparoscopy unit

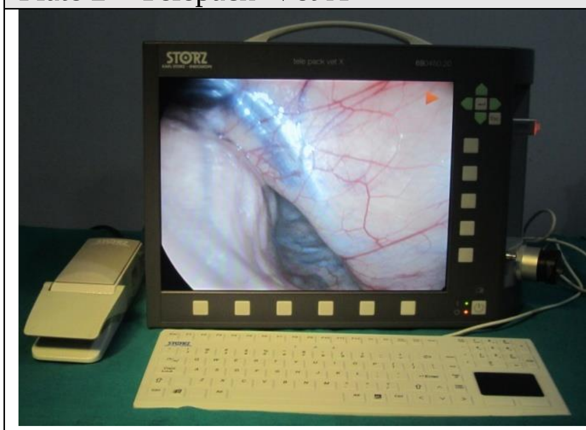
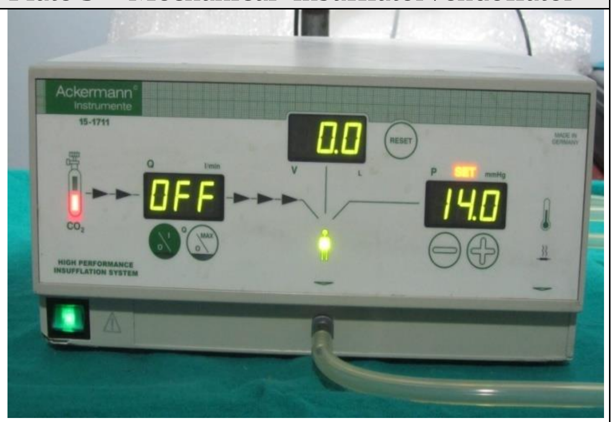
| Plate 2 – Telepack Vet X | Plate 3 – Mechanical insufflator /endoflator |
|---|---|
|   |   |
| Plate 4 – Video camera head | Plate 5 – Light Cable |


Plate 6 – Electrosurgical unit

### 3.2.2 Laparoscopic trocar and cannulas

Plate 7 - Cannula with multifunctional valve

Plate 8– Threaded cannula with multifunctional valve

Plate 9 A, B – Various types of trocars

A

B

### 3.2.3 Laparoscopes

Plate 10 – Laparoscope straight forward telescope 0 degree, 10 mm diameter & 57 cm length

Plate 11 – Laparoscope straight forward telescope 0 degree, 10 mm diameter & 31 cm length

### 3.2.4 Laparoscopy forceps

Plate 12 – Clickline jaw forceps

Plate 13 – Clickline biopsy forceps

Plate 14 – Laparoscopy needle holder

Plate 15 – Claw forceps

### 3.2.5 Some other accessories

Plate 16 – Muscle retracting hook

Plate 17 – Palpation probe

Plate 18 – Veress needle

**3.3 Case record: -**A Performa designed for the study is mentioned below

**Section 1: Case presentation and History**

- Registration number ……………………………………………………
- Date of examination ……………………………………………………
- Species ……………………………………………………
- Age (years) ……………………………………………………
- Sex ……………………………………………………
- Approximate weight ……………………………………………………
- History ……………………………………………………

**Section 2: Physical examination on presentation**

- Heart rate (beats per minute) ……………………………………………………
- Respiration rate (per minute) ……………………………………………………
- Rectal temperature (°F) ……………………………………………………
- Mucous membrane colour ……………………………………………………

**Section 3: Diagnostic procedure**

- Fasting time ……………………………………………………………
- Site of ports ……………………………………………………………
- Laparoscope port ……………………………………………………………
- Instrument port 1 ……………………………………………………………
- Instrument port 2 ……………………………………………………………
- Any complication at mentioned site ……………………………………………………………
- Port distance from lumbar ……………………………………………………………
- Port distance from tuber coxae ……………………………………………………………
- Pneumoperitoneum ……………………………………………………………
- Any complication ……………………………………………………………
- Laparoscope used ……………………………………………………………
- Anaesthesia ……………………………………………………………

**Section 4: Observations:**

**Section 5:**

- Duration of procedure ……………………………………………………………
- Carbon dioxide consumption ……………………………………………………………
- Pressure of carbon dioxide maintained at ……………………………………………………………

**Section 6: Post-operative**

- Care ……………………………………………………………
- Complications ……………………………………………………………

### 3.4 Preparation of animal

The animals were prepared for the procedure by fasting for at least 24 hours. Water was withheld only for 8 hours. The required paralumbar fossa was clipped, shaved, washed and scrubbed aseptically (Plate - 19).

Plate 19 – Preparation of flank of animal for laparoscopy

### 3.5 Anaesthetic protocol

The animals were administered Inj. Xylazine hydrochloride (Xylodac) @0.03 mg/Kg b.wt. intramuscular route. Twenty minutes later as the animal showed calmness and standing restraint the paralumbar analgesia was achieved by infiltrating Inj. Lignocaine hydrochloride (LOX 2%) in inverted L fashion (Plate - 20).

Plate 20 - Local anaesthesia (inverted L fashion) in flank region of animal


### 3.6 Patient positioning

All the laparoscopic procedures were carried out in standing animals. The tail was tied to prevent contamination of the operative field. The specially designed crate was used to perform the laparoscopy (Plate 21) so as to have a maximum of the instruments engaged in the procedure without any hindrance.

Plate 21 – Patient positioned for laparoscopy in specially designed crate

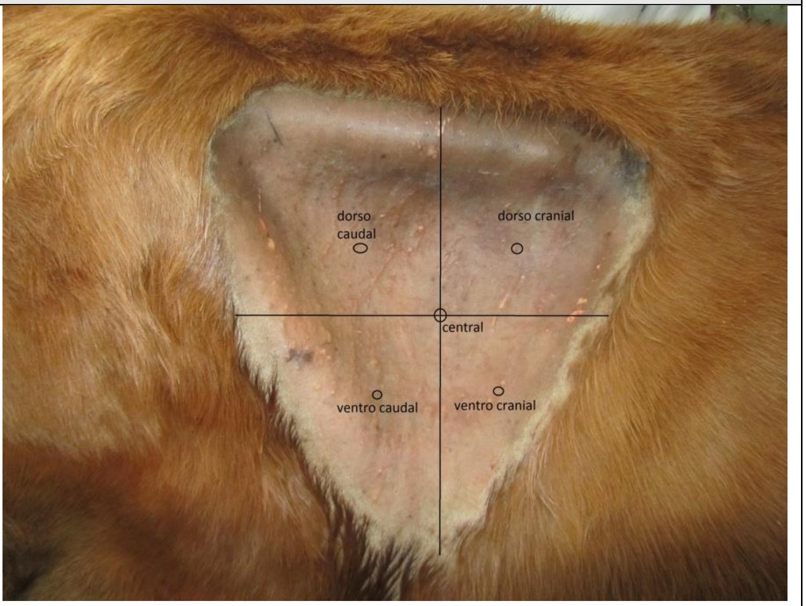
## 3.7 Plan of work

To study and standardize the ease of accessibility of organs either of the flanks was sectioned into 5 regions as described below in the plate (Plate 22). The midsection of the paralumbar fossa was marked by a straight line from lumbar 3 vertebrae going down dividing it into 2 equal halves.

**Port sites of laparoscope on both the flanks**

- Dorso cranial
- Dorso caudal
- Ventro cranial
- Ventro caudal
- Central

Plate 22 – Five primary entry portals of paralumbar fossa




## 3.8 Surgical technique

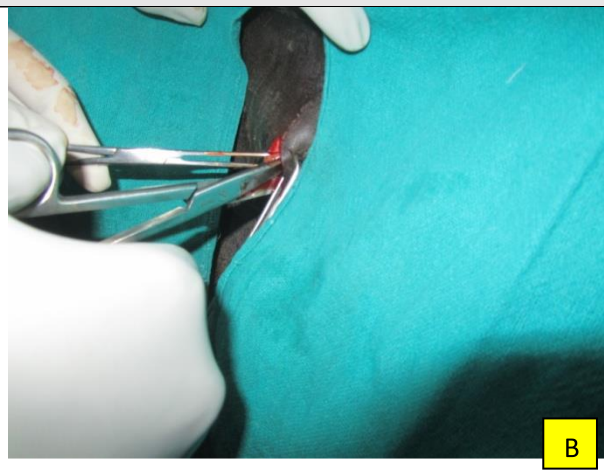
### 3.8.1 Entry to the abdominal cavity

After aseptic preparation and draping of the animal, the tentative cannula portal placement sites as per indication were marked over the right or left flank with the help of betadine soaked gauge. Three different techniques were followed / devised to make the entry into the abdominal cavity.

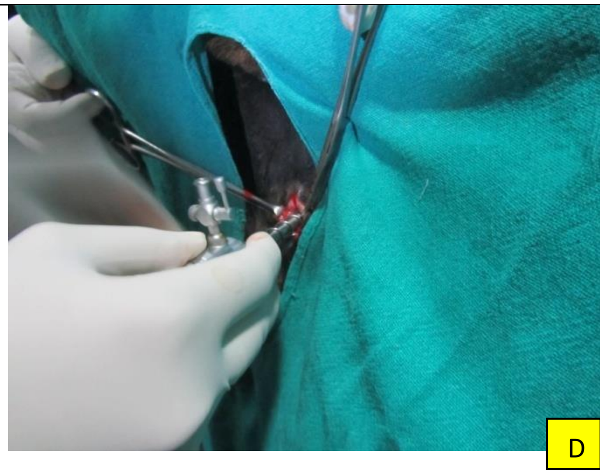
I. **Conventional direct entry (Plate 23 A-B) -** A small nick was given at the site of laparoscope insertion and the trocar with cannula was advanced through the musculature and peritoneum until air influx could be heard entering the abdominal cavity.

| Plate 23 – Steps of conventional direct entry | |
|---|---|
|  |  |
| A - Small nick at site of laparoscope insertion | B - Insertion of trocar for pneumoperitoneum |

II. **Modified direct entry - forceps assisted (Plate 24 A-D)** - A small incision (approximately 2 cm) was made through the skin and muscles were grasped with Allis tissue forceps and incision in muscles and peritoneum was given and extended with the help of scissors by blunt dissection. Air influx was heard upon insertion of the trocar into the abdominal cavity.

| Plate 24 – Steps of modified direct entry - forceps assisted | |
|---|---|
|  |  |
| A – Muscles grasped with Allis tissue forceps. | B – Extending the incision with the help of scissors by blunt dissection. |

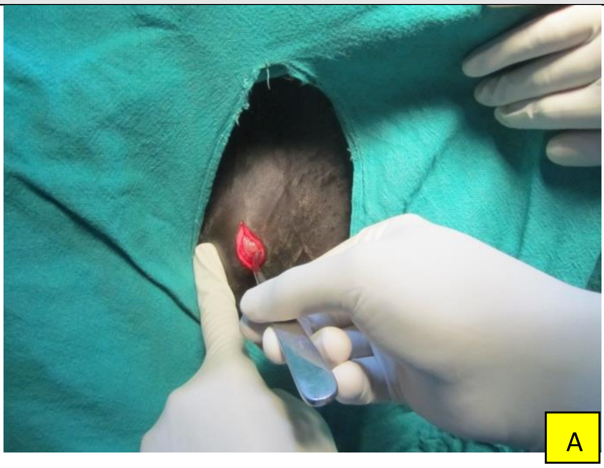

C – Incision made



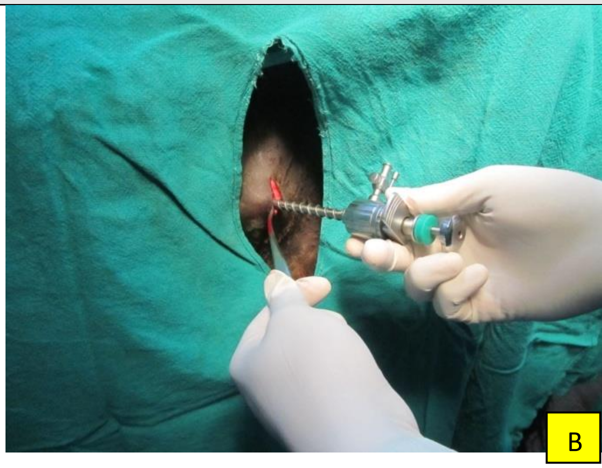

D – Insertion of trocar and cannula

III. **Modified direct entry - hook assisted (Plate 25 A-B) -** A small incision (approximately 2 cm) was made through the skin and muscles were grasped and pulled with the help of hook and blunt dissection of muscles was done to create mini port space so as to create space between the abdominal wall and underlying abdominal organs. With the help of pointed scissors, a miniport was created by the separation of muscle fibres. From the mini port, entry of trocar into the abdominal cavity was made while the hook was being pulled outside.

Plate 25 – Steps of modified direct entry - hook assisted




A – Grasping muscles with help of hook




B – Inserting trocar and cannula through mini port

### 3.8.2 Verification of entrance into the abdominal cavity

a) Insufflation tube was connected to the trocar: The intraabdominal pressure should register negative on the insufflator when the abdominal wall was lifted.

b) Hiss test: After insertion of the trocar, a stopcock was opened on the insufflating trocar and abdominal wall was elevated. A hissing noise was heard as air rushed into the abdominal cavity.

c) Flow test: Insufflator was connected to the insufflation needle. The insufflator was turned on. Care was taken not to exceed the intraabdominal pressure more than 5 -8 mm Hg within the first litre of flow.

d) External evaluation of the abdominal cavity: As the insufflating gas entered, the bubbling of the abdominal wall was seen. The symmetric distension of both the flanks confirmed the appropriate insufflation.

### 3.8.3 Insufflation/Capnoperitoneum

Capnoperitoneum was established before insertion of the laparoscope and accessory instruments. Carbon dioxide gas was used for abdominal insufflation using electronic carbon dioxide insufflators (Ackermann).The intraabdominal pressure limit was set on 14 mm Hg. The flow rate of the gas remained between 4.5 – 5.5 L/ min. At 9 mm Hg of intraabdominal pressure, the influx of $CO_2$ stopped to facilitate entry of laparoscope (Plate 26).

Plate 26 - Insufflation of abdominal cavity

### 3.8.4 Portal entry and Visualization

a. Having achieved the requisite capnoperitoneum the cannula used for direct entry into the abdominal cavity was retrieved back.
b. From the same incision, a threaded endocannula with the multifunctional valve was introduced into the abdominal cavity by gentle thrust and screw motion.
c. The moment cannula entered the abdominal cavity, it lost the resistance and upon opening the functional valve gas evacuation was heard. Now from the obturator, the pre warmed telescope was inserted into the cavity.
d. Frequently image became blurred as the telescope entered the abdominal cavity as a result of tissue, fluid or blood contaminating the lens as the telescope passed through the cannula or from condensation on the lens as a result of temperature change. As and when this occurred, the tip of the telescope was cleaned by carefully wiping the tip against the abdominal tissue.
e. Once the telescope was in the abdominal cavity, a thorough examination of the abdominal organs/lesions/surgical perforations was performed.
f. Secondary portal was established to allow manipulation of viscera and to perform laparoscopic procedures. The secondary port was made in the same plane as of the optic axis of the laparoscope and was established under direct visualization. It was placed through the abdominal wall as described in the procedure for placement of the first telescope cannula, except the trocar entry was viewed internally and the correct entry point was marked by the tenting of the peritoneum by the tip of the cannula into the abdominal cavity. Once the cannula had entered the abdomen, the trocar was removed for making way for laparoscopic instruments.
g. Exploration of the abdominal cavity was assisted using the palpation probe to feel and to move the organs as needed. The organs of interest were explored and photographic documentation was made.

### 3.8.5 Photographic documentation (Plate 27)

The most common method of documenting endoscopic findings is taking images and videos. A Telepack vet X enabled to capture images and record videos. Digital image can be turned into prints, slides or reports including text that can be used for medical records, client education or referral.

Plate 27 – Photographic documentation


A - Documentation of patient data


B – Retrieving the data


C - Image recording


D – Video recording

### 3.8.7 Procurement of organ biopsy

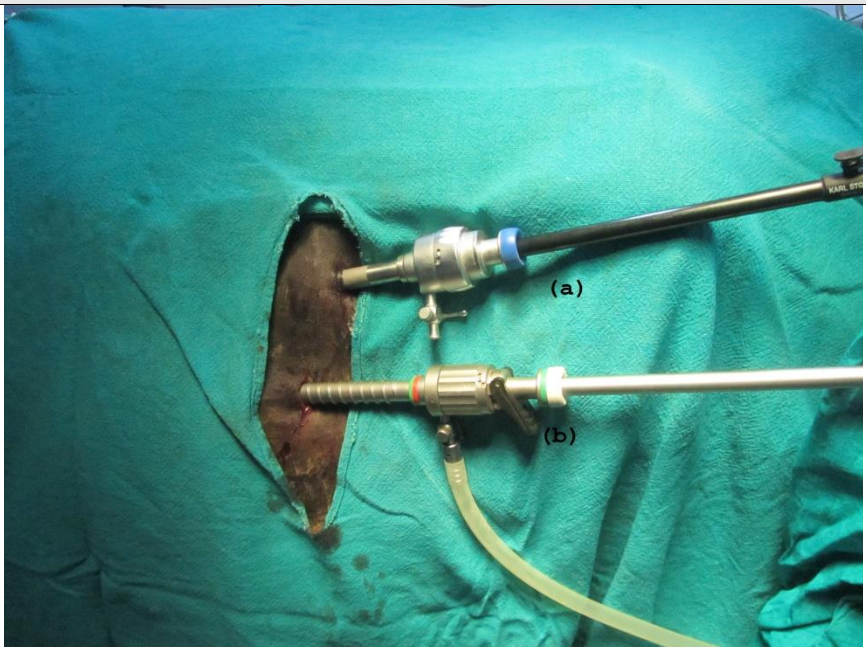
Laparoscopic biopsy under direct visualization has been tried in the patients where diagnostic and prognostic information was desired. The biopsy specimens of the liver, kidney, and spleen were collected under laparoscope guidance after introducing a second cannula equidistant parallel or opposite to the first cannula introduced for a particular approach.

The biopsy forceps was connected to the electrosurgical unit. The unit was operated using bipolar electro surgery mode. The jaws of biopsy forceps were kept closed until the instrument reached the required site. The tissue to be biopsied was held between the jaws of instrument and current was applied to harvest the tissue.

Liver biopsy was taken from the right side of the animal. Kidney biopsy was obtained from ipsilateral paralumbar fossa. Biopsy of the spleen was obtained from the left paralumbar fossa region. An edge of the liver lobe or spleen was grasped by holding the jaws tightly closed for approximately 20-30 seconds. The kidney is contained in perirenal fat. The biopsy forceps was inserted into the caudal aspect of the kidney and was grasped by holding the jaws tightly closed for approximately 20-30 seconds. After that, the sample was pulled away from liver/kidney/spleen.

Care was taken to examine the tissue obtained after kidney biopsy, to ascertain that renal tissue was obtained and not just perirenal fat. The biopsy area was monitored for bleeding after obtaining the biopsy. Meticulous care is needed while catching the edge of the spleen to crush the surface of the spleen to avoid multiple attempts.

Plate 28 – (a) Accessory cannula for insertion of grasping forceps
(b) Primary cannula for insertion of laparoscope




### 3.8.6 Termination of the procedure

For termination of laparoscopic procedure following points were considered.

a) A terminal review of the abdominal cavity was made to check for any bleeding perforation or rupture.
b) The instruments were removed from all the created ports.

c) The multifunctional valve was press released for maximal evacuation of the $CO_2$ from the abdominal cavity.
d) The deflated abdominal cavity was sutured by placing single horizontal mattress stitch on the skin.
e) The animal was observed for half an hour and was administered Inj. Flobac SA @ as post operative prophylaxis and Inj. Melonex @ 0.2 mg/Kg b.wt. once daily for 3 days as systemic analgesia. Daily antiseptic dressing with Betadine was done, the suture was removed after 7 days.

# RESULTS AND DISCUSSION

A total of 20 female bovine patients referred for exploratory laparotomy/ diagnostic abdominal explorations were included in the study. As per diagnostic indication, the study is executed by allocating the animals in two groups namely right flank laparoscopy and left flank laparoscopy. The results are discussed to elucidate the standardization and application of the laparoscopy in a clinical setting.

## 4.1 Pre operative preparation of animal for laparoscopy

### 4.1.1 Fasting

Pre-surgical fasting of 24 hours was done and water was withheld for 8-10 hours. Preoperative fasting was found to be highly beneficial to reduce the size and motility of the gastrointestinal tract. It not only allowed satisfactory visualization but also prevented inadvertent puncture of the viscera in the animals. Seeger and Klatt (1980), Maxwell and Kraemer (1980) and Steiner and Zulauf (1999) advised fasting to decrease the content of rumen and large intestine and reduce intestinal peristalsis. It reduces the risk of organ penetration during trocar introduction and improves observation of abdominal structures.

### 4.1.2 Preparation and premedication

The flank was surgically prepared – clipped, shaved, washed and scrubbed. All the animals were premedicated with xylazine hydrochloride @ 0.03 mg/kg b.wt intramuscularly. After that local analgesia was achieved by infiltration of lignocaine in inverted L fashion in the flank. Babkine and Desrochers (2005) gave paravertebral anaesthesia of T13, L1, and L2 for laparoscopic interventions performed on left or right flank in cattle. Janowitz *et al.* (1998) and Anderson *et al.* (1993) performed only local anaesthesia at the site of trocar insertion in cattle.

## 4.2 Laparoscopic protocol

### 4.2.1 Entry to the abdominal cavity

Normally two types of methods are followed to make entry into the abdominal cavity i.e. direct entry and indirect entry.

1. **Direct entry** – It was made by the direct insertion of the trocar into the abdominal cavity without prior pneumoperitoneum (Anderson *et al.* 1993; Naoi *et al.*1985; Seeger 1977).
2. **Indirect entry** – This type of entry was made where prior pneumoperitoneum is made with the introduction of Veress needle into the abdominal cavity (Guidoni *et al*. 2002).

In the present study, to access the abdominal cavity direct entry method was followed. Three different methods of direct entry were adopted and evaluated.

IV. **Conventional direct entry -** A small nick was given at the site of laparoscope insertion and the trocar with cannula was advanced through the musculature and peritoneum until air influx could be heard entering the abdominal cavity. Bleul *et al.* (2005), Fischer *et al*. (1986) and Witherspoon *et al.* (1980) followed this method for making an entry in the abdominal cavity. But this technique has disadvantages of rupture of viscera or entrapment of cannula in the omentum while it is being thrusted through the skin incision. The trocar must be prevented from sliding out of the cannula when applying pressure to the body wall. The fingers not holding the trocar cannula assembly should be extended to act as safety stops. Firm pressure should be used until the trocar can be felt entering the abdominal cavity (Fischer 2002).Successful entry into the abdominal cavity was recognized by the free movement of the telescope in a cranial and caudal plane. The intraabdominal pressure on insufflator should read negative to slightly positive (2- 5 mm Hg). When the insufflating gas is turned on, the flow should be high without any restrictions. If the pressure increases rapidly, the trocar is not in the abdominal cavity and should be revaluated (Fischer *et al.* 1986)

V. **Modified direct entry forceps assisted –**This method does not have any citation in the present literature and was developed during the course of study. A small incision (approximately 2 cm) was made through the skin and muscles were grasped and pulled outside with allis tissue forceps and incision in muscles and peritoneum was made with the help of BP blade and extended with the help of scissors by blunt dissection. Entry by this method was found to be satisfactory as the passage of cannula into abdominal cavity needed little force. The entry with this method was smooth and chances of rupture of visceral organs were less. The only hassle was to make an entry with the clutter of forceps at the site.

VI. **Modified direct entry hook assisted -** This method also does not have any citation in the present literature and was developed to overcome the hassles of previous two methods. In this method a small incision (approximately 2 cm) was made through the skin and muscles were hooked and pulled with the help of hook. Blunt point dissection of muscles was done to create a mini port with the help of pointed scissors. From the mini port, entry of trocar into the abdominal cavity was made while the hook was being pulled outside. This method was found to be comparatively easy because of some advantages mentioned *ut infra*.

a) There was minimal dissection involved in this method.
b) Hook engaged the thick layer of muscles of abdominal muscles.
c) It provided a strong pull and confident entry.
d) It was very useful in fasted animals where there was tucking of abdominal muscles into the abdominal cavity.
e) It ensured separation of visceral layer of the peritoneum from the abdominal wall.
f) It created a guide space for smooth insufflations of the abdominal cavity.

Kaneko *et al.* (2015) used another technique, where 2 cm of incision through the skin was made and blunt dissection was done through the subcutaneous tissues and muscles to expose the peritoneum. The peritoneum was then grasped with pean forceps and after incision of the peritoneum, nylon stay sutures were placed through the skin and the peritoneum.

The open technique minimizes the chances of injuring underlying structures. It is similar to the modified grid approach for a flank laparotomy. A 4-5 cm incision is made through the skin and subcutaneous tissues. The fascia of the external abdominal oblique muscle is sharply divided in a dorsal to ventral direction with a scalpel. A finger or Metzenbaum scissors is used to separate the muscle fibres parallel to their orientation. The retroperitoneal space and fat have thus been entered. An extended finger is then thrust through the peritoneum and access to the abdominal cavity is confirmed (Fischer 2002).

### 4.2.2 Insufflations/ capnoperitoneum

The capnoperitoneum was created after successful entry to abdominal cavity. Naoi *et al*. 1985 and Seeger 1977 obtained capnoperitoneum after the direct insertion of the trocar into the abdominal cavity without prior capnoperitoneum. Carbon dioxide was used for achieving capnoperitoneum. Carbon dioxide is widely available, affordable, unlikely to cause gas emboli, is non-combustible and only mildly irritating to the peritoneal and serosal surfaces. Other agents which can be used for achieving capnoperitoneum are helium and nitrous oxide (Ragle 2002). To ensure correct capnoperitoneum distension of abdominal cavity should be symmetrical. If during insufflations, the intra-abdominal pressure increases too quickly, or if the abdomen does not distend uniformly, it is preferable to stop insufflation and check for retroperitoneal distension by transrectal examination (Babkine and Desrochers 2005). Insufflation of the cow's abdomen by means of the left flank has been recommended (Guidoni *et al*. 2002) because the peritoneum is less prone to detachment on this side, this is probably due to the fact that the rumen takes up more space on the left flank and keeps the peritoneum against the abdominal wall. Capnoperitoneum resulted in creation of sufficient space within the abdominal wall and in between the viscera, essential for satisfactory visualization and manipulation.

A pressure of 8.6 ± 0.2449 - 9.2 ± 0.5831 mmHg (Table 2) (ranging from 8 – 9.5 mmHg) was maintained to create capnoperitoneum in cattle. In most of the animals 9 mm Hg of pressure showed satisfactory distension for making the primary port entry and at the same time avoiding a pressure tension stress on the animal. It was observed that if pressure exceeded more than 10 mm Hg the animal used to show discomfort enough to interfere with the laparoscopic procedure. After introduction of laparoscope into the abdominal cavity, the insufflation valve of the canula port was opened for continuous capnoperitoneum. This valve was opened and closed as per requirement of visualization of the organs of the abdominal cavity during the procedure. A pressure of 8-12 mmHg was recommended in dogs (Ivankovich *et al.* 1975), and 10-12 mmHg recommended in llamas (Lin *et al.* 1997) in order to decrease the harmful effects. Insufflation in cattle was done when all organs were sufficiently separated without exceeding a pressure of 20 mm Hg, as suggested by Anderson (2004). It has also been stated that the pressures greater than 20mmHg for prolonged periods can produce negative cardiovascular and respiratory effects and cause some reduction in blood supply to the serosa of the intestinal tract (Ishizaki *et al.* 1993.)

There are no reports or studies that discuss the secondary effects on cattle of induced capnoperitoneum using either carbon dioxide or ambient air. The only reports concerning ruminants involve the effects of a carbon dioxide induced pneumoperitoneum on pregnant ewes (Curet *et al.* 1996), where the creation of a pneumoperitoneum with a pressure greater than 15 mm Hg in pregnant ewes caused an increase in uterine pressure, decrease in uterine blood flow, and induced acidosis in the mother and foetus. Despite these effects, the ewe's gestations were brought to term favourably.

In the present study discomfort and restlessness was observed in animals when the intrabdominal pressure exceeds more than 10 mm Hg. Animals showed the tendency of shifting the limbs frequently and tried to sit down due to excessive pressure inside the abdominal cavity. As the influx of carbon dioxide was paused or gas is released, it helped in relieving the discomfort thus allowing the satisfactory procedure.

**4.2.3 Amount of $CO_2$ consumed to create capnoperitoneum**

One (1) kg of liquid $CO_2$ expands to about 550 L of $CO_2$ gas at atmospheric pressure. The $CO_2$in the cylinder is in the liquid state i.e. "under pressure liquefied". The pressure in the cylinder is approximately, 830 psi 57 bar at 20c. When $CO_2$is withdrawn from the cylinder through a regulator at an outlet pressure of less than 75.5 psi 5.2 bar gaseous $CO_2$is produced. The average amount of $CO_2$ used to create capnoperitoneum was 22.6 L per animal. However, the actual consumption of $CO_2$ from the cylinder was 0.040 kg per animal.

Capnoperitoneum was done in all the patients suffering from abdominal and pelvic diseases for performing laparoscopy and to ascertain the diagnostic utility of laparoscopy. The amount and pressure of carbon dioxide used in the patients is presented in the tabulated form below:

**Table 2 –Table representing amount and pressure of $CO_2$ used for capnoperitoneum**

| S. No. | Approximate Body weight of animal (Kg) | Amount of $CO_2$ influx (Litres) | Amount of $CO_2$ used from cylinder (Kg) | Intra abdominal pressure of $CO_2$ (mmHg) |
|---|---|---|---|---|
| 1. | 300 (n=5) | 24.2 ± 1.782 | 0.043 ± 0.003209 | 9.2 ± 0.5831 |
| 2. | 250 (n=5) | 23.4 ± 1.576 | 0.042 ± 0.002739 | 8.6 ± 0.2449 |
| 3. | 200 (n=4) | 19.625 ± 2.304 | 0.0355 ± 0.004133 | 8.75 ± 0.2500 |

**4.2.3 Position of entry ports into abdominal cavity**

Different port sites namely dorso cranial, dorso caudal, ventro cranial, ventro caudal and central were made for either side of flanks.

The distance of entry port for laparoscope in various animals ranging from 200 kg to 300 kg body weight is mentioned in Table 3 and Table 4 for right and left flank respectively.

Plate 29 – Picture representing two reference landmarks for measuring the distance of two ports


| **Table 3 – Table representing Laparoscopic port distance from lumbar region and tuber coxae for left flank laparoscopy** | | | |
|---|---|---|---|
| Port | Approximate body weight of animal (Kg) | Laparoscopic Port distance from lumbar (cm) | Laparoscopic Port distance from tuber coxae (cm) |
| Dorso cranial | 200 (n=2) | 6 ± 1.000 | 11.5 ± 1.500 |
| Dorso cranial | 300 | 7 cm | 18 |
| Central | 200 | 7 cm | 15 |
| Ventro caudal | 300 | 12.5 cm | 16 |
| Ventro cranial | 250 | 11 cm | 17 |

| **Table 4 – Table representing Laparoscopic port distance from lumbar region and tuber coxae for right flank laparoscopy** | | | |
|---|---|---|---|
| Port | Approximate body weight of animal (Kg) | Laparoscopic Port distance from lumbar (cm) | Laparoscopic Port distance from tuber coxae (cm) |
| Dorso cranial | 200 | 5 | 16 |
| Dorso cranial | 300 | 6 | 17 |
| Dorso caudal | 250 | 7 | 12 |

| | | | |
|---|---|---|---|
| Dorso caudal | 300 | 8 | 14 |
| Central | 250 (n=3) | 9.33 ± 1.33 | 18.33 ± 1.86 |
| Ventro caudal | 300 | 10 | 15 |

### 4.3 Procedural instrumentation

Two types of laparoscopes were used in the present study viz. straight forward telescope 0 degree with 10 mm diameter, and 57 cm length, and straight forward telescope 0 degree with 10 mm diameter, and 33 cm length. The most popular are 0 degree and 30 degree angle of view. Using a telescope with a 0 degree angle of view makes orientation and manipulation of instruments easier. Light transmission is also maximized in 0 degree telescopes as compared with those with an offset viewing angle (Fischer 2002). Telescopes are available in a variety of diameters and length. A 10 mm outer diameter telescope is most commonly used in large animal laparoscopy. Small diameter telescopes such as 5 mm, does not provide adequate light transmission in the large abdomen. That is why in this study 10 mm laparoscope was used. Short length telescope is more convenient for operative laparoscopy, whereas the large length telescope is often chosen for diagnostic purposes because it reaches further within the large abdomen (Fischer 2002).

The threaded trocar cannula with multifunctional valve and screw tip port were preferred for making an entry in the abdomen. The internal diameter of a cannula is slightly larger than the outer diameter of the instruments designed to be used with it so that insufflations gas may pass easily through the cannula around the inserted instruments. These threaded cannulas screw into the abdominal wall, allowing for better gripping of the cannula. Threaded cannulas are less likely to slip or fall out of the abdomen (Tear 2011).

The bipolar electrosurgery mode was used to take biopsy samples of different organs such as liver, kidney, spleen. It is advantageous as it decreases the concerns of arcing of electric energy to non target tissues, safety advantages of less smoke generation, no capacitance effect and sparking (Maiman 1960). Bipolar electrosurgery has significantly less tissue thermal effects lateral to the application site than monopolar electrosurgery. According to current recommendations, bipolar forceps should be kept at least 2 cm away from the adjacent bowel (Palmer and McGill 2000).

### 4.4 Laparoscopic visualization and examination

Laparoscopic examination of the abdomen can be done from either side of the animal. In cattle left flank approach is suggested because peritoneum is less prone to detachment on this side, this is probably due to the fact that the rumen takes up more space on the left flank and keeps the peritoneum against the abdominal wall (Guidoni *et al.* 2002). Likewise, it is recommended to perform left flank laparoscopy in horses to avoid inadvertent cecal rupture (Galuppo *et al.* 1995). In the present study, laparoscopic visualization of the abdominal cavity of the animal was done from both the sides *i.e.* right flank and left flank.

#### 4.4.1 Critical appraisal of various port entries

**Right flank Laparoscopy** – Five primary ports were made and evaluated to visualize the organs of the abdominal cavity. The dorsal caudal port had no hindrance of the peritoneum or any other structure. Primary entry to the abdomen was smooth without the chance of puncturing the abdominal organs. Visualization of organs from the central port was satisfactory but in one case visceral peritoneum hindered the path of the laparoscope. Different organs which can be visualized from the dorso caudal port were diaphragm, caudate lobe of liver, anterior border of the right lobe of the liver, parietal and the visceral surface of liver, cranial part of the duodenum, descending duodenum, ovary, ovarian vessels, mesovarium. And from the central port diaphragm, anterior border of the right lobe of the liver, parietal and the visceral surface of the right lobe of liver, caudate lobe of the liver, caudate ligament, right kidney, cranial part of the duodenum, ovary, and urinary bladder were visualized. The dorso cranial port, ventro cranial port and ventro caudal port posed hindrance of the peritoneum. However, dorso cranial site can be very well utilized for making a secondary port for other instruments only under laparoscope guidance. It has been found in this study that dosrso caudal and central ports are the best studiedports which allow the visualization of the organs of the right abdominal cavity.

**Left flank laparoscopy** – Five primary ports were made and evaluated to visualize the organs of the abdominal cavity. Dorso cranial port, dorso caudal port and ventro cranial port had no hindrance of the peritoneum or any other structure. Primary entry to the abdomen was smooth without the interference of the abdominal organs. Visualization of organs from central port and ventro caudal port was satisfactory but chances of puncture of distended rumen cannot be precluded while making the entry from these ports. Different organs visualized from dorso cranial port were diaphragm, dorsal sac of rumen, anterior border of spleen, parietal and the visceral surface of spleen, dorsal part of spleen, spleno ruminal space, peritoneal fluid and from central port were diaphragm, dorsal sac of rumen, anterior border of spleen, parietal and visceral surface of spleen, dorsal part of spleen, attachment of spleen to the rumen, peritoneal fluid, left kidney and from ventro cranial port were dorsal sac of rumen, anterior border of spleen, parietal and visceral surface of spleen, dorsal part of spleen, peritoneal fluid, left kidney and from dorso caudal and ventro caudal port were dorsal sac of rumen, left kidney, large intestine, ovaries, ovarian vessels, urinary bladder, mesovarium. Various ports of left flank however, allowed visualization of all the organs on the left side by redirecting the directions of the instrumentation. It has been found in this study that while assessing the abdominal organs of the caudal abdomen and pelvic cavity, it’s better to go for central or dorso caudal port and for cranial left side abdomen, dorso cranial approach should be used.

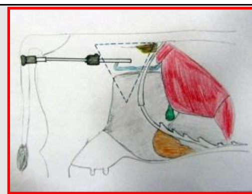
### 4.5 Right flank laparoscopy

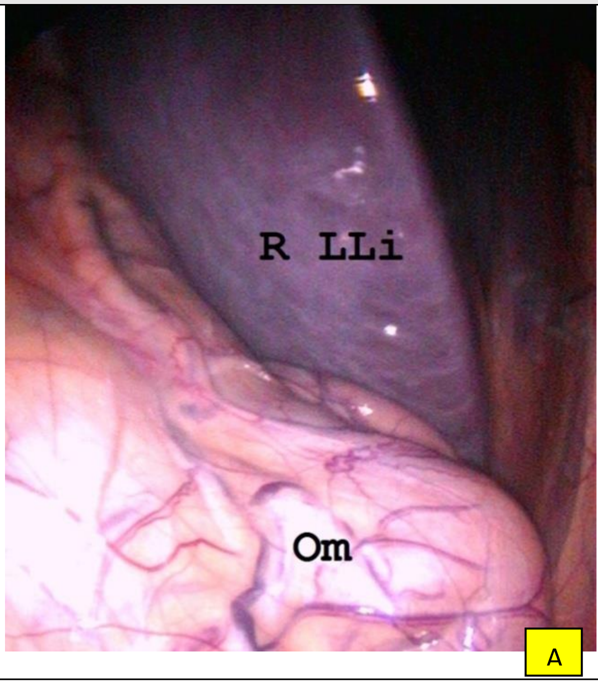
#### 4.5.1 Liver (Plate 30 A - J)

In ruminants liver lies almost entirely to the right of the median plane, being rotated 90 degrees from its position in the embryo so that the right lobe is dorsal and left lobe is ventral. It is placed in an obliquely downward and forward direction. It extends from 6$^{th}$ to 13$^{th}$ rib. The caudate process is present near the13$^{th}$ rib. Right lobe extends from 8$^{th}$ to 12$^{th}$ or 13$^{th}$ rib and left lobe extends from 6$^{th}$ to 8$^{th}$ rib. It is not very accessible to diagnostic procedures because much of it is covered by lung (Sisson and Grossman 1975; Budras and Habel 2003).

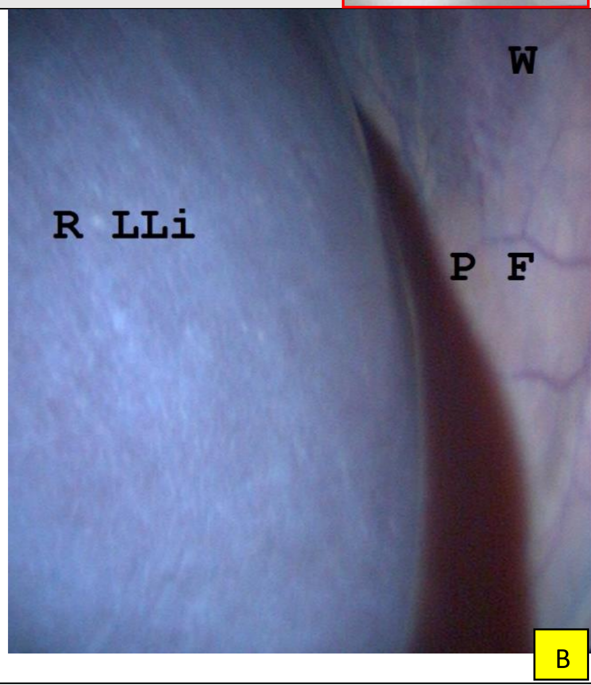
On laparoscopy, the liver was recognized by its physical appearance as it is the largest gland of the body and is reddish brown in colour. Right flank, central and dorsocaudal laparoscopy ports offered maximum visualization of liver lobes and surface. By cranial orientation of laparoscope in the abdominal cavity, the caudal lobe and part of the principal lobe of liver were easily identifiable (Plate 30 C, Plate 30 E, Plate 30 F). Parietal surface and the visceral surface of right liver lobe can also be visualized (Plate 30 A, Plate 30 B). The hepato renal ligament attaching caudate lobe (Plate 30 G, Plate 30 H) with the right kidney and the right triangular ligament (Plate 30 J) attaching the dorsal border to the anterior part of the sublumbar region were also visualized. The finding of the study was similar to Babkine and Desrochers (2005), Anderson *et al.* (1993) and Maxwell and Kraemer (1980). Perihepatic space (Plate 30 D, Plate 30 G) was also identified in anterior of the right abdominal cavity. While examining the abdominal cavity ventrally, peritoneal fluid was also seen (Plate 30 B). Left lobe of liver could not be seen, owing to the anterior location of the left lobe of liver and length of the laparoscope and to some extent due to non flexibility of laparoscope. Gall bladder could not be located even after manipulation of liver lobes by secondary port instrumentation. It is although a pear shaped sac, only 10-15 cm long and since it lies partly in contact with the visceral surface of the liver, to which it is attached, but is largely against the abdominal wall at the ventral part of the10$^{th}$ or 11$^{th}$ rib (Sisson and Grossman 1975).

Plate 30 - Normal laparoscopic anatomy of the liver





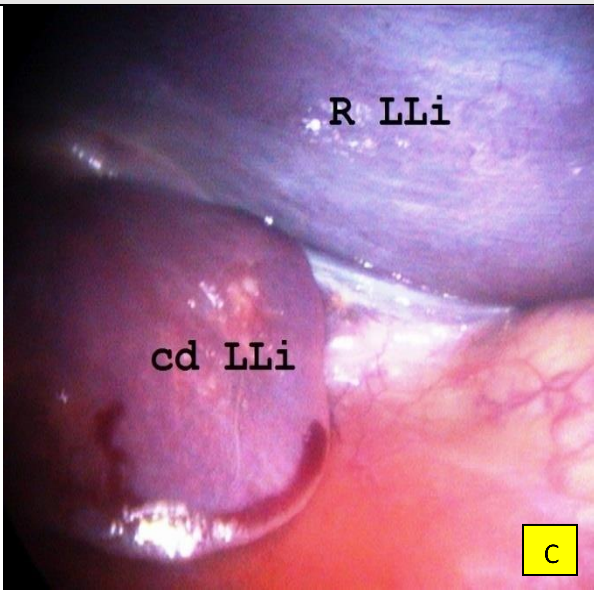

**RLLi**–*Right lobe of liver (visceral surface)*
**Om**–*Omentum*



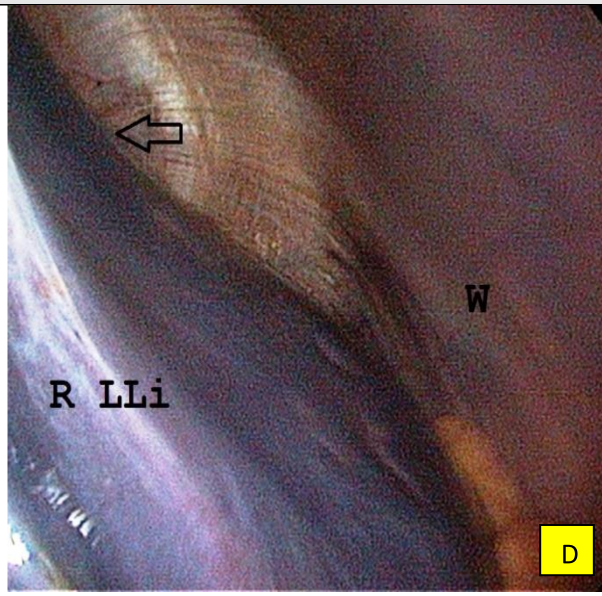

**RLLi**–*Right lobe of liver(parietal surface)*
**W**- *Abdominal wall*
**PF** – *Peritoneal fluid*

Due to its ventral position, it was difficult to be visualized by laparoscopy. Such direct imaging of the liver could be of use in monitoring various liver affections like liver abscess or cyst, toumouyrs, hepatomegaly and cirrhosis of liver etc.

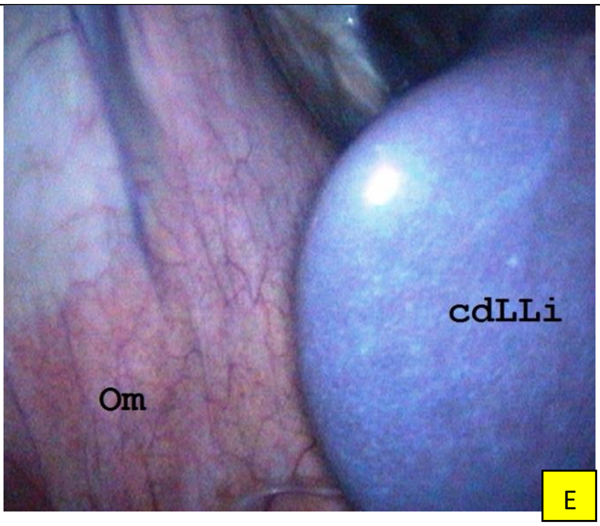
Plate 30 contd…….



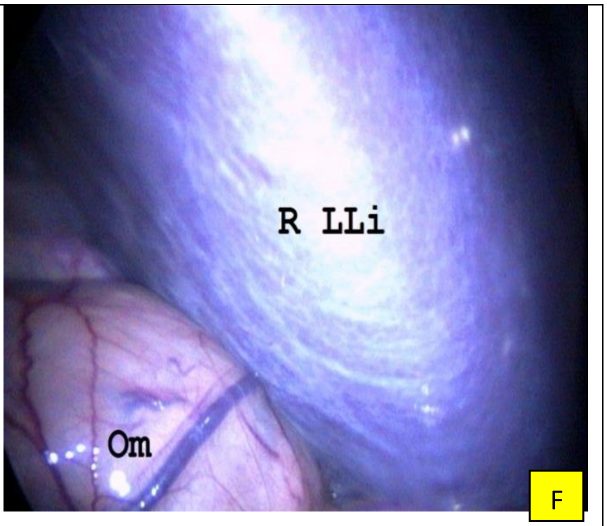

**RLLi**–*Right lobe of liver*
**cdLLi**- *Caudate lobe of the liver*




***Arrowhead*** *indicates the perihepatic space*
**RLLi**–*Right lobe of liver(parietal surface)*
**W**- *Abdominal wall*

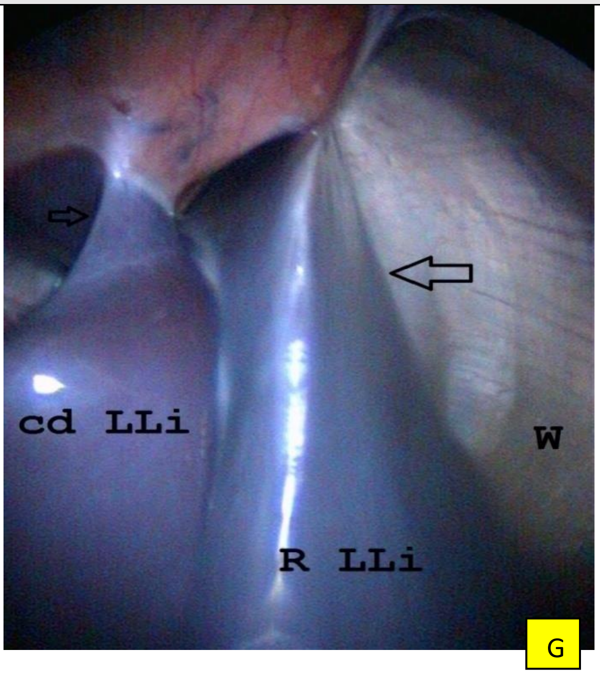



**cdLLi**- *Caudate lobe of liver*
**Om**–*Omentum*

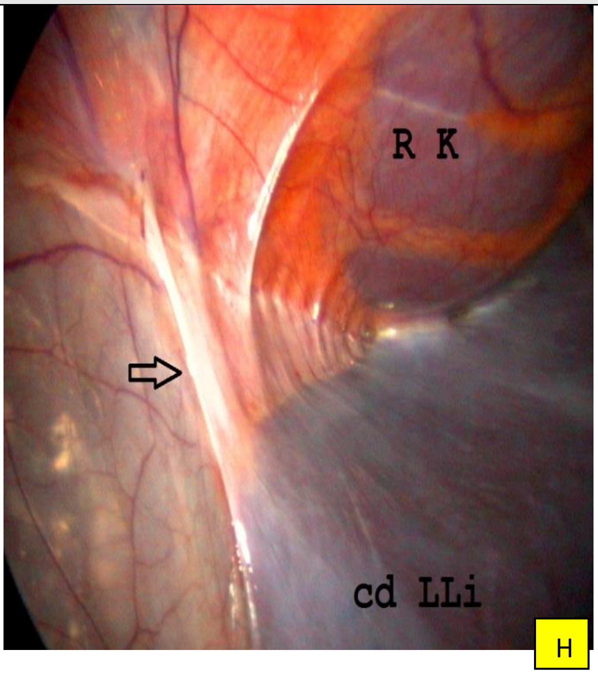



**RLLi**–*Right lobe of liver*
**Om**–*Omentum*

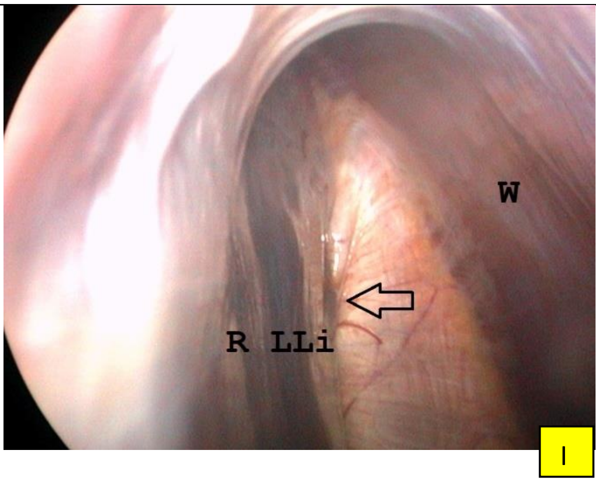
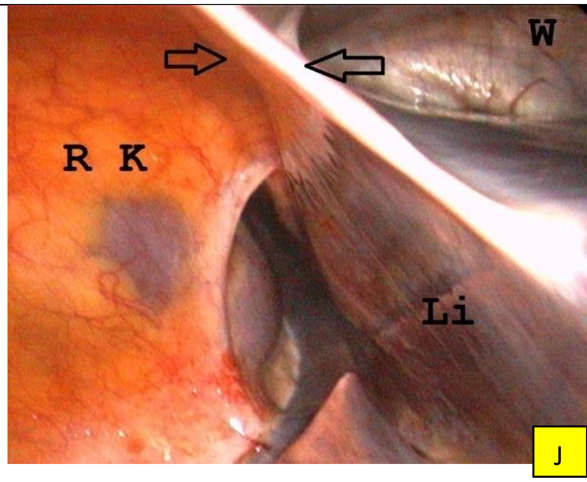
Plate 30 contd…….




***Bigger arrowhead*** *indicates perihepatic space*
***Smaller arrowhead*** *indicates hepato renal ligament*
**RLLi**–*Right lobe of liver*
**cdLLi**- *Caudate lobe of liver*
**W**-*Abdominal wall*




***Arrowhead*** *points towards hepato renal ligament*
**cdLLi**- *Caudate lobe of liver*
**RK**– *Right kidney*

| | |
|---|---|
|  |  |
| ***Arrowhead** indicates anterior right abdominal cavity (diaphragm)*<br>**RLLi**–*Right lobe of liver*<br>**W**- *Abdominal wall* | ***Arrowheads** indicate right triangular ligament*<br>**Li**– *Liver*<br>**RK**– *Right kidney*<br>**W**-*Abdominal wall* |

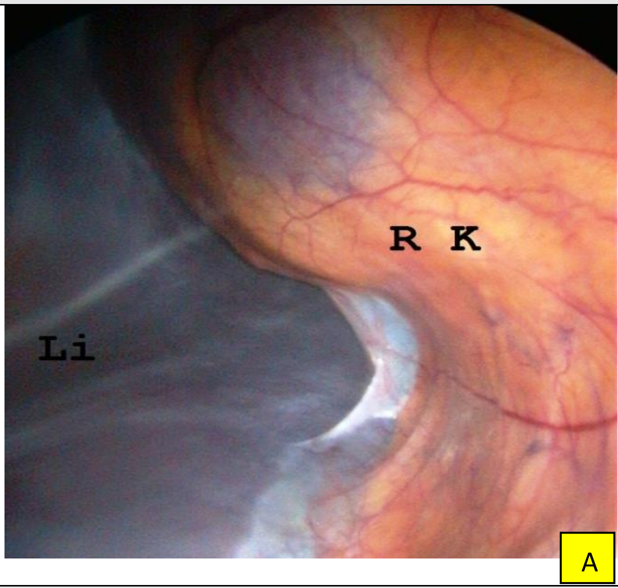
**4.5.2 Right kidney (Plate 31 A - D)**

Kidneys of cattle are superficially divided into polygonal lobes by fissure of variable depth. The lobes vary in size and are commonly about 20 in number. The fissures are filled with fat; they are brownish red in colour. The right kidney has an elongated elliptical outline and is flattened dorsoventrally. It commonly lies ventral to the last rib and first two three lumbar transverse processes, but its extremities may be ventral to the first and fourth lumbar transverse processes. The dorsal surface is rounded and is in contact chiefly with the sublumbar muscles. The ventral surface is less convex and is related to the liver, pancreas, duodenum and colon. It is palpable in the paralumbar fossa in the live cow. The kidneys are embedded in a large amount of perirenal fat termed the capsula adiposa (Sisson and Grossman 1975; Budras and Habel 2003).

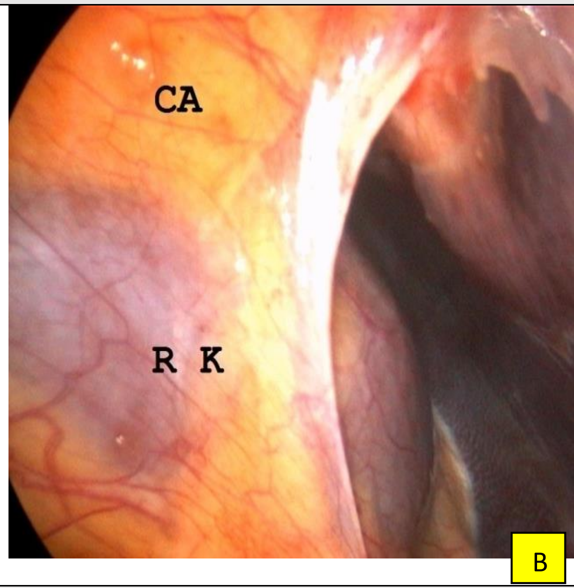
Right flank laparoscopy was performed to visualize right kidney. The Central port was conveniently used for visualizing the right kidney as this approach offers ample space to direct the instruments upward in the direction of lumbar transverse processes. Naoi *et al.* 1985 inserted the laparoscope into the peritoneal cavity from the center of the right paralumbar fossa. To examine kidney laparoscope was positioned dorsally towards lumbar transverse processes at retroperitoneal space. The kidney was found to be flat, elongated, oval and retroperitoneal, extending from the 12th intercostal space to the 2nd or 3rd lumbar vertebra. It has thin elastic covering of capsula adiposa (Plate 31 B). Capsula adiposa is also called as perirenal or perinephric fat. It is found between the renal fascia and renal capsule. It provides protection from trauma and injury. On laparoscopy, the hilus was not visible as it is towards medial side. The cranial end was in contact with the liver (Plate 31 A, Plate 31 D). Dorsal and ventral surfaces of kidney were easily visualized. The dorsal surface was below the proximal end of last rib and first two or three lumbar transverse processes. The ventral surface was lying on the cecum and ascending colon. Grasping forceps was used for manipulation while examining the kidney (Plate 31 C).

Hepato renal ligament attaching caudate lobe of liver and kidney was also visualized. The kidney has loose attachments and thus gives an ease being manipulated in all directions by palpation probe or grasping forceps. Such direct imaging of the kidney could be of use in monitoring lesions like tumour, abscess, ectopia, hyperplasia or hypoplasia of kidney etc. Some laparoscopic surgeries of the kidney in horses had been reported (Keoughan et al. 2003; Cokelaere et al. 2007; Rocken et al. 2007; Romero et al. 2010).While surgery of the kidneys was not common in the horse, a hand assisted laparoscopic approach had allowed the surgeon to perform more procedures with less morbidity than the standard open approach.

Plate 31 - Normal laparoscopic anatomy of right kidney




**RK** –*Right kidney*
**Li** –*Liver*




**RK** –*Right kidney*
**CA**- *Capsula adiposa*

| | |
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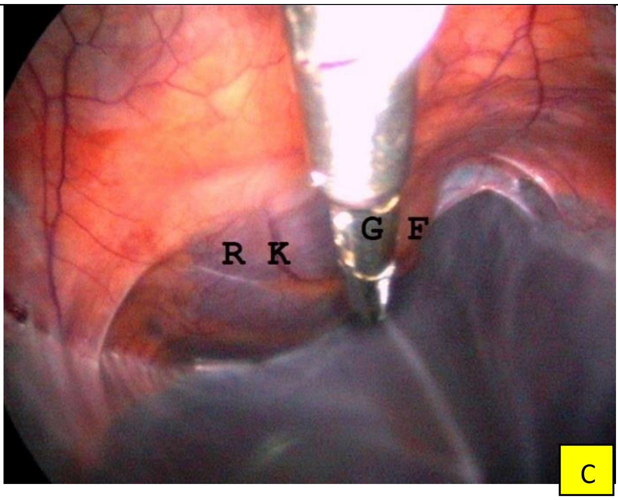
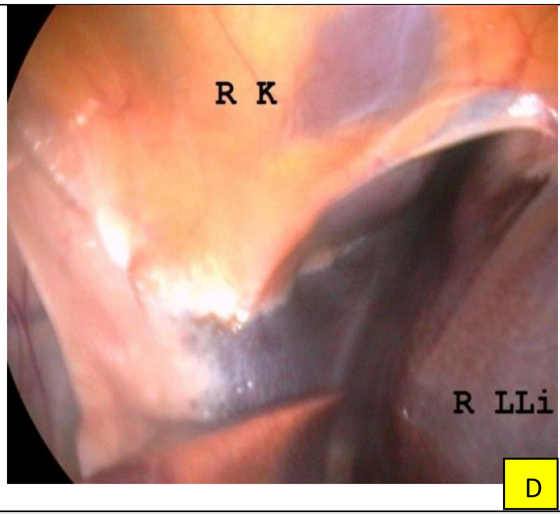
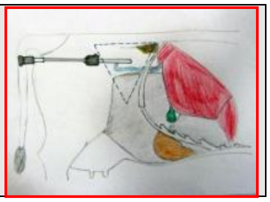
|   |   |
| **RK** –*Right kidney*<br>**GF** – *Grasping forceps, used for manupulation* | **RK** –*Right kidney*<br>**RLLi** – *Right lobe of liver* |

### 4.3.3 Duodenum (Plate 32 A - B)

The duodenum is about 3 or 4 feet in length. Beginning at the pylorus the first part passes dorsally and forward to the visceral surface of the liver, here it forms an "S" shaped curve. The second part runs backward almost to the tuber coxae where it turns forward forming the iliac flexure (Budras and Habel 2003). The third part extends forward in contact with the terminal part of the colon and joins the mesenteric part. It is attached to the liver by lesser omentum. The cranial and descending parts and the caudal flexure of the duodenum are the only parts of the intestine that are exposed when the peritoneal cavity is opened from the right side (Sisson and Grossman 1975).

| | |
|---|---|
| Plate 32 - Normal laparoscopic anatomy of duodenum |  |

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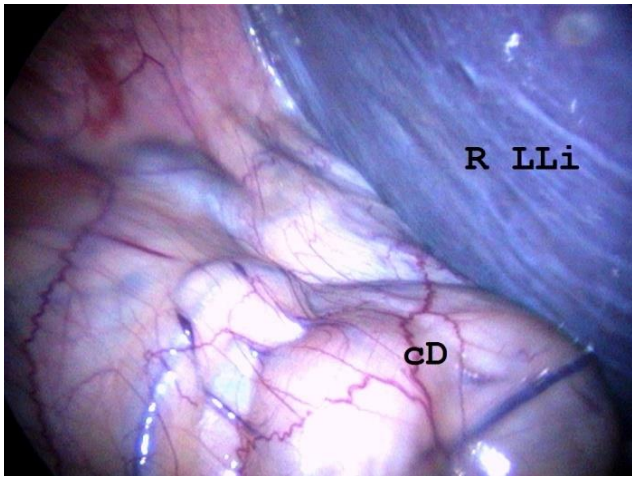
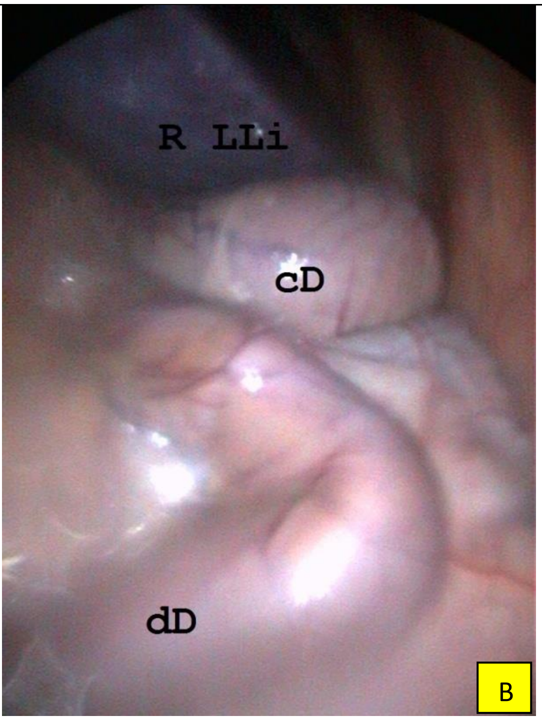
|  |  |
| **RLLi**- *Right lobe of liver*<br>**cD**- *Cranial part of duodenum* | **RLLi**- *Right lobe of liver*<br>**cD**- *Cranial part of duodenum*<br>**dD**- *Descending part of duodenum* |

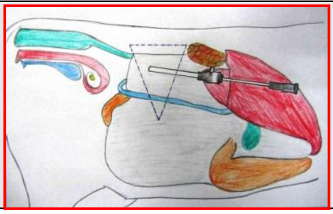
To visualize duodenum right flank laparoscopy was followed. Dorso caudal and central port approaches were utilized for examination of the duodenum. The laparoscope was cranially oriented. The duodenum was identified on the basis of its physical characteristics and on the basis of its position. It was found to be covered by the omentum and ventral to the caudate process of the liver was the cranial part of the descending duodenum (Plate 32 A).There were characteristic peristaltic movements shown by duodenum due to which yet being inside the omentum, duodenum could be identified (Plate 32 B). On the cranial orientation of the laparoscope in the right abdominal cavity, cranial duodenum and descending duodenum were visualized (Babkine and Desrochers 2005). Such direct imaging of the intestine could be of use in monitoring mechanical, simple or strangulated affections of the intestine. There are some conditions like adhesions of the duodenum, which can only be diagnosed by means of laparoscopy (Archer 2009). He also reported that adheolysis can also be easily performed by means of abdominal laparoscopy. It is reported that laparoscopy was used to diagnose an adenocarcinoma of the small intestine of the horse (Fulton *et al.* 1990) and also in the case of intestinal intussusceptions in the horse (Holak *et al.* 2013).

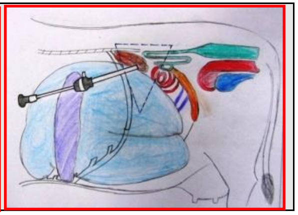
### 4.3.4 Urinary bladder (Plate 33 A - D)

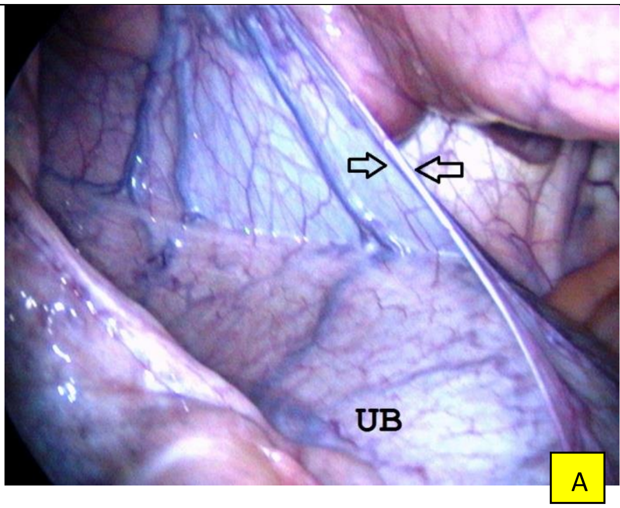
Urinary bladder differs in form, size, and position according to the volume of its contents. When empty and contracted it is a dense, piriform mass, about a size of a fist and lies on the ventral wall of the pelvic cavity at a variable distance behind the inlet. When moderately filled it is ovoid in form and extends a variable distance along the ventral abdominal wall. It is fixed in place by the medial and lateral ligaments (Sisson and Grossman 1975; Budras and Habel 2003).

Right flank and left flank laparoscopy were followed for visualization of the urinary bladder. According to Anderson *et al*. (1993) bladder is usually identifiable at the right side and occasionally identifiable at the left side (one case out of six). It was identified on the basis of its physical appearance and laparoscopically it was explored as musculo membranous organ (Plate 33 C). It was identified on the caudal orientation of laparoscope. Central port for right flank laparoscopy and central, dorso caudal and ventro caudal ports for left flank laproscopy were followed to examine the urinary bladder. The apex and body were covered with peritoneum (Plate 33 B, Plate 33 D). The neck was extra peritoneal (Plate 33 D). The ligament of the bladder (Plate 33 A) was appreciated having an attachment to the apex of the bladder, which probably is known to stabilize the bladder in the pelvic cavity. The maximum surface of the urinary bladder can be easily examined and visualized by laparoscopic guided maneuvering with the help of palpation probe or grasping forceps. Such direct imaging could be of use in monitoring the seepage, rent or healing of the bladder.

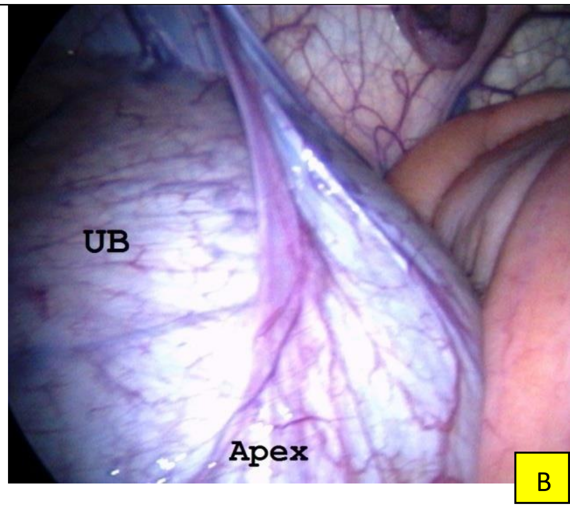
Plate 33 - Normal laparoscopic anatomy of urinary bladder



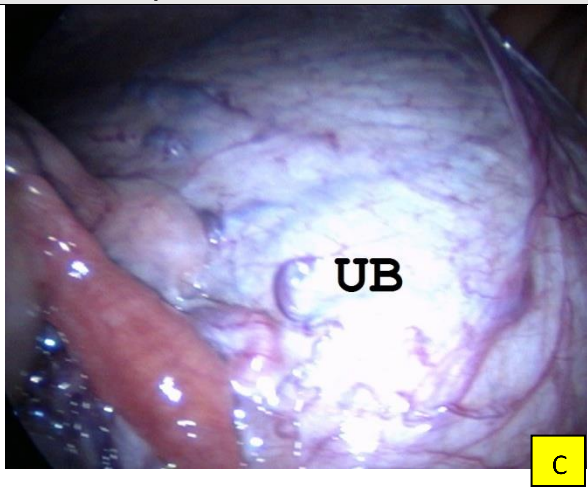




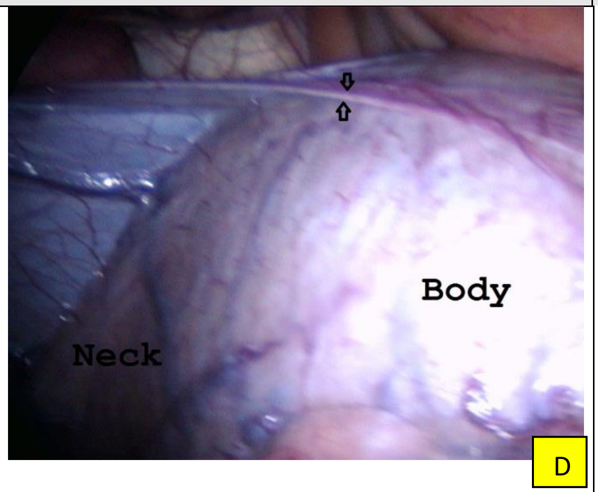

***Arrowhead**s indicate ligament*
**UB** – *Urinary bladder*




**UB**– *Urinary bladder, showing its apex*




**UB**– *Muscular sac of urinary bladder*




*Extension of muscular sac into the neck of urinary bladder*

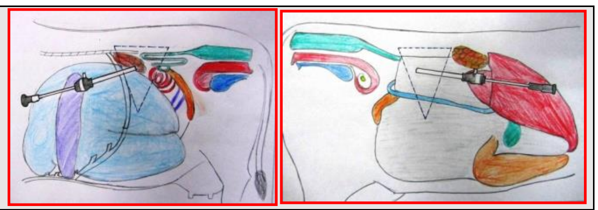
Laparoscopy has been used in bladder surgery of the horse, primarily in the repair of the ruptured bladder (Edwards *et al.* 1995; Walesby *et al.* 2002; Tuohy *et al.* 2009) and for removal of uroliths (Beard 2004; Rocken *et al.* 2006). In the report by Edwards et al. (Edwards *et al.* 1995) a stapling device was used to repair the bladder tear in a foal. Rijkenhuizen *et al.* (2003) did a laparoscopic repair of a bladder rupture using an endoscopic automatic suturing device in two foals. It was concluded that Laparoscopic techniques in bladder ruptures offered a better visualization of the bladder (the dorsal and ventral part of the bladder as well as the urachus) and associated structures.

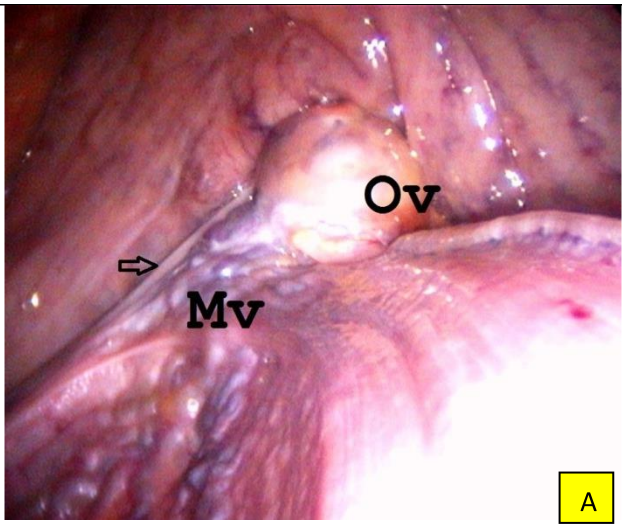
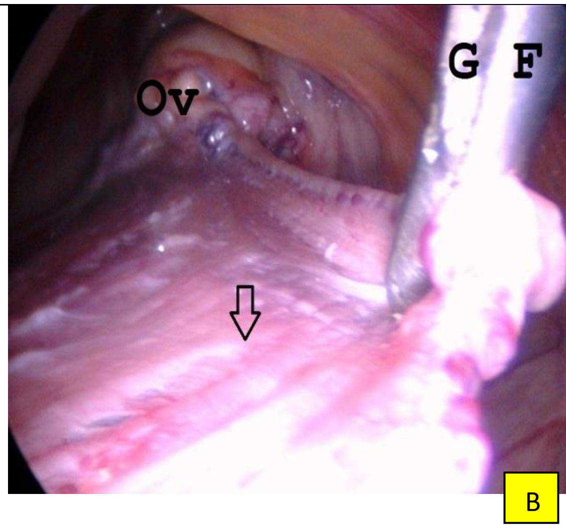
**4.3.5 Ovary, mesovarium, suspensory ligament, broad ligament (Plate 34 A - E)**

Ovaries are oval in form and are pointed at the uterine end. In bovines, they measure usually about 3.5 – 4.0 cm in length and 2.5 cm in width and are about 1.5 cm thick in their largest part. They are situated usually near the middle of the lateral margin of the pelvic inlet cranial to the external iliac artery. The mesovarium contains the ovarian artery, coming from the aorta. The cranial border of the mesovarium has a suspensory ligament of the ovary. Caudally the mesovarium is continuous with the mesometrium. The mesovarium, mesosalpinx, and mesometrium together form the broad ligament which contains smooth muscle. Follicles of various sizes are often seen projecting from the surface (Sisson and Grossman 1975; Budras and Habel 2003).

Ovaries can be visualized by right flank laparoscopy as well as left flank laparoscopy, from right flank laparoscopy central and dorso caudal approaches were found to be best and from the left flank, ventro caudal and dorso caudal laparoscopic approaches were the best to visualize ovaries, broad ligament, suspensoryligament, and mesovarium. The laparoscope has to be oriented caudally to explore the ovaries. To navigate the entry of laparoscope in the pelvic cavity, there is a need of little manipulation of the omental fold, which was done with the help of grasping forceps (Plate 34 D). Ovaries (Plate 34 C), broad ligament (Plate 34 B), suspensory ligament (Plate 34 A) and mesovarium (Plate 34 E) were visualized in the present study. Babkine and Desrochers (2005) acknowledged that if an assistant performing a rectal palpation, lifting the rumen and manipulating the reproductive system of the cow then it permitted a better visualization. A right-flank approach involves the risk of intestinal perforation and poor visualization of the ovaries and uterus due to the omentum (Wishart and Snowball 1973).In the present study, caudal abdomen visualization was done without any rectal palpation and without manipulation. The broad ligament or uterine body was grasped with the help of the forceps to lift the genitalia that allowed the visualization of proximal and distal portions of the mesovarium and the ovaries (Plate 34 B).Such direct imaging of the ovaries could be of use in diagnosing the ovarian cyst, persistent CL, parovarian cyst and ovarian tumour etc.

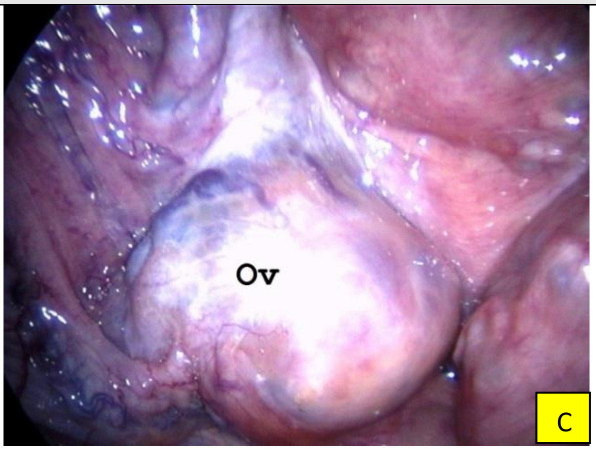
Plate 34 - Normal laparoscopic anatomy of ovary, mesovarium, broad ligament and suspensory ligament



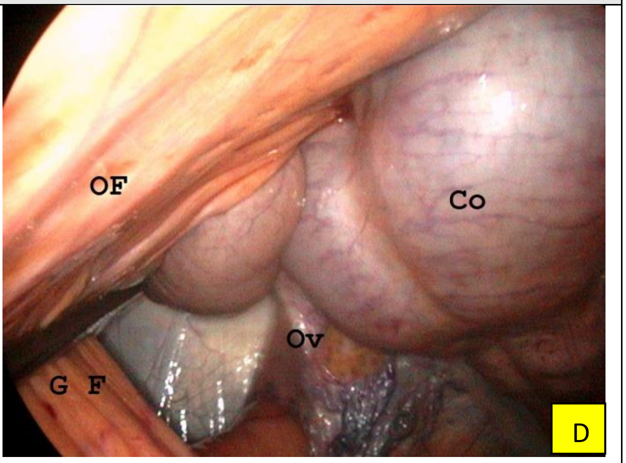
|  |  |
| --- | --- |
| ***Arrowhead*** *represents suspensory ligament*<br>**Ov** – *Ovary*<br>**Mv**- *Mesovarium* | ***Arrowhead*** *represents broad ligament*<br>**Ov** – *Ovary*<br>**GF** – *Grasping forceps* |

Ovariectomy in cows was performed by Bluel *et al.* (2005). It was concluded that ovariectomy performed under visual control, reduced the risk of complications. Such serious complications, including life-threatening haemorrhage of the ovarian pedicle and peritonitis, were common after colpotomy (Grunert 1999; Habermehl 1993; Hofmeyr 1987; Rosenberger 1970; Rupp and Kimberling 1982). Bluel *et al.* (2005) reported that in cattle the ovaries are situated in close proximity to one another, bilateral ovariectomy can be performed via a single-flank approach.

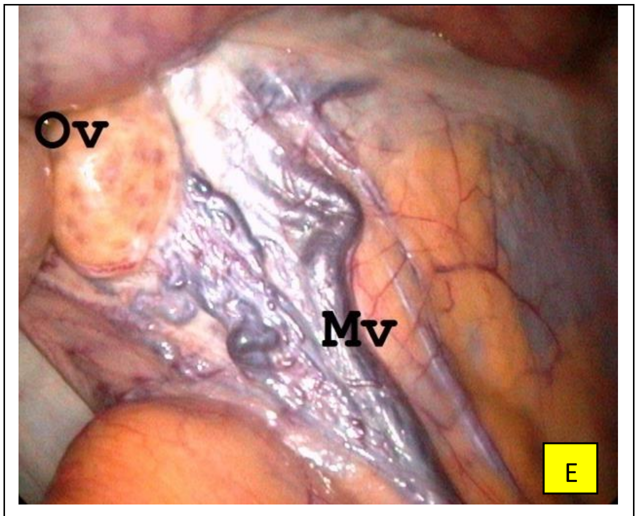
Plate 34 Contd……




**Ov** – *Ovary*




**Ov** – *Ovary*
**OF** – *Omental fold*
**GF** – *Grasping forceps*
**Co** - *Colon*



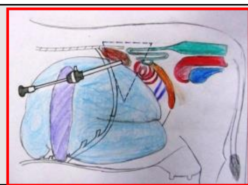

**Ov** – *Ovary(having graffian follicles),*
**Mv**- *Mesovarium*

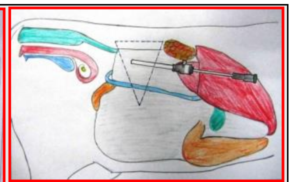
In juvenile mares, it has been reported that the ovary can be amputated and dropped within the abdomen with no untoward effects (Shoemaker *et al.* 2004). Hand-assisted laparoscopy had been performed for ovariectomy in mares (Rodgerson *et al.* 2002; Ragle *et al.* 1996).

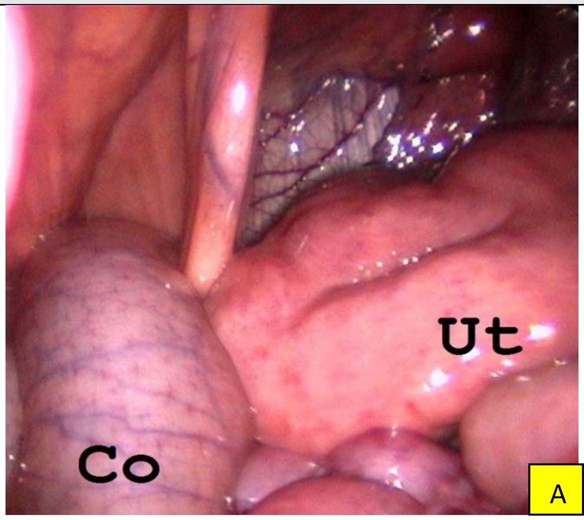
### 4.3.6 Uterus (Plate 35 A - B)

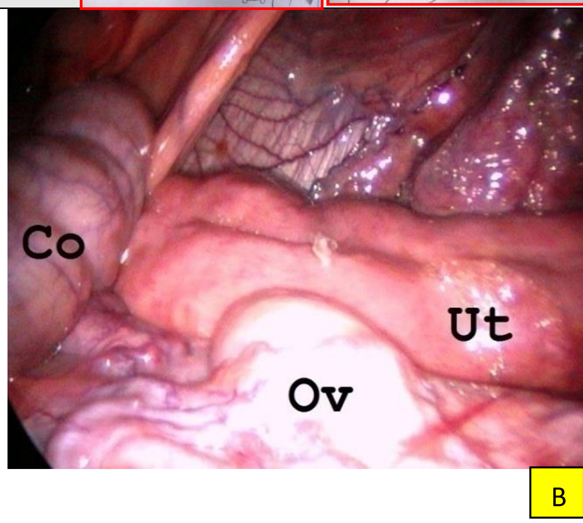
The uterus is a uterus bicornis. The horns of the uterus are 30–40 cm long, rolled through cranio ventral to caudo dorsal, and fused caudally into a 10–15 cm long double cylinder in bovines. Cranial to the union, the horns are connected by the dorsal and ventral intercornual ligament. Internally the true, undivided body of the uterus is only 2–4 cm long. The neck of the uterus (cervix uteri) with the cervical canal begins at the internal uterine orifice and ends at the external uterine orifice on the vaginal part of the cervix .The cervix is 8–10 cm long and can be distinguished from the body of the uterus and the vagina by its firm consistency (Sisson and Grossman 1975; Budras and Habel 2003).

Plate 35 - Normal laparoscopic anatomy of uterus







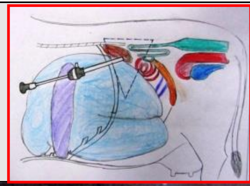

| A | B |
|---|---|
| **Ut** – *Body of uterus*<br>**Co** – *Colon* | **Ut** – *Body of uterus*<br>**Co** – *Colon*<br>**Ov**- *Ovary* |

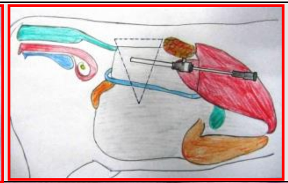
Both right flank and left flank laparoscopies were performed to visualize uterus. The laparoscope was oriented caudally to the pelvic cavity for the ease of visualization. From right flank laparoscopy, central and dorso caudal approaches were the best and from the left flank, ventro caudal and dorso caudal laparoscopic approaches were the best to visualize uterus. With the help of grasping forceps, a little manipulation of the omental fold was done to make the entry into the pelvic cavity. The spiral colon, left ovary and uterus are visualized more easily by manipulating the rectum during a transrectal palpation (Babkine and Desrochers 2005). The uterine body, intercornual region, and bifurcation of the horns were easily visualized (Plate 35 A, Plate 35 B). With the help of grasping forceps, the uterine horn could be easily lifted to examine the broad ligament and reach upto the ovary. This visual window can be of use in diagnosing uterine affections, uterine wall space occupying lesions, congenital defects and harvesting biopsy from the uterus. In one study, chromopertubation test was performed to mark the patency of the fallopian tubes (Sofi 2015). Brink *et al.* (2010) reported the use of laparoscopy for raising the uterus in multiparous mares that were not rebreeding. A hand-assisted technique was used to remove a uterine leiomyoma in a standing mare (Janicek *et. al* 2004)

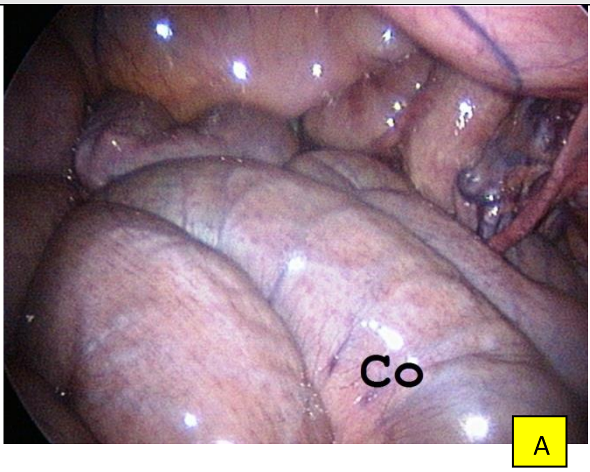
### 4.3.7 Colon (Plate 36 A – C)

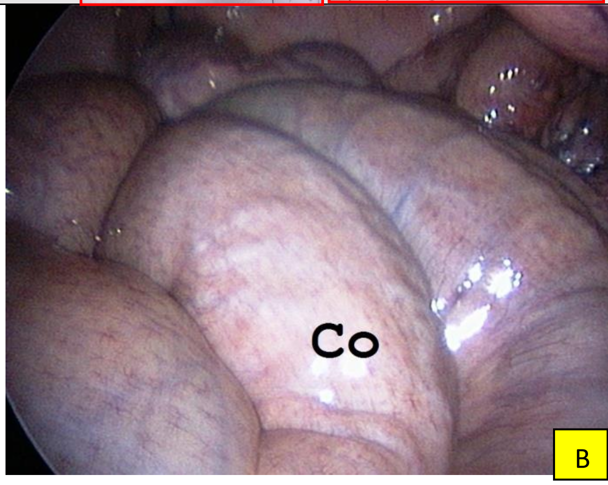
The colon is about 7–9.5 m long, and consists of the ascending colon, transverse colon, and descending colon (Sisson and Grossman 1975; Budras and Habel 2003). Both left and right flank laparoscopy with the caudal orientation of the laparoscope was followed to visualize the colon. From right flank laparoscopy, central and dorso caudal approaches and from the left flank, ventro caudal and dorso caudal laparoscopic approaches were used to visualize the colon. Colon being a long tubular structure cannot be completely visualized. The colon could only be visualized by reflecting the first omental fold. In the present study only the part of the descending colon at the level of the pelvic inlet could be visualized (Plate 36 A, B and C). Since most of the colon is towards to the right side and being a dynamic structure it hinders the working space for the instrument channel within the abdominal cavity. Likewise, Babkine and Desrochers (2005) said that if the laparoscope is long enough or if it is inserted more caudally, it is possible to view the descending colon. The laparoscopic visualization of the colon and associated structures can give the idea about the viability of the colon as a result of infective or non infective affections. However, it can only be performed if intrabdominal pressure is not high and permits capnoperitoneum to follow.

Plate 36 - Normal laparoscopic anatomy of colon

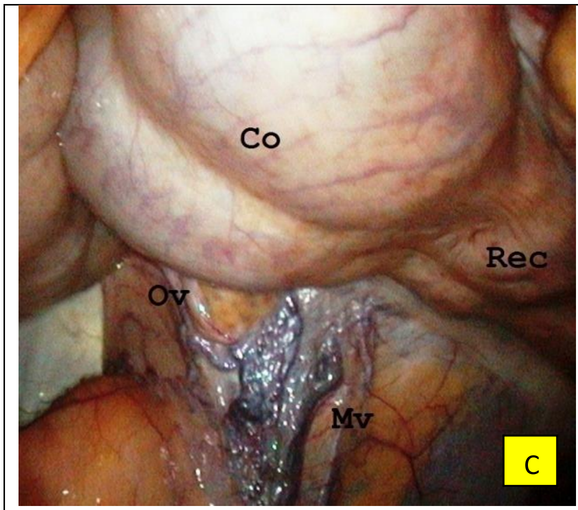







| | |
|---|---|
| **Co**– *Colon during segmenting contraction* | **Co**- *Colon during giant contraction* |




*Part of colon continuing to rectum*

**Co** – *Colon*

**Rec** – *Rectum*

**Ov**– *Ovary*

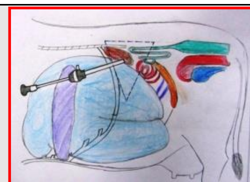
**Mv** – *Mesovsrium*

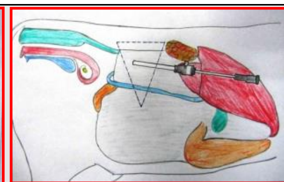
### 4.3.8 Cecum (Plate 37 A - B)

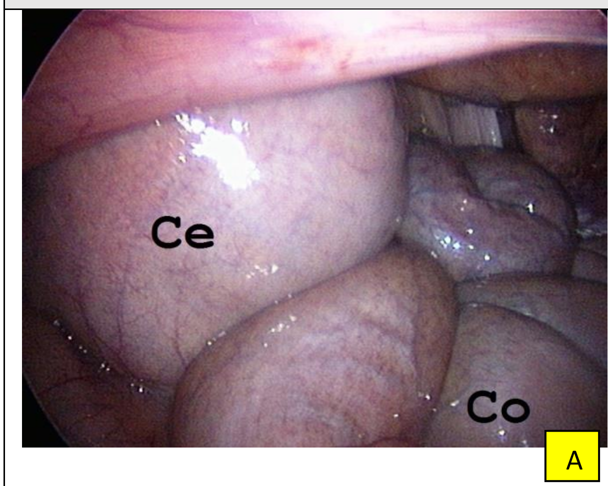
The cecum is cylindrical, 50–70 cm long and slightly curved. It lies in the dorsal part of the right abdominal cavity and extends to the pelvic inlet with a free, rounded blind apex. The body of the cecum is attached to the common mesentery to the proximal and distal loops of the colon, and is continuous with the colon, with no change in the lumen, at the cecocolic orifice (Sisson and Grossman 1975; Budras and Habel 2003).

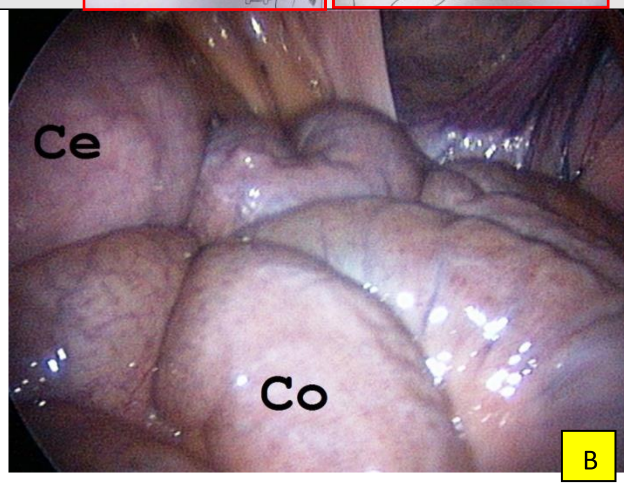
Right flank laparoscopy and left flank laparoscopy were followed to examine cecum. From right flank laparoscopy, central and dorso caudal approaches and from left flank only dorso caudal laparoscopic approach was found to be suitable to visualize the cecum. Laparoscope was placed in caudal orientation to visualize the cecum, just before the pelvic inlet. Only a small part of the blind end of the cecum could be seen (Plate 37 A, Plate 37 B). It is difficult to visualize the apex of the cecum as it is directed more ventro cranially and most of the part is covered by colon. Schambourg and Marcoux (2006) obtained full thickness biopsies of cecum and duodenum through right flank laparoscopy in a standing horse. Babkine and Desrochers (2005) visualized cecum through right and left flank laparoscopy by orienting the laparoscope more caudally into the pelvic cavity.

Plate 37 - Normal laparoscopic anatomy of cecum







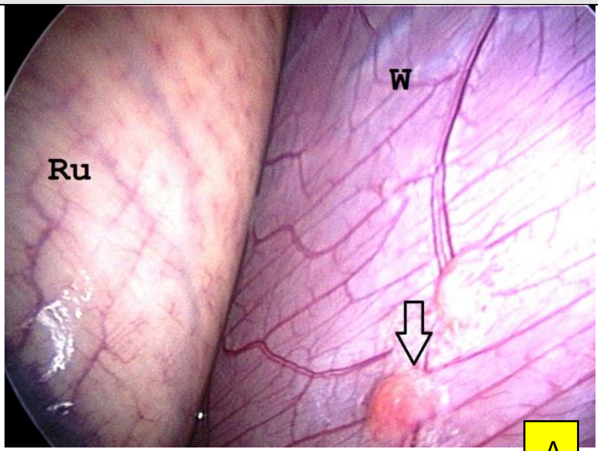




**Ce** - *Blind end of cecum*
**Co**– *Colon*

**Ce** - *Blind end of cecum*
**Co**– *Colon*

### 4.3.9 Peritoneum (Plate 38 A - D)

It is the thin serous membrane which lines the abdominal cavity and the pelvic cavity and covers to a greater or lesser extent, the viscera contained therein. The peritoneal cavity has its opposing walls normally separated by the thin film of serous fluid, which acts as a lubricant. The free surface of the membrane has a glistening appearance and is very smooth. This is due to the fact that this surface is formed by a layer of flat mesothelial cells and is moistened by the peritoneal fluid (Sisson and Grossman 1975; Budras and Habel 2003).

<table>
<tr><td colspan="2">Plate 38 - Normal laparoscopic anatomy of peritoneum</td></tr>
<tr><td>


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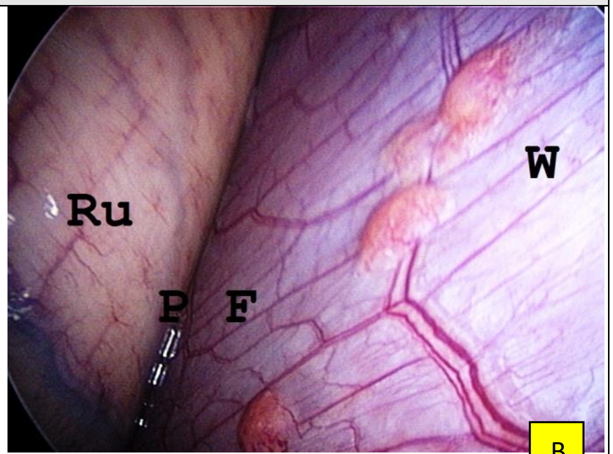
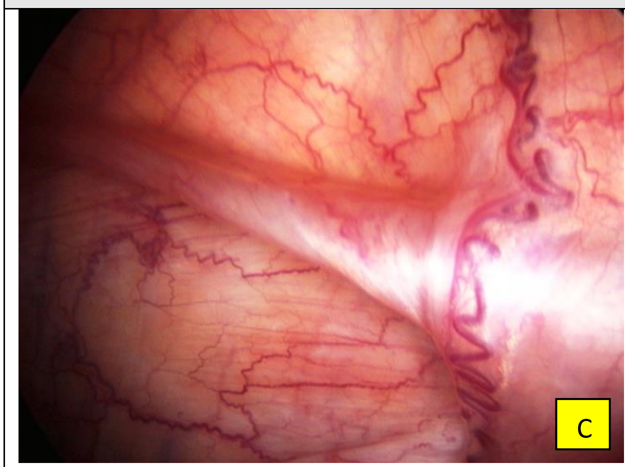


</td></tr>
<tr><td>Arrowhead indicates lesion on the wall<br>W – Abdominal wall (peritoneum)<br>Ru – Rumen</td><td>W – Abdominal wall (peritoneum)<br>PF– Peritoneal fluid<br>Ru – Rumen</td></tr>
<tr><td>


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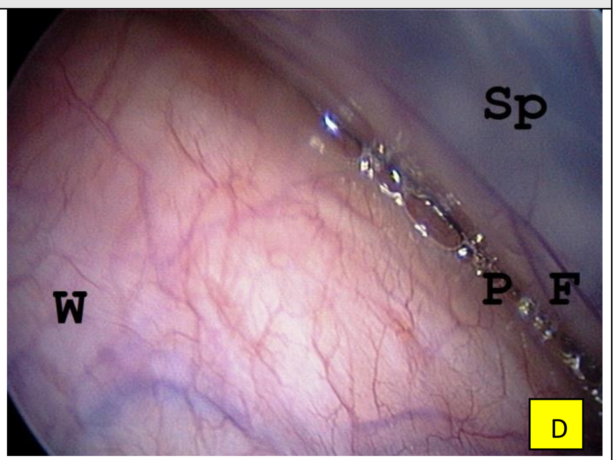


</td></tr>
<tr><td>Vasculature of peritoneum</td><td>W – Abdominal wall (peritoneum)<br>Sp – Spleen<br>PF– Peritoneal fluid</td></tr>
</table>

The peritoneum was visualized from left and right flank laparoscopy. The vasculature pattern (Plate 38 A, Plate 38 C), colour and appearance of the parietal peritoneal layer were assessed by laparoscopic visualization. It helps in evaluation of any infection, discharge or fibrin built up in the peritoneal cavity. The peritoneal fluid secreted by the peritoneum is generally of straw colour and clear (Plate 38 B, Plate 38 D), any change in the colour of peritoneal fluid is indicative of infection present in the peritoneal cavity. With the help of laparoscopy, peritoneal fluid can also be aspirated from even the difficult location within the abdomen as conventional or USG guided abdominocentesis only yields superficial fluid and with the help of laparoscopic imaging it can be obtained from the cranial most abdomen and even pelvic cavity.

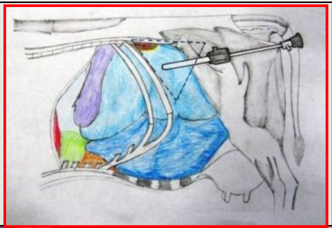
## 4.4 Left flank laparoscopy

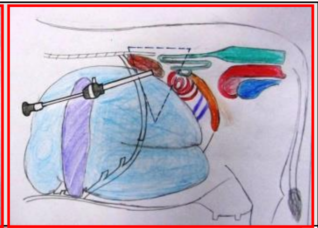
### 4.4.1 Rumen (Plate 39 A - F)

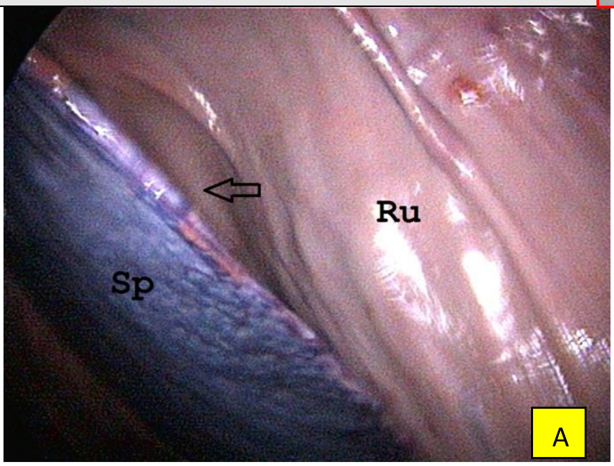
It occupies most of the left half of the abdominal cavity and extends considerably to the right of the median plane ventrally and caudally. Its long axis reaches from a point opposite the ventral part of the seventh or eighth intercostal space almost to the pelvic inlet. The parietal surface of the rumen is convex and is related to the diaphragm, the left wall of the abdomen and spleen (Sisson and Grossman, 1975). The visceral surface is somewhat irregular and is related chiefly to the omasum and abomasum, the intestine, the liver, the pancreas, the left kidney, the left adrenal gland, the aorta and the caudal vena cava. The cranial sac is continuous caudally with the dorsal sac of rumen and cranially with the reticulum. It curves ventrally over the round cranial end of the ventral sac. The caudal extremity extends nearly to the pubis and is related to the intestine and bladder (Budras and Habel 2003).

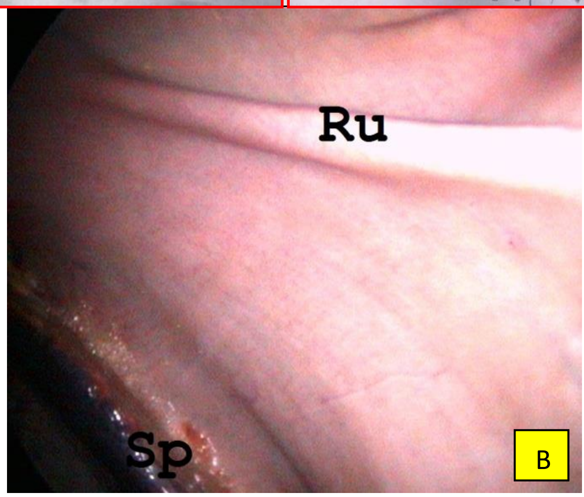
For visualization of rumen, left flank laparoscopy was performed. Rumen was visualized by all the ports made in the present study i.e. dorso cranial, dorso caudal, ventro cranial, ventro caudal and central. It was easily identified as it is the major organ occupying left hemiabdomen. Adequate capnoperitoneum separates rumen from the abdominal wall thus allowing enough space to navigate the laparoscope to examine various regions of the rumen. The dorsal sac of the rumen (Plate39 B) was visualized through all the ports made on the left flank and by manipulation of the laparoscope towards dorso cranial direction. On the cranial region, the attachment of the spleen to the ruminal atrium was also visualized (Plate39 F). Enough space had been appreciated to navigate the laparoscope between the abdominal wall and the spleen to reach the level of reticulum and left sided diaphragm (Plate39 E). The Gastrosplenic space was also clearly visible (Plate 39 A) and even the hilus of the spleen was also examined. The small hilus was found in a dorsal third of the cranial border in the area of adhesion to the rumen. It was possible to easily visualize the splenic attachment to rumen by cranial and central ports (Plate39 D). The caudodorsal blind sac of the rumen was easily visualized by all the central and dorso caudal laparoscopic ports. Caudodorsal blind sac had a close association with left kidney (Plate 39 C).The laparoscope was directed parallel to the spine cranially and caudally to visualize most of the accessible rumen. A cranial orientation of the laparoscope permits the observation of part of the diaphragm, the spleen and the rumen (Bakine and Desrochers 2005). From all the entry ports, the laparoscope orientation towards the ventral side revealed the level of peritoneal fluid.

Plate 39 - Normal laparoscopic anatomy of rumen



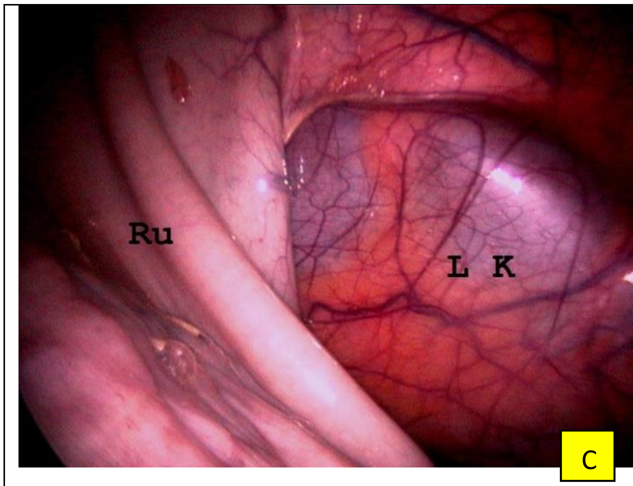




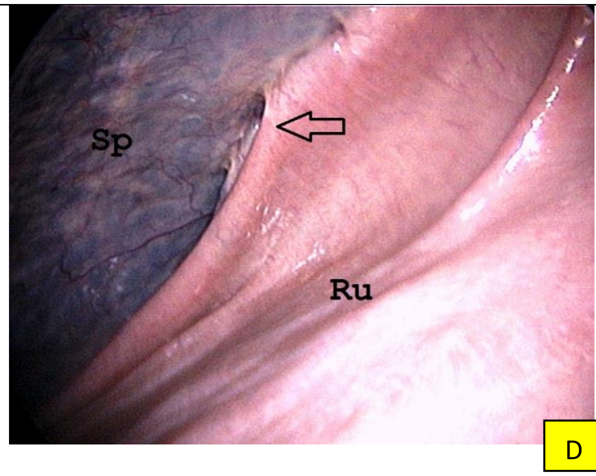




***Arrowhead*** *depicts gastro splenic space*
**Sp** – *Spleen*
**Ru**- *Rumen*

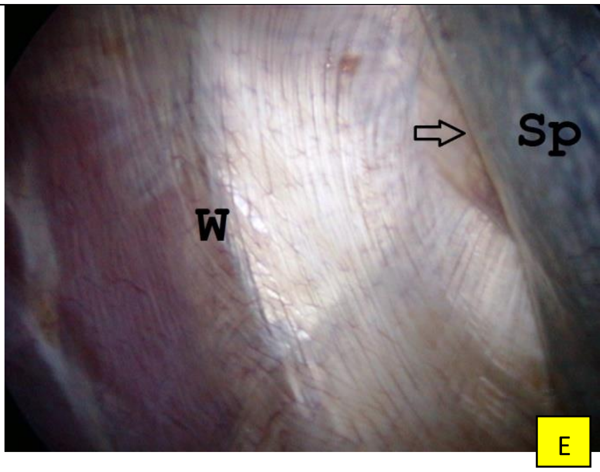
**Ru**- *Rumen (dorsal sac )*
**Sp** – *Spleen*



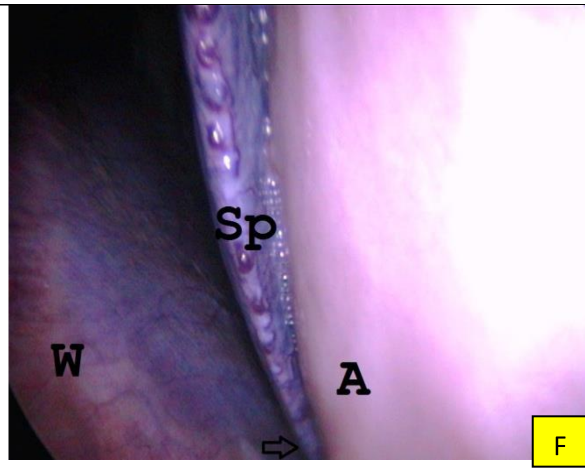

**Ru** - *Rumen caudo dorsal blind sac*
**L K**- *Left kidney*




***Arrowhead** indicates attachment of spleen to rumen*
**Sp** – *Spleen*
**Ru**- *Rumen*




***Arrowhead** depicts diaphragm*
**Sp** – *Spleen*
**W**– *Abdominal wall*




***Arrowhead** depicts ventral portion of spleen*
**Sp** – *Spleen*
**W** – *Abdominal wall*
**Sp** – *Spleen*
**A** – *Atrium of rumen*

The laparoscopic imaging of atrium of the rumen, spleen and the part of the diaphragm can be very helpful in diagnosing the traumatic reticulo pericarditis.

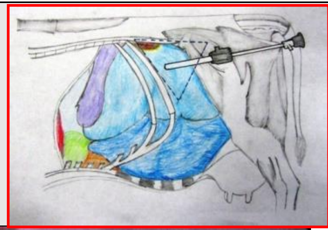
#### 4.4.2 Spleen (Plate 40 A - J)

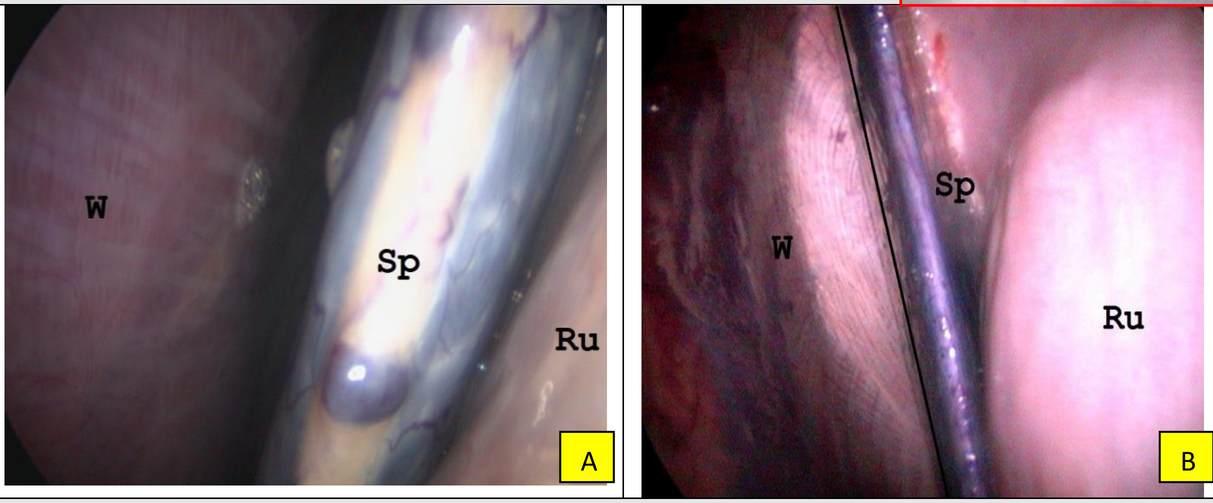
The spleen is placed in the left side of the abdominal cavity and has an elongated, elliptical outline, both extremities being thin, rounded and similar in size. Dorsal extremity lies under the dorsal ends of the last two ribs. The ventral extremity varies in position but is commonly opposite the eighth and ninth rib. The parietal surface is convex and is related to the diaphragm. The visceral surface is concave and is related chiefly to the left face of the rumen. The dorsal part is attached the left crus of the diaphragm and the left surface of the rumen by peritoneum and connective tissue, the ventral part is free (Sisson and Grossman 1975; Budras and Habel 2003).

The spleen was imaged from left flank laparoscopy. The orientation of laparoscope was towards the cranial abdominal cavity. Central, dorso cranial and ventro cranial ports were used for visualization of the spleen. The laparoscope was directed parallel to the spine cranially to identify the body of the spleen (Rao *et al.* 2013). The spleen was identified according to its physical appearance as a bluish red or somewhat purple coloured structure (Plate 40 H). The posterior border of spleen (Plate 40 A and B), the dorsal (Plate 40 J) and ventral extremities (Plate 40 F) of spleen were visualized. Both surfaces i.e. parietal (Plate 40 H) and visceral surfaces (Plate 40 G) were visualized. Attachment of spleen to the rumen was also seen at the visceral surface of the spleen (Plate 40 G). Attachment of spleen to the sublumbar muscles (Plate 40 C, Plate 40 D) and perisplenic space was also recognized (Plate 40 E).The hilus of the spleen was also clearly visible (Plate 40 I).

While moving ventral to visualize the ventral extremity of spleen peritoneal fluid was encountered. The ventral part being free could easily be lifted using palpation probe or grasping forceps. The thickness of the spleen can also be measured using graduated palpation probe. For taking a biopsy of the spleen secondary port was created in the dorso caudal region of the left flank. Such direct imaging of the spleen could be of use in monitoring spleenomegaly, ruptured spleen, an abscess, splenic tumor, and adhesive reactions etc. as it had been reported that laparoscopy was used to evaluate a subcapsular splenic hematoma in a horse (Mehl *et al.* 1998).

Plate 40 - Normal laparoscopic anatomy of spleen



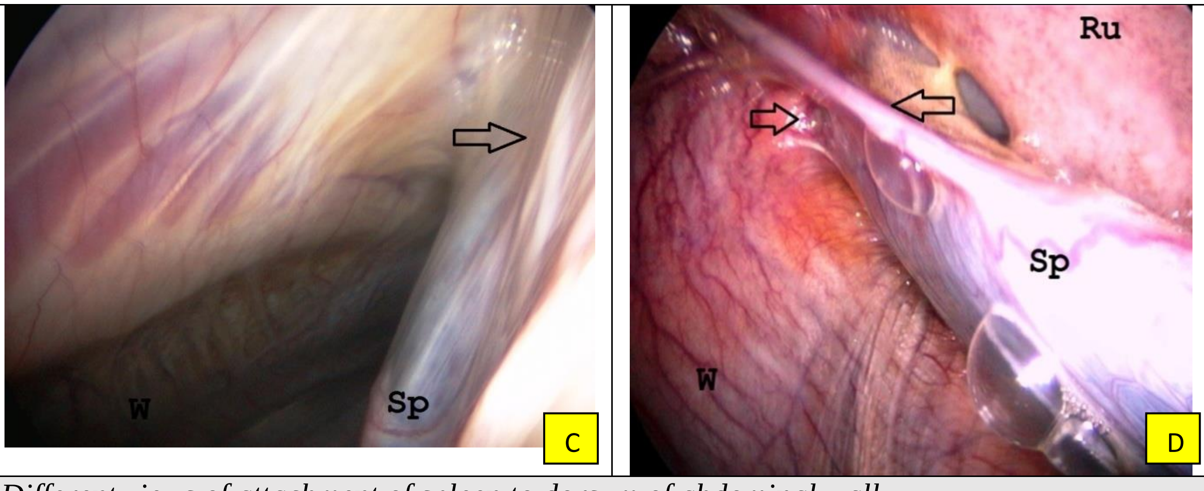



*Different views of posterior border of spleen*

**Ru** – *Rumen*

**Sp**- *Spleen*

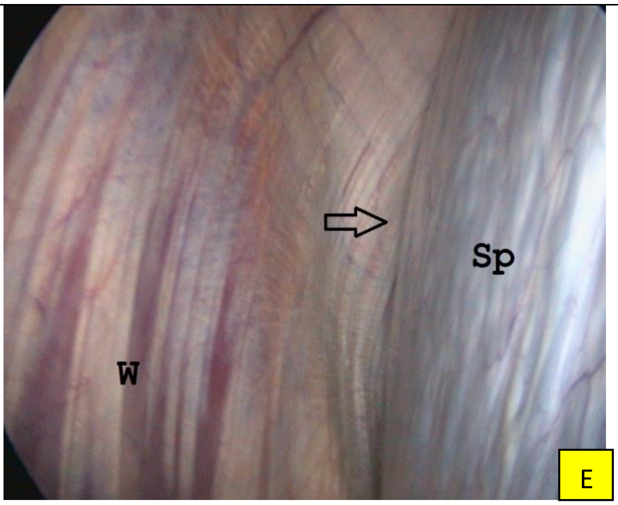
**W**- *Abdominal wall*



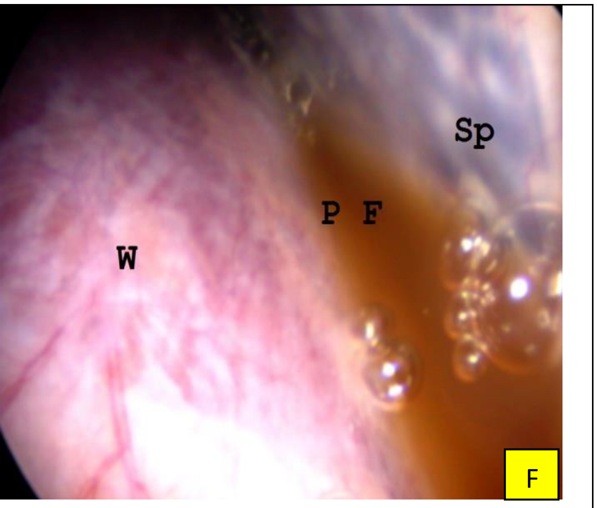

*Different views of attachment of spleen to dorsum of abdominal wall*

**Sp**- *Spleen* **Ru** – *Rumen* **W**- *Abdominal wall*

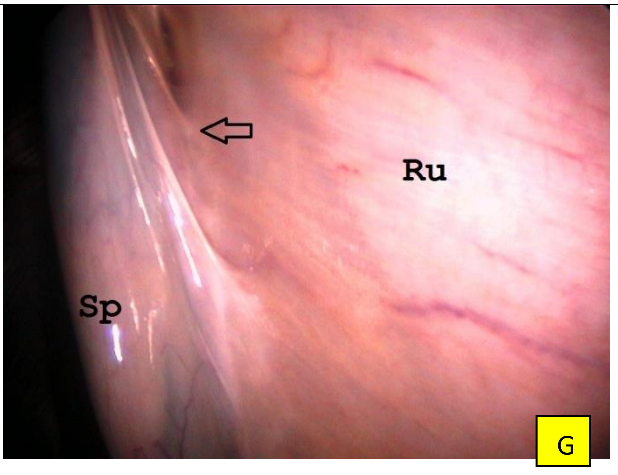
***Arrowheads** indicate attachment of spleen to dorsum of abdominal wall*



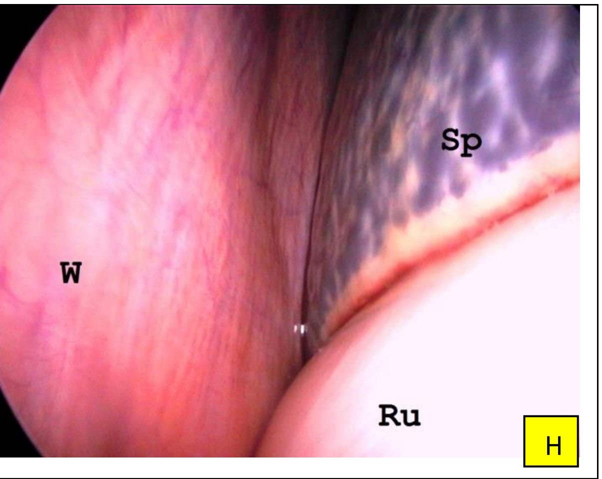

***Arrowhead** indicatesperisplenic space*
**Sp**- *Spleen*
**W**- *Abdominal wall*



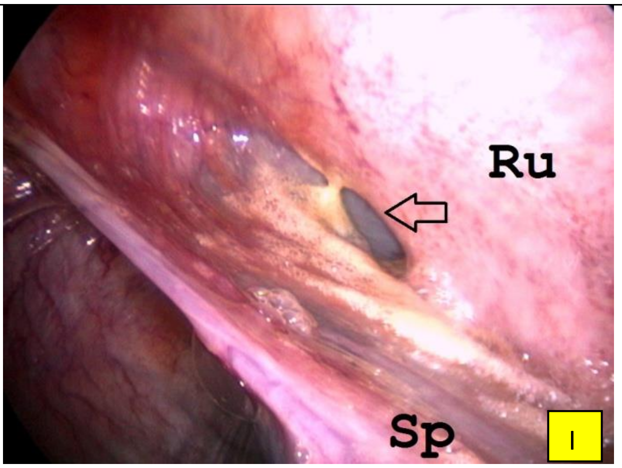
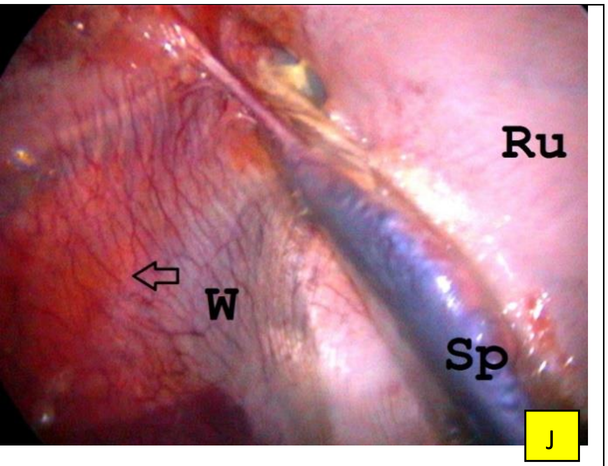

**Sp** *–Ventral extremity of spleen*
**W**- *Abdominal wall*
**PF** *– Peritoneal fluid*




***Arrowhead** indicates attachment of spleen to rumen*
**Sp**- *Spleen*
**Ru**– *Rumen*




**Sp**- *Spleen*
**W**- *Abdominal wall*
**Ru**– *Rumen*

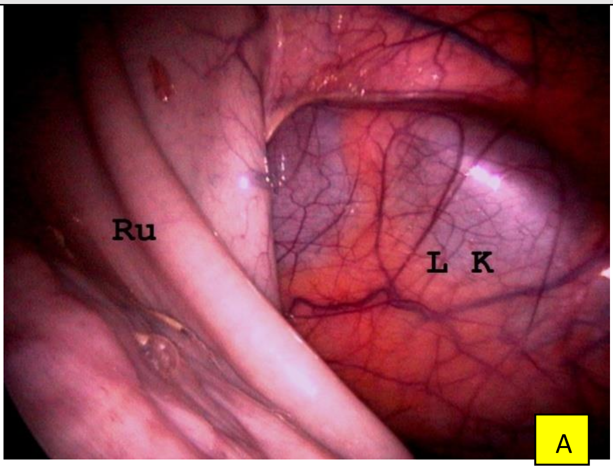
| | |
|---|---|
|  |  |
| ***Arrowhead*** *indicates hilus*<br>**Sp**- *Spleen*<br>**Ru**– *Rumen* | ***Arrowhead*** *represents congestion on the abdominal wall*<br>**Sp**- *Spleen*<br>**W**- *Abdominal wall*<br>**Ru**– *Rumen* |

**4.4.3 Left kidney (Plate 41 A - C)**

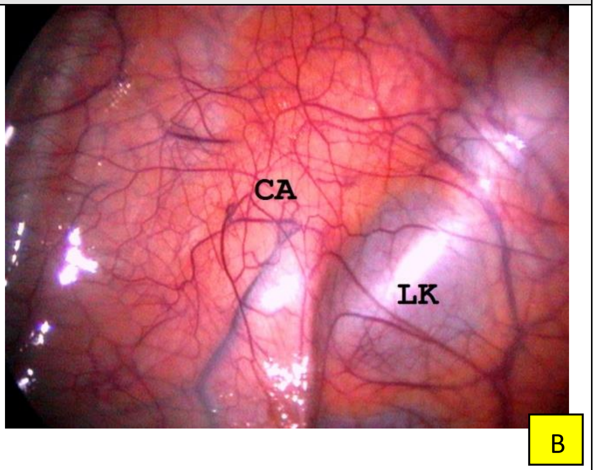
The left kidney normally is towards left flank in its normal position and when rumen is full, it pushes the kidney towards the right side. It is, therefore, pendulous, and lies ventral to lumbar vertebrae 2–5, and caudal to the right kidney and across the median plane from which it is separated by the descending mesocolon (Sisson and Grossman 1975). It is almost completely surrounded by peritoneum with its hilus on the dorsal. Medially it adjoins the rumen and laterally, the intestinal mass. When the rumen is not full, the left kidney may lie partly to the left to the median plane (Budras and Habel 2003), therefore, it is necessary to fast the animal properly in order to visualize the left kidney.

For visualization of the left kidney, laparoscopy from the left flank was performed. Different ports made to visualize left kidney were ventro cranial, ventro caudal and central. The dorsal and ventral surfaces of kidney were visualized. It could not be explored intotality, particularly on their dorsal surface because of peritoneal attachment on the cranial and caudal poles. So the orientation of the laparoscope to visualize the left kidney was distal towards fourth and fifth lumbar vertebrae. The kidney was recognized due to its physical appearance as it is surrounded by fat i.e. capsula adiposa (Plate 41 B) and its position (Plate 41 A). The renal capsule can be grasped and can be cut using the laparoscopic scissors to have the access to the parenchyma of the kidney (Plate 41 C).

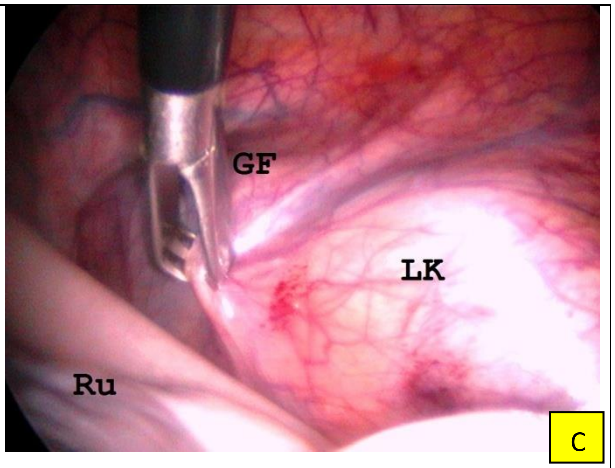
Plate 41 - Normal laparoscopic anatomy of left kidney




**LK**- *Left kidney*
**Ru**– *Rumen*




*Left kidney surrounded by capsulaadiposa*
**LK**- *Left kidney*
**CA**– *Capsula adiposa*

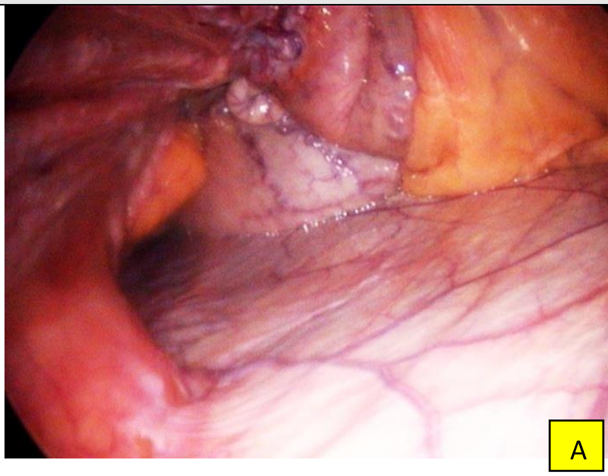



*Renal capsule grasped with the help of grasping forceps*
**LK** – *Left kidney*
**GF**– *Grasping forceps*
**Ru**– *Rumen*

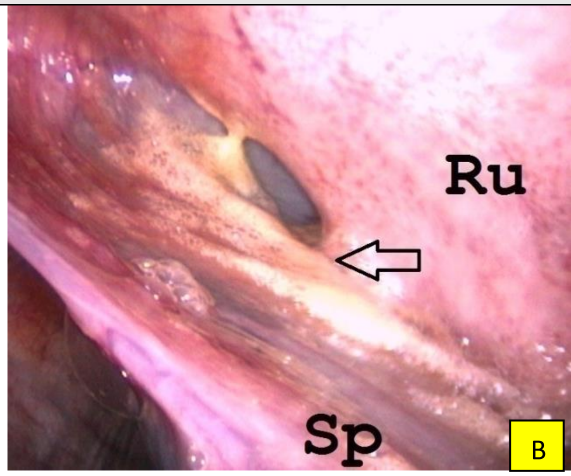
**4.5 Sites and regions of the abdominal cavity visible only by laparascopy procedure**

There are some sites and regions which are only visible by laparascopy procedure and cannot be seen at all, even by celiotomy or laparotomy. Some of the rings, apertures, hilus and inttrabdominal attachments can be easily approached by laparascopy. Some of such sites are mentioned in Plate 42 A-D.

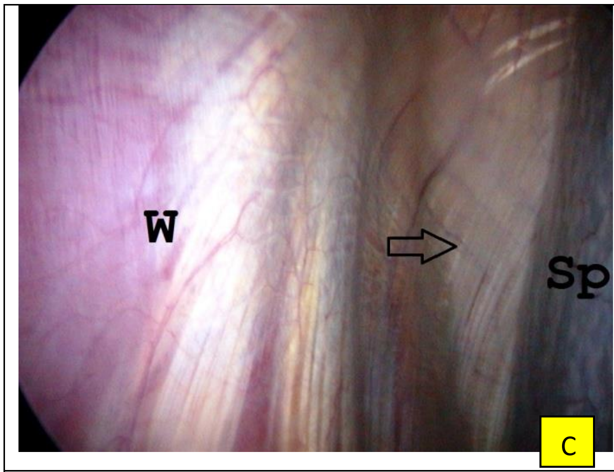
Plate 42 Sites and regions of the abdominal cavity visible only by laparascopy procedure



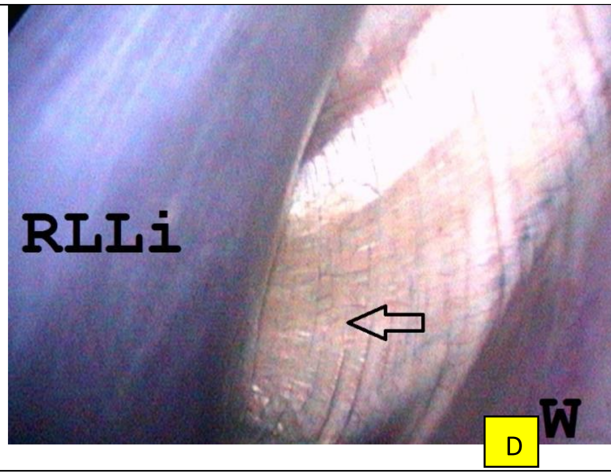

*Caudal Pelvic floor*




*Area of splenic hilus*




*Perisplenic space*




*Anterior Perihepatic space*

### 4.6 Application or Adaptation of laparoscopy in clinical cases

#### 4.6.1 Traumatic reticulo peritonitis (Plate 43 A - C)

Three cows with a history of inappetence ranging from one week to three weeks were presented with the history of recurrent tympany, retarded rumination, and reduced milk yield. The reduction in milk yield was sudden. The stiffness of forelimbs and abducted elbows were seen in all the 3 cases. Grunting and reluctance to walk were also reported.

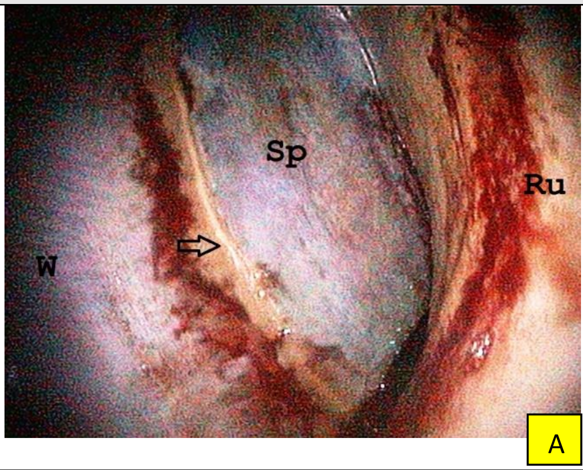
On physical examination, animals were dull, depressed and dehydrated with the pale conjunctival mucous membrane. There was a slight increase in heart rate and distressed respiration was seen. After a physical examination, blood was collected from jugular vein for analysis, which revealed neutrophilia with the shift to the left. A lateral plain radiograph of the reticular area is a useful diagnostic tool which revealed the presence of foreign bodies in reticulum. Following physical and radiographic examination animals were prepared for left flank laparoscopy.

For carrying this study both flexible and rigid laparoscope were used. The telescopes were passed through obturator in a routine manner. The left cranial abdominal cavity was approached for examination. The major laparoscopic observation confirming TRP was the severe adhesive reaction of spleen with the abdominal wall so much so that the space between both the organs was obtunded and did not allow the progression of telescope further (Plate 43 A). The peripheral adhesive reaction was candidly evident. From the present study, it can be concluded that the firm and adhesive fixation reaction of spleen with abdominal wall can also be one of the major reason for both abdominal discomfort and recurrent tympany as well. There was a lot of fibrin deposits on rumen (Plate 43 B), abdominal wall and spleen and increased volume of discoloured peritoneal fluid (Plate 43 C) strongly indicative of generalized peritoneal reaction.

Laparoscopy does not allow visualization of foreign body, but the nature and extent of pathological lesions and onsite gross lesional pathology could be easily visualized. Visualization of the organs that can be seen by laparoscopy is limited to the dorsal third of the abdomen due to the presence of increased amount of peritoneal fluid obscuring the view in the ventral two-thirds (Wilson and Ferguson 1984). In diseases, where there is a large accumulation of fluid in the abdomen laparoscopic examination is more difficult. Use of flexible fiberopticlaparoscope as a diagnostic aid in cattle was also done by Wilson and Ferguson (1984).

The possibility of combining procedures such as clinical examination, radiology, peritoneal fluid analysis and laparoscopy to evaluate Traumatic reticulo peritonitis was certainly an exciting diagnostic combination.

Plate 43 - Traumatic reticulo peritonitis

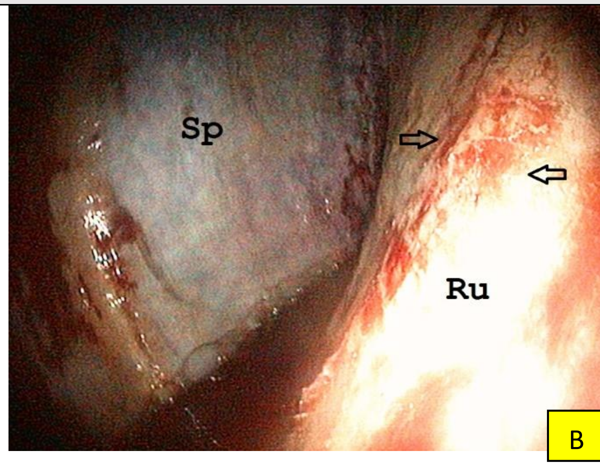



***Arrowhead*** *indicates adhesive reaction of spleen with the abdominal wall*

**Sp** *– Spleen*

**Ru** – *Rumen*

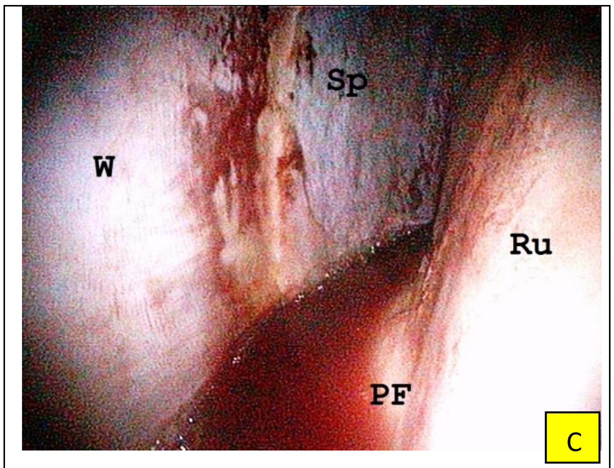
**W** *– Abdominal wall*




***Arrowheads*** *indicate fibrin deposits on the rumen*

**Sp** *– Spleen*

**Ru** – *Rumen*




*Change in the colour of peritoneal fluid*

**Ru** – *Rumen*

**W** *– Abdominal wall*

**PF** *– Peritoneal fluid*

#### 4.6.2 Intestinal intussusceptions (Plate 44 A - D)

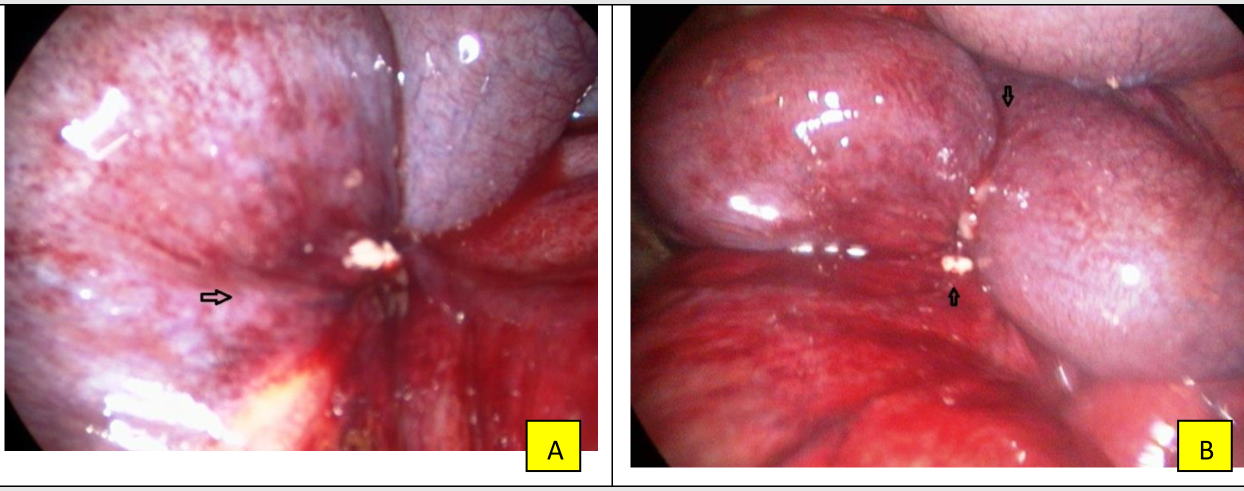
Three cases of cows were presented. History of abdominal colic manifested by frequent sitting and standing up, kicking at the belly, vocalization was common. The defecation was absent since 2-8 days, instead, constant straining was found. The animals could only pass blood tinged mucoid fibrinous faeces. A common history of feeding of bamboo leaves was found.

On physical examination animals were dull depressed, dehydrated and were having light conjunctival mucous membrane and non motile rumen. All the animals had a typical finding of soiling of the tail with the mucoid tarry coloured faecal material. The muzzle was dry with symptoms of dehydration. The animals were not agile in walking and tended to guard their abdomen while in motion. The rectal temperature was subnormal. The respiratory rate was often elevated with shallow respiration. Ruminal contractions were totally abolished with tympanitic sound on light palpation and impacted on deep palpation. Affected animals were depressed and reluctant to move. Per rectal examination revealed dryness and oedema of the rectal mucosa with a lot of tarry coloured mucous and occasionally mucosal shreds. The lumen of the rectum was collapsed in some animals whereas it was gas filled in other animals. The rumen had a doughy consistency and had reached almost to the brim of pelvic inlet almost in all the animals. The more cranial palpation towards the right side of the abdomen revealed gas filled intestinal loops along with an obstructed loop which appeared as thick, slightly movable and impacted mass of intestinal tract. The manipulation of this segment elicited a severe painto the animal.

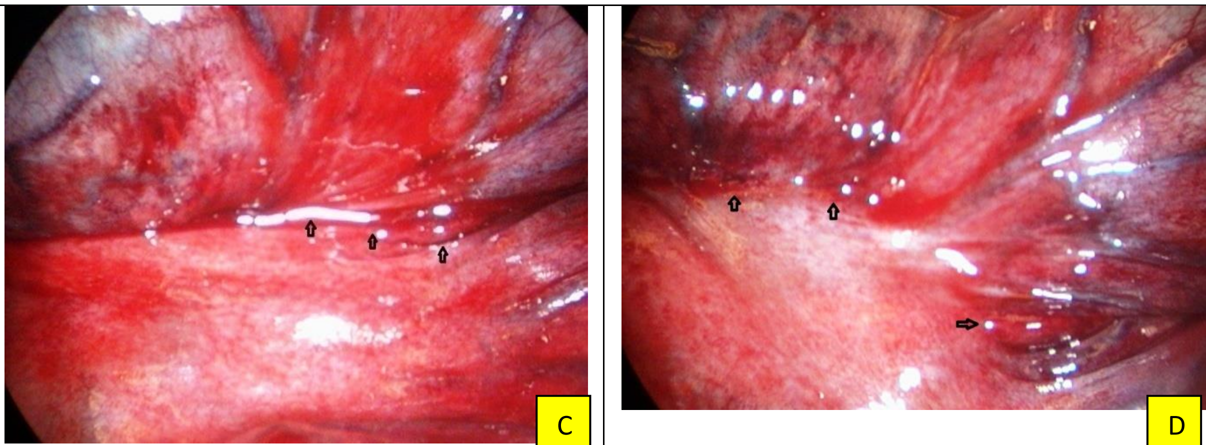
An attempt was made to laparoscopically examine the abdominal cavity, but increased intraabdominal pressure due to obstruction of intestines and distension of abdominal cavity precluded the possibility of pneumoperitoneum. Thus it was decided to perform intra operative gasless laparoscopy for examination of the abdominal cavity. The rigid laparoscope was inserted through the laparotomy incision which facilitated the visualization of the cavity by little manipulation.

With the help of laparoscope first of all the peritoneal cavity was examined for fibrinous reaction and colour of peritoneal fluid. The intestinal loops were examined for change in its colour, vascular supply, and distension (Plate 44 A). An attempt was made to search for collapsed intestinal segment. The intususpetum was also located (Plate 44 B) along with congestion in the mesentry ((Plate 44 C, Plate 44 D) and the site of intusussception was also examined. It was concluded that during laparotomy, there are many parts of the abdominal cavity which can only be felt with hands but cannot be visualized *in situ*. Intraoperative laparoscopy offers a great advantage in visualizing such organs. It has substantiative potential and clinical applicability in diagnosing such affection like rupture or tear of tubular organs, adhesions, and the presence of extraluminal space occupying lesions *etc.* in the abdominal cavity. Additionally, it can also give an overview of gross appearance of the intestines due to pathology.

Plate 44 - Intestinal intussusceptions




***Arrowheads** indicate intussuscepted loop of the intestine, change in the colour and distension*



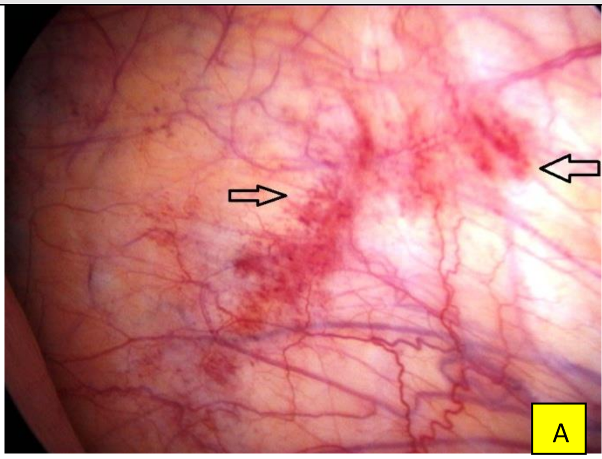

***Arrowheads** indicate congestion in the mesentry of intestine*

**4.6.3 Peritonitis (Plate 45 A - D)**

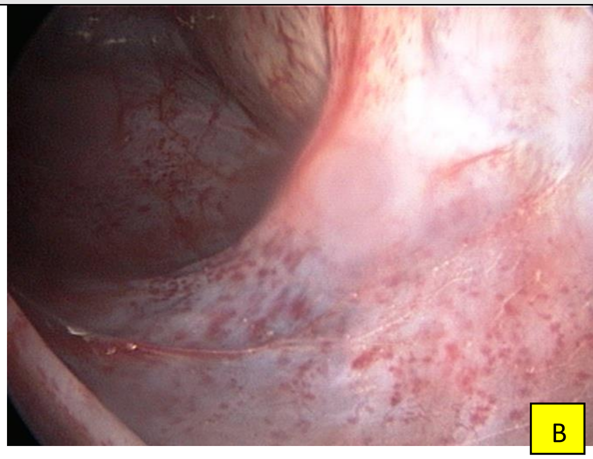
Animals were presented with complete anorexia since 5-7 days. Abdominal pain was there, they had arched back, tucked up abdomen and extended neck. Grinding of teeth was also seen. Some animals showed reflex guarding of the abdomen and were reluctant to move. Suspended rumination was constant finding.

On physical examination, theabdomen was tender on palpation. Rectal temperature of the animal was elevated. Respiratory and heart rates were also elevated. During blood examination, it showed leucocytosis with the shift to the left.

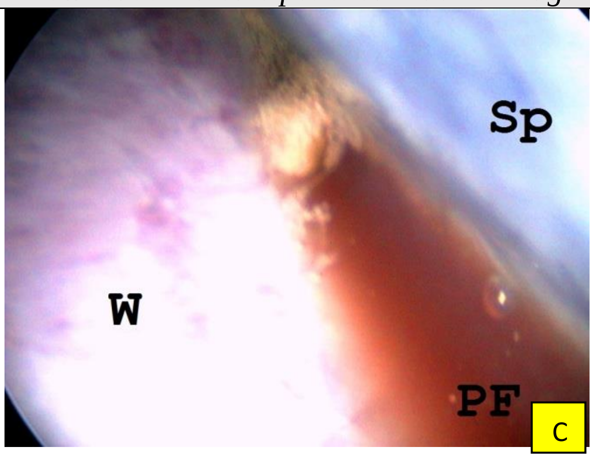
Plate 45– Different observations in the animals having peritonitis



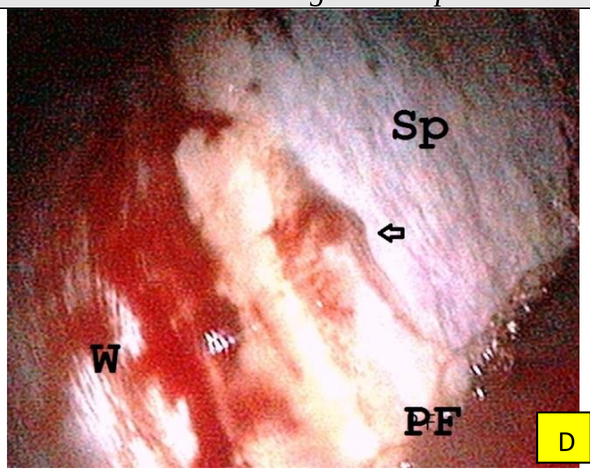

***Arrowheads*** *indicate peticheal haemorrhage*




*Generalized haemorrhage on the peritoneum*




*Change in colour of peritoneal fluid*
**PF** – *Peritoneal fluid*
**W** – *Abdominal wall*
**Sp** – *Spleen*




*Characteristic adhesive reaction of spleen to the abdominal wall*
**PF** – *Peritoneal fluid*
**W** – *Abdominal wall*
**Sp** – *Spleen*

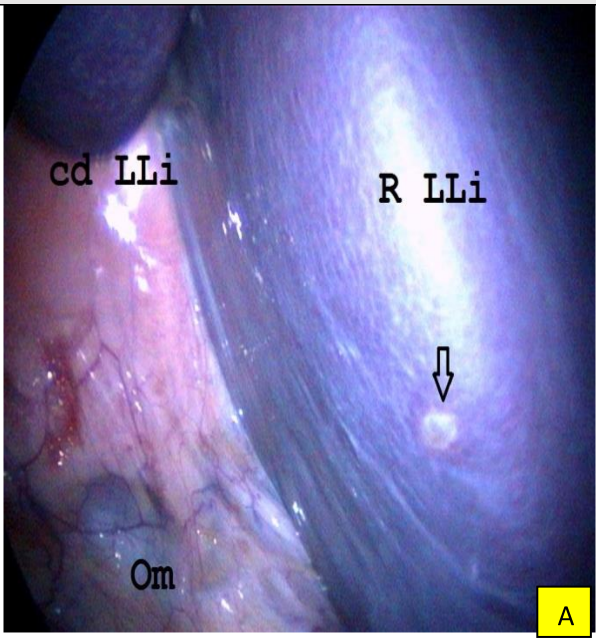
Examination of the peritoneum was done from both right and left flank laparoscopy. In one case the colour of the peritoneal fluid had changed from straw and transparent to darkcoloured fluid. This is a diagnostic finding of peritonitis. Wide spread paticheal haemorrhages were evident on the surface of the peritoneum in two cases (Plate 45 A, Plate 45 B). The characteristic adhesive reaction of the organ to the abdominal wall (Plate 45 D) was also seen with the change in the colour of peritoneal fluid (Plate 45 C). Changes in the peritoneal fluid occur rapidly in response to inflammation involving the peritoneum or intestinal tissues. Fluid transudation occurs from lymphatics or venous obstruction or increased capillary permeability. The nature and composition of peritoneal fluid depend on the extent of vascular occlusion or severity of the inflammatory changes.

The turbidity with particulate matter occurs due to the appearance of the cellular contents, inflammation and presence of fibrin and the exudates. Long standing peritonitis leads to the formation of fibrinous exudates which loose the omentum to inflamed viscous for walling of the spread of infection. This results into adherence of greater omentum to the surrounding organs thereby inhibiting the peristalsis. Abdominal laparoscopy offers a scope of accessing the extent of adhesions between the peritoneum and surrounding organs and these adhesions can also be removed or severed using laparoscopic scissors or electro surgery.

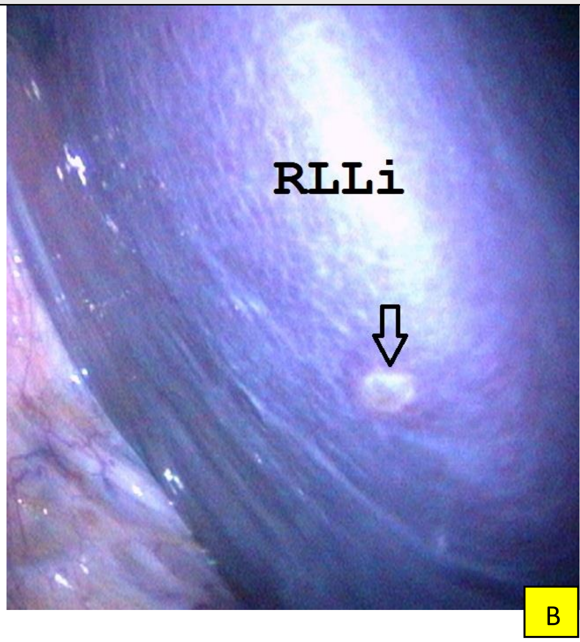
**4.6.4 Hepatic cysts (Plate 46 A - D)**

The laparoscopic examination of the organs in the abdominal cavity provides the magnified exploration of the surface of the contents. Many times occurrence of surface cystic lesions were the incidental finding in the present study. These cystic lesions (Plate 46 B, Plate 46 D) although asymptomatic can easily be visualized. Likewise, it is inferred that some pathological cysts like hydatid cysts, a very common parasitological condition can also be diagnosed and can be managed by abdominal laparoscopy. They are seen as fluid filled structures and the extent of their swelling and involvement can be easily ascertained.

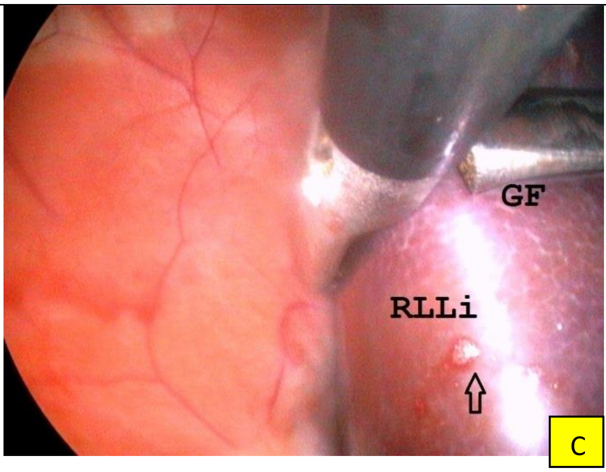
Plate 46 - Hepatic cysts



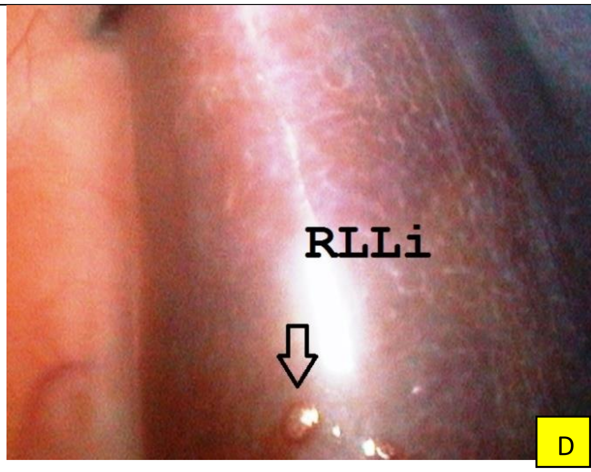

***Arrowhead*** *points to a lesion on the liver*
**RLLi** – *Right lobe of liver*
**cd LLi** – *Caudate lobe of liver*
**Om** – *Omentum*




*Magnified view of cyst on the liver surface*
**RLLi** – *Right lobe of liver*




***Arrowhead*** *represents cyst on the liver*
**RLLi** – *Right lobe of liver*
**GF** – *Grasping forceps*

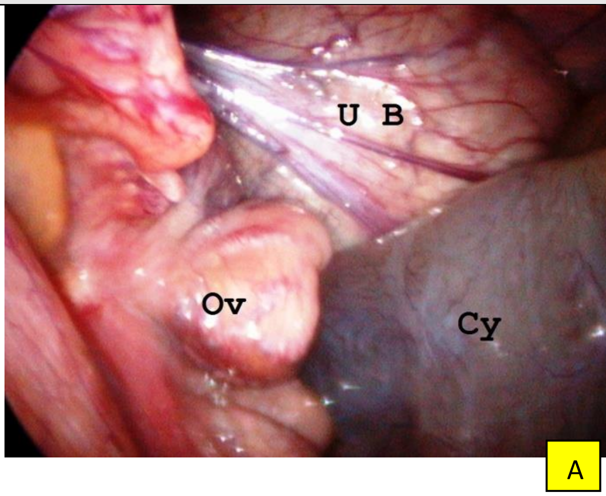



*Magnified view of cyst on the liver surface*
**RLLi** – *Right lobe of liver*

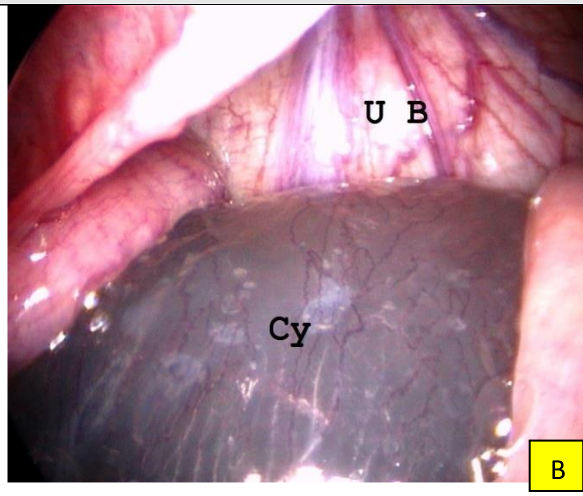
### 4.6.5 Cyst in the pelvic cavity (Plate 47 A - D)

Laparoscopy proves to be a beneficial tool in assessing the genital organs in female animals. Some of the pathologies which could not be diagnosed by any other methods can easily be delineated by laparoscopic imaging.

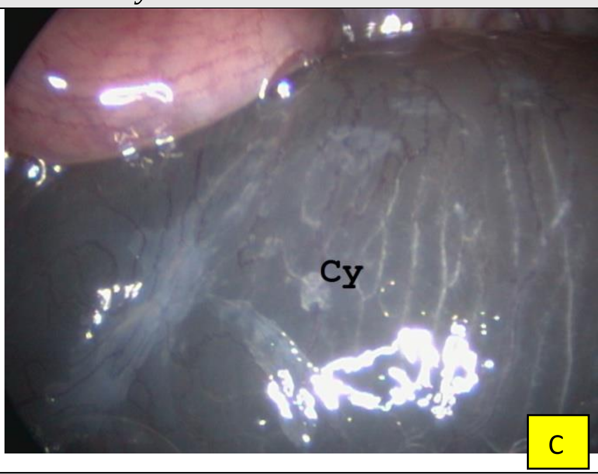
Plate 47 - Cyst in the pelvic cavity



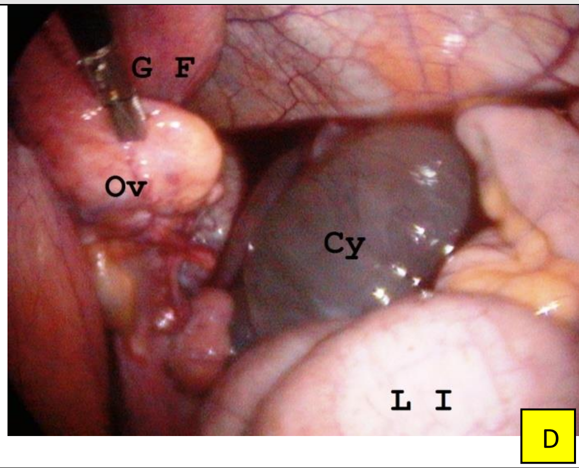

**Cy**- *Cyst*
**UB** – *Urinary bladder*
**Ov** – *Ovary*




*Cyst attached with broad ligamaent*
**Cy**- *Cyst*
**UB** – *Urinary bladder*




*Magnified view of cyst showing capillary meshwork*




*Cyst after exploratory puncture revealed sero sanguinous fluid*
**Cy**- *Cyst*
**Ov** – *Ovary*
**GF** – *Grasping forceps*
**LI** – *Large intestine*

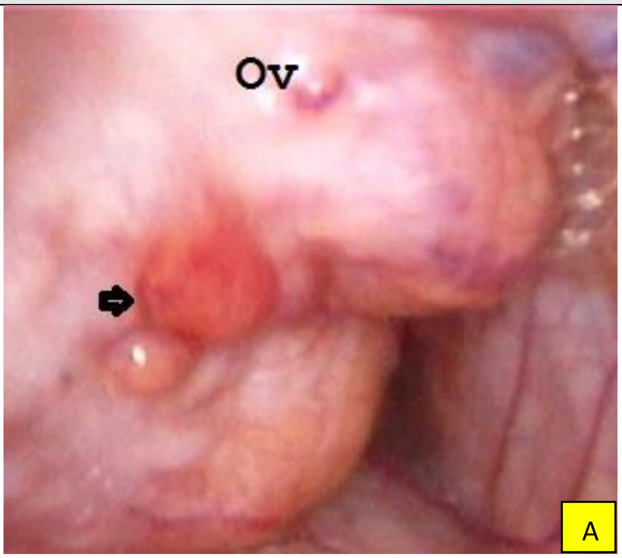
A large cyst occupying the pelvic cavity having a firm attachment with broad ligament was diagnosed in one of the cows (Plate 47 A). The cow was infertile from a long time. The cyst was having a thin membrane like covering traversed with small capillaries (Plate 47 C). Exploratory puncture, by a forceps, yielded serosanguineous fluid (Plate 47 D). The puncture did not result in the collapse of the structure, inferring that it had multiple sacculations inside. Similar cysts having broad ligament attachment have been reported in humans. The vesicular appendage of the epoophoron called as hydatid of morgagni arises from one or more small pedunculated vesicles in connection with the fimbrae of the uterine tube or with the broad ligament close to them. It can be peritoneal multi locular inclusion cyst which is reactive and has mesothelial proliferation from peritoneal cells that results from insult to the peritoneum. The most common insults are endometriosis, pelvic inflammatory disease, previous abdominal or pelvic surgery and trauma (Moyle *et al.* 2010). Similar finding was also reported in camels (Mahmoud *et al.* 2011)

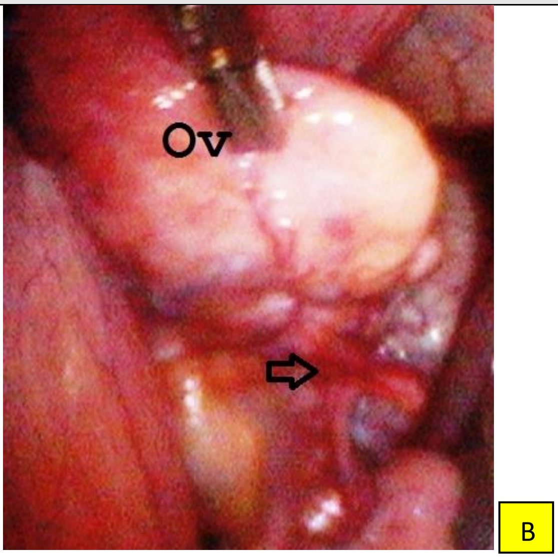
**4.6.6 Par ovarian cyst (Plate 48 A - B)**

Parovarian cysts are cystic structures that do not occur in the ovaries themselves, but rather in the broad ligament close to the ovaries and the uterine tubes. They appear as “fluid-filled anechoic structures (Plate 48 A, Plate 48 B) and are usually round or oval in shape (Peter *et al.* 2009). There are two different types of paraovarian cysts, those derived from the cranial mesonephric tubules are called epoophoron, while those from the caudal tubules are referred to as paroophoron. All paraovarian cysts are benign, with no negative effects on reproduction and fertility (Peter *et al.* 2009).

Examination of the ovary was done by right flank laparoscopy and left flank laparoscopy. From right flank laparoscopy, central and dorso caudal approaches were used and from the left flank, ventro caudal and dorso caudal laparoscopic approaches were the used to visualize ovaries. The laparoscope had to be oriented caudally to visualize the ovaries. To make the entry in the pelvic cavity there is need of little manipulation of omental fold, which was done with the help of grasping forceps.

Plate 48 – Parovarian cysts



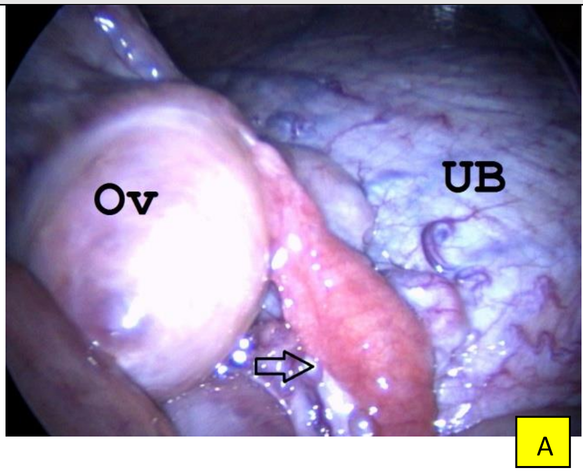

*Arrowhead indicates parovarian cyst,* **Ov** *– Ovary*

**4.6.7 Salpingitis (Plate 49 A - B)**

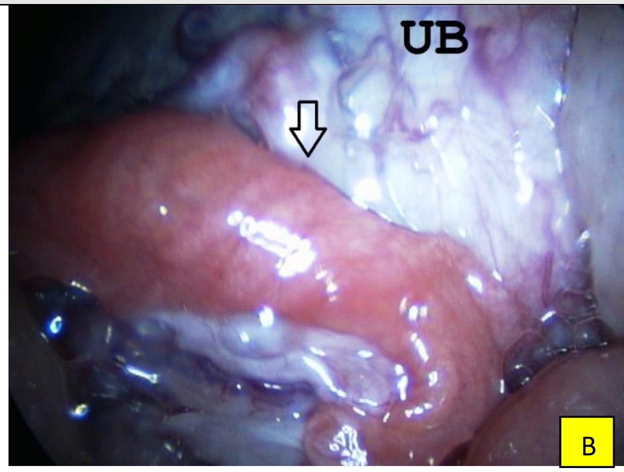
The oviduct, also known as the fallopian tube, is an essential component of the normal reproductive process. The incidence of pathological conditions of different segments of bovine and buffalo genitalia has been reported to widely vary and tubal affections are opined to be more common in buffaloes than in cows (Alam 1984). The Fallopian tubes are amazing because they not only collect the eggs from the surface of the ovary but they provide a hook-up spot for eggs and sperm that is simply perfect for fertilization. They provide the early nursery for the new embryo for the first five days of its life, while gently transporting it to the waiting uterus for implantation. The fallopian tube is not just a passive pipe or a conduit, but an active organ with its separate locations performing separate functions (Shivhare *et al.* 2012). Starting from the ovarian end (fimbria) and proceeding toward the uterus. Abnormalities of the fallopian tubes have been attributed as one of the most important causes of female infertility in all species. The prevalence of gross abnormalities and lesions of the uterine tube in relation to parity like endosalpingitis, pyosalpinx, hydro-salpinx, occlusion, aplasia and other micro lesion which is not palpable per rectum and could be responsible for reproduction failure in farm animals (Bhattacharya *et al*.1970)

During this study, while making an attempt to delineate fallopian tube, an inflamed fallopian tube was encountered. Salpingitis was characterized by abnormal swelling of salpinx with increased vascualraity (Plate 49 A, Plate 49 B). Salpingitis can be described as dilated fallopian tube filled with fluid, pus or blood. It is one of the serious causes of infertility as it leads to the blockade which usually occur at the fimbriated end of the fallopian tubes and is caused by adhesions from infectious or non inflammatory causes (Moyle *et al.* 2010). Examination of pelvic cavity organs could be done by right flank laparoscopy and left flank laparoscopy. From right flank laparoscopy, central and dorso caudal approaches were used and from the left flank, ventro caudal and dorso caudal laparoscopic approaches were used to visualize these organs. The laparascope had to be oriented caudally to visualize the organs of the pelvic cavity. To make the entry in the pelvic cavity, there is need of little manipulation of the omental fold, which can be done with the help of grasping forceps.

Plate 49 – Salpingitis in cow




***Arrowhead** depicts salpingitis*
**UB** – *Urinary bladder*
**Ov**– *Ovary*




***Arrowhead** depicts salpingitis*
**UB** – *Urinary bladder*

**4.7 Laparoscopic guided tissue biopsies**

**4.7.1 Biopsy of different organs**

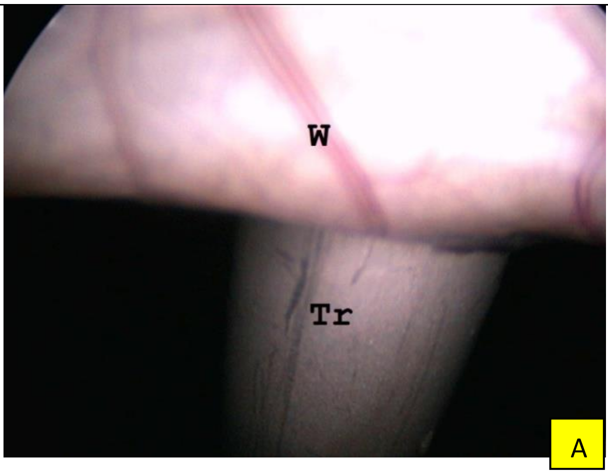
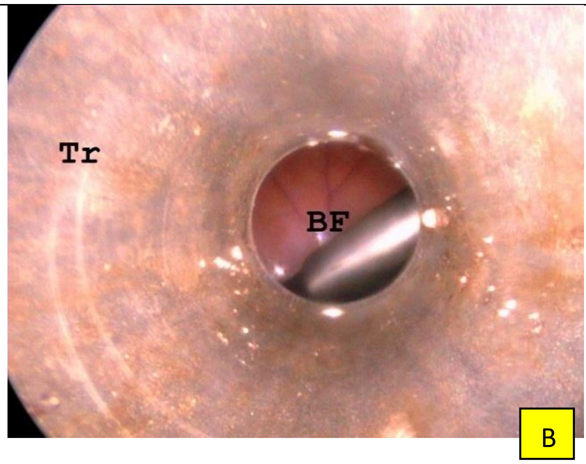
A biopsy is a method, aiding in the determination of a precise diagnosis and disease prognosis. Diagnostic evaluation of many different medical conditions can be assisted by obtaining biopsy samples from multiple abdominal organs. The sample collection has traditionally been performed in several ways like fine-needle aspiration biopsy, percutaneous biopsy, biopsy under the guidance of ultrasonography, biopsy under endoscopic guidance, and biopsy at the time of exploratory laparotomy (Mayhew 2009). In cattle, the first reports on an organ biopsy by laparoscopy guidance involved the kidney (Naoi *et al.* 1985) and the liver (Whitehair *et al.* 1998) while Klein *et al.* (2002) described an intestinal biopsy technique in calves and sheep.

A laparoscopic biopsy is indicated whenever a biopsy of abdominal or thoracic or pelvic viscera is necessary, and it has replaced an ultrasound guided biopsy. Early biopsy offers prognostic information and whether further therapy is likely to be beneficial and cost effective. Laparoscopic biopsy has many advantages which make it preferable over other conventional biopsy taking techniques. With the help of laparoscopy, direct visualization of the organ is feasible which helps in selection of exact biopsy site. With this technique obtaining a biopsy specimen from the wrong site is avoided. When there is a direct visualization of biopsy taking, possible haemorrhages can be easily identified and controlled accordingly. The direct view of the target organ can provide additional information concerning the condition and eventually its prognosis.

**4.7.2 Pre operative work up and preparation (Plate 50 A - B)**

Biochemical abnormalities should be confirmed to rule out laboratory error before performing biopsies. The animals scheduled for laparoscopic biopsy were prepared for the routine laparoscopic procedure.

Plate 50 – Laparoscopic guided entry of secondary instruments

| | |
|---|---|
|  |  |
| *Entering of accessory trocar*<br>**W**– *Abdominal wall*<br>**Tr** – *Trocar canula* | **BF** – *Biopsy forceps*<br>**Tr** – *Trocar canula* |

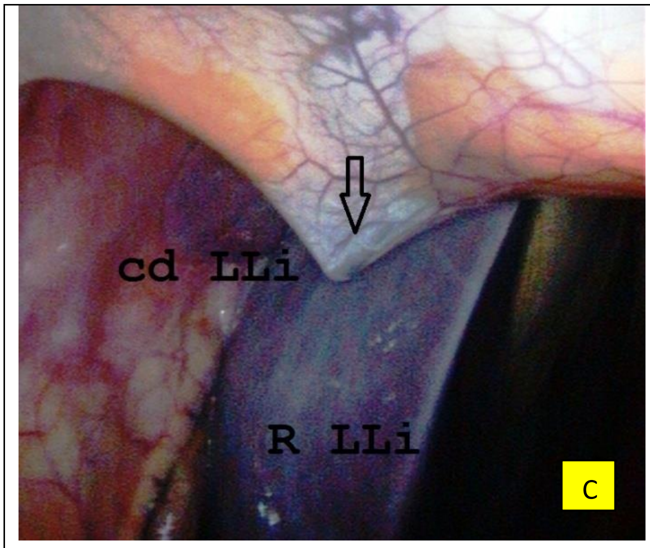
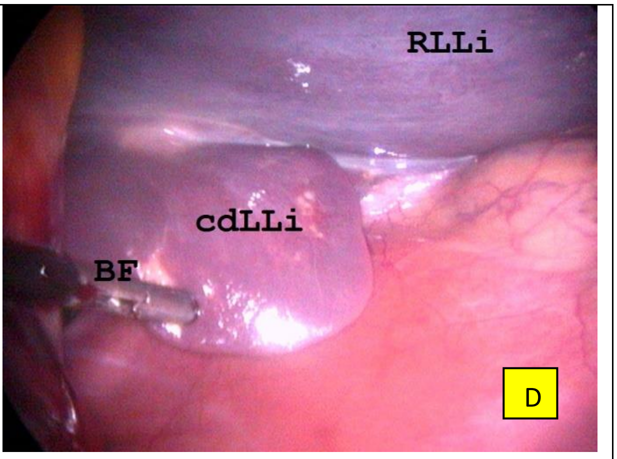
The biopsy forceps was introduced in the abdominal cavity under telescopic guidance from the primary port (Plate 50 A, Plate 50 B). The instrument channel port was created in a way to have maximum working space without any hindrance from abdominal contents.

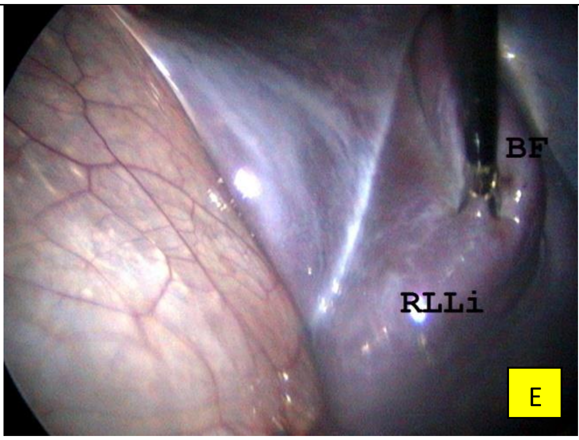
### 4.7.3 Biopsy of liver (Plate 51 A - F)

Liver biopsies were taken by the right flank laparoscopy. The laparoscope was introduced through right flank and biopsy instrument was placed through a secondary obturator (Plate 51 C). In this study, central and ventro caudal ports were used for laparoscope and dorso cranial port for biopsy forceps (Plate 51 B).The biopsy forceps was directed cranially to reach the lobe of the liver. Generally, the discoloured areas evident on the liver were biopsied as has also been suggested by (Fischer, 2002). The jaw of the biopsy forceps was opened and the area in question is grasped to harvest the sample (Plate 51 D, Plate 51 E). In the present study, two methods for collecting the biopsy were used i.e. with electrosurgical unit and without electrosurgical unit. With the help of electrosurgical unit haemorrhages could be avoided. Bipolar electrosurgery mode was used to collect the biopsies as this mode uses low voltage cutting current and can be easily used with the biopsy forceps.

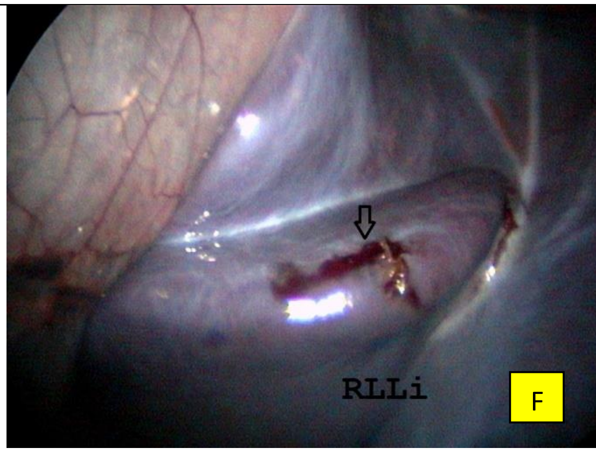
Plate 51 – Laparoscopic guided Liver biopsy

| | |
|---|---|
|  |  |
| *Ventro caudal port for insertion of laparoscope* | *Ventro caudal port for laparoscope and dorso cranial port for biopsy forceps* |

| | |
|---|---|
|  |  |
| ***Arrowhead*** *depicts the marking of entry of trocar cannula for insertion of biopsy forceps in the abdominal cavity* | *Acquiring biopsy from the caudate lobe of liver*<br>**RLLi** – *Right lobe of liver*<br>**cdLLi** – *Caudate lobe of liver*<br>**BF** – *Biopsy forceps* |




*Acquiring biopsy from the right lobe of liver*
**RLLi** – *Right lobe of liver*
**BF** – *Biopsy forceps*




***Arrowhead*** *indicates site after biopsy*
**RLLi** – *Right lobe of liver*

With this method, the current heats the tissue slowly and safely. Whereas with another method, a small amount of the tissue can be pinched away from the organ with pressure and gentle force. Care was taken to monitor the site for excessive or continuous bleeding before closure of abdominal cavity (Plate 51 F). At the end of the procedure, the abdomen was deflated and the skin was sutured with a single horizontal mattress suture pattern. The most common indications for liver biopsy were the persistent elevation of hepatic enzymes concurrent with disease or common plant toxicities. In horses (Pearce *et al.* 1997) and in goats (Kassem *et al.* 2011) liver biopsy was taken laparoscopically. It was concluded that laparoscopic liver biopsy in goats was safe, practical and easily performed with an advantage of direct visualization of liver. Liver biopsies in horses often lead to more changes in the peritoneum and peritoneal fluid than other biopsy procedures, probably because of bile leakage (Silva *et al.* 2002; Tabet *et al.* 2005).

### 4.7.4 Biopsy of kidney (Plate 52 A - E)

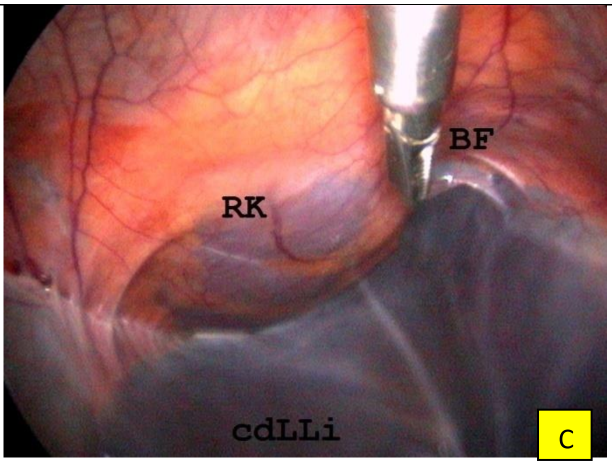
Ultrasound guided percutaneous kidney biopsy may be the most minimally invasive procedure and has been reported in cattle (Mohammed and Oikawa 2008). Unfortunately, this approach only provided access to the right kidney and the samples obtained are not of sufficient size for chemical analysis. Chiesa *et al*. 2006 developed a laparoscopic technique for serial renal biopsy in steers. Chiesa *et al.* 2009 used one port kidney biopsy procedure to take kidney biopsy in steers.

In the present study, the biopsies of kidney were obtained from ipsilateral paralumbar fossa. Routine insertion of the laparoscope into the abdominal cavity was performed. The biopsy forceps was inserted into the abdominal cavity through a separate port after satisfactory endosufflation. The biopsy forceps were inserted into the abdominal cavity under direct visualization. In this study for obtaining right kidney biopsy, ventro caudal port was used for laparoscope and dorso cranial port for biopsyforceps (Plate 52 B) and for obtaining left kidney biopsy, dorso cranial port was used for laparoscope and ventro caudal port for biopsy forceps (Plate 52 A). It was important to examine the tissue obtained to ascertain that renal tissue was obtained and not just perirenal fat. The biopsies were generally taken from the caudal pole in the cortical region to avoid the medullary blood vessels (Fischer 2002). It was concluded from this study that kidney is a difficult organ for collecting the biopsy as kidneys in ruminants have a thick fibrous capsule (Plate 52 C, Plate 52 D) and sometimes needs careful dissection to reach to the parenchyma of the kidney (Plate 52 E). At the conclusion of the procedure, the abdomen was deflated and the skin was sutured with single horizontal mattress suture. The most common indications for kidney biopsy were the persistent elevation of renal enzymes concurrent with the disease.

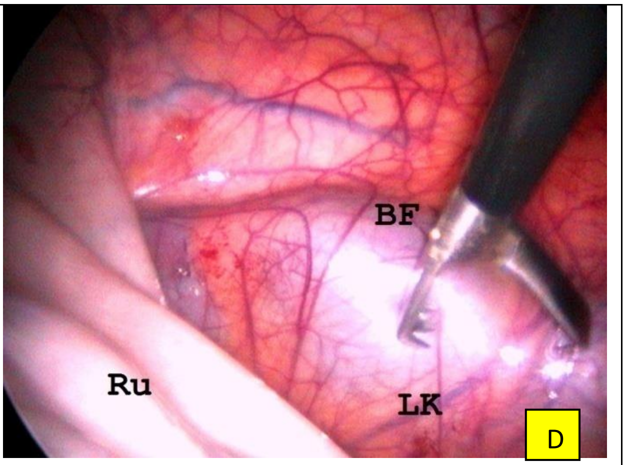
Recently in the year of 2014 Kassem *et al.* performed a gasless renal biopsy in standing mares. It was concluded that gasless approach was possible in the sedated standing mare for topographic renal anatomy and renal biopsy. Gasless laparoscopic renal biopsy was a simple, safe, reliable (100%success), a minimally invasive alternative to open renal biopsy.

Plate 52 – Laparoscopic guided Kidney biopsy

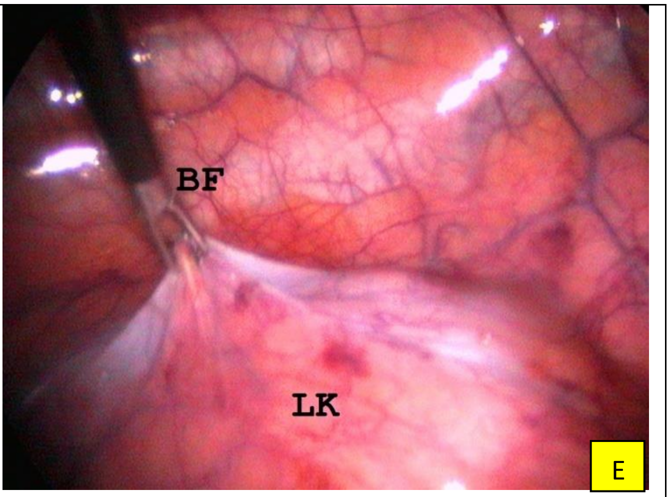

| | |
|---|---|
| *Dorso cranial port for laparoscpe and ventro caudal port for biopsy forceps for left kidney* | *Ventro caudal port for laparoscope and dorso cranial port for biopsy forceps for right kidney* |




*Acquiring biopsy from the right kidney*
**RK** –*Right kidney*
**cdLLi**- *Caudate lobe of liver*
**BF**– *Biopsy forceps*




*Acquiring biopsy from the left kidney*
**LK** – *Left kidney*
**Ru** – *Rumen*
**BF** – *Biopsy forceps*




*Renal capsule grasped with the biopsy forceps*
**LK** – *left kidney*
**BF** – *Biopsy forceps*

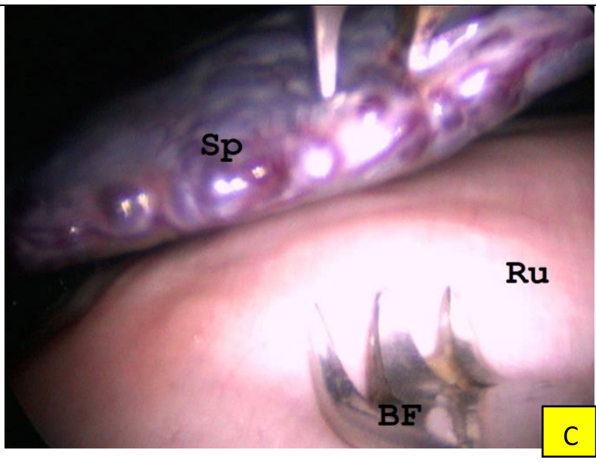
**4.7.5 Biopsy of spleen (Plate 53 A - D)**

The biopsy of the spleen was obtained from left paralumbar fossa region. In this study, ventro cranial port was used for laparoscope and dorso caudal port for biopsy forceps (Plate 53 B).The laparoscope was directed parallel to the spine cranially to identify the body of the spleen.

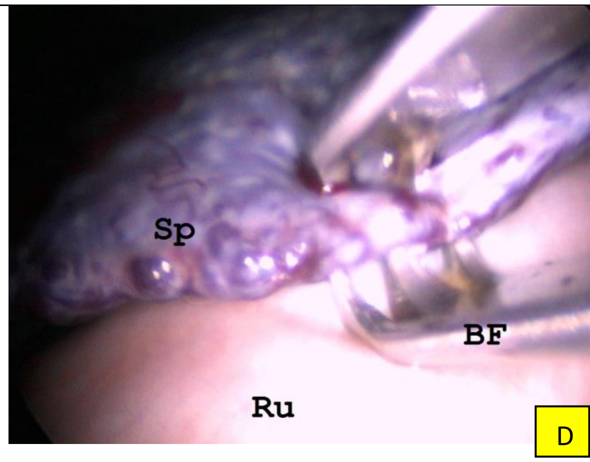
Plate 53 – Laparosocpic guided Spleen biopsy


*Incisions made for entering laparoscope and biopsy forceps in the abdominal cavity*


*Ventro cranial port for laparoscope and dorso caudal port for biopsy forceps*




*Holding the spleen with biopsy forceps*
**Sp**- *Spleen*
**Ru**– *Rumen*
**BF** - *Biopsy forceps*




*Taking biopsy sample of spleen*
**Sp**- *Spleen*
**Ru**- *Rumen*
**BF** - *Biopsy forceps*

The parietal and visceral surfaces were easily visualized. The intended site for the biopsy was selected and harvested with the help of biopsy forceps under direct visualization (Plate 53 C,

Plate 53 D). Haemorrhage was usually minimal and does not require any special attention or use of electrosurgery. If abnormal areas are seen during the laparoscopic examination they should be biopsied (Fischer, 2002). At the conclusion of the procedure, the abdomen was deflated and the skin was sutured with single horizontal mattress suture. Rao *et al.* (2013) performed a biopsy of the spleen in buffalo calves aged about one and a half to two years.

### 4.7.6 Post operative care

There was no specialized post operative care for laparoscopic biopsy. The animals were returned to food and water as soon as the sedative effects of Xylazine hydrochloride worn off. As the communication of abdominal and pelvic cavity with the external environment was minimal in this procedure, a single dose of antibiotics was found to be sufficient. Most of post operative medical care was directed towards the reason the biopsy was performed. The skin sutures were removed after 10 days following the procedure.

**CHAPTER-5**

# SUMMARY AND CONCLUSIONS

The diagnostic laparoscopy has largely remained limited to small animal practice. The present study was undertaken mainly explore its diagnostic utility in large animal practice. An attempt was made to delineate the landmarks for flank laparoscopy and to obtain a normal laparoscopic anatomy of the abdomen for clinical application.

The clinical bovine patients presented to Teaching Veterinary Clinical Complex, DGCN COVAS, Palampur suspected of abdominal or pelvic organ involvement were subjected to laparoscopy for assisting the diagnosis. As per diagnostic referral, the patients were allocated into two groups i.e. right flank laparoscopy group and left flank laparoscopy group. The animals were kept off feed for 24 hours and water was withheld for 8 hours. The animal was premeditated with Xylazine hydrochloride @ 0.03 mg/kg b.wt intramuscular followed by desensitization of flank using Inverted L block.

Straight forward telescope 0 degrees with 10 mm diameter and 57 cm length was used in large sized animals and straight forward telescope 0 degrees with 10 mm diameter and 31 cm length was used for small sized animals for visualization of abdominal and pelvic contents. The laparoscopic ports for laparoscope placement in order to optimally visualize various abdominal and pelvic organs from respective flanks were studied in detail.

For making an entry into the abdominal cavity three methods were followed in the present study viz. Conventional direct entry into the abdominal cavity, modified direct entry forceps assisted, modified direct entry hook assisted. Modified direct entry forceps assisted and Modified direct entry hook assisted were evolved during the present study to overcome the shortcomings of conventional direct entry method.

Capnoperitoneum of the abdominal cavity was achieved using electronic endoflator. A pressure of 8.6 ± 0.2449 - 9.2 ± 0.5831 mmHg (ranging from 8 – 9.5 mmHg) was maintained to create capnoperitoneum in cattle. In most of the animals 9 mm Hg of pressure showed satisfactory distension for making the primary port entry and at the same time avoiding a pressure tension stress on the animal. In the present study discomfort and restlessness was observed in animals when the intra-abdominal pressure exceeds more than 10 mm Hg. The flow rate of gas remained between 4.5 – 5.5 L and the average amount of carbon dioxide used to create capnoperitoneum was 22.6 L or 0.040 Kg.

While performing right flank laparoscopy only central and dorso caudal ports illustrated satisfactory results. Other three ports i.e. dorso cranial, ventro cranial and ventro dorsal ports posed the problem of a hindrance due to the peritoneum. For left flank laparoscopy all the five ports provided good visualization of the contents of abdominal and pelvic cavities. But from central and ventrocaudal ports, care has to be exercised while making an entry to avoid chances of puncture of the distended rumen.

The liver was visualized through right flank laparoscopy by keeping the cranial orientation of the laparoscope. Right flank, central and dorso caudal laparoscopy ports offered maximum visualization of liver lobes and surface. With the help of these ports caudate lobe of the liver, parietal and the visceral surface of principle lobe of the liver, hepato renal ligament, right triangular ligament and perihepatic space were visualized.

The right kidney was visualized through right flank laparoscopy by keeping the laparoscope dorsally towards lumbar transverse processes at retroperitoneal space. The Central port was used for visualization of right kidney, as this port provided ample space for the handling of instrumentation. The right kidney was found in the thin elastic covering of capsula adiposa and its cranial end was found in contact with liver. Dorsal and ventral surfaces of kidney were easily visualized. The dorsal surface was visualized below the proximal end of last rib and first two or three lumbar transverse processes and the ventral surface was lying on the cecum and ascending colon. Hepato renal ligament was also visualized. The left kidney was visualized by left flank laparoscopy. The laparoscope was placed dorsally towards lumbar transverse processes at retroperitoneal space. Ventro cranial, ventro caudal and central ports were used for visualization of the left kidney. Dorsal and ventral surfaces of the kidney were visualized within the capsula adiposa.

The spleen was visualized from left flank laparoscopy. The cranial orientation of laparoscope was followed. Central, dorso cranial and ventro cranial ports, were used for visualization of the spleen. The laparoscope was directed parallel to the spine cranially to identify the body of the spleen. Dorsal and ventral extremities, parietal and visceral surfaces, the posterior or caudal border of the spleen, attachment of visceral surface of spleen to the rumen, attachment of spleen to sub lumbar muscles, perisplenic space were visualized.

The urinary bladder was visualized by right and left flank laparoscopy in the caudal orientation of the laparoscope. Central port for right flank laparoscopy and central, dorso caudal and ventro caudal ports for left flank laproscopy were followed to examine the urinary bladder. Body, apex, and neck of the bladder were visualized. The ligament, stabilizing the urinary bladder in the pelvic cavity was also visualized, having an attachment to the apex of the bladder.

The uterus was visualized by right and left flank laparoscopy by keeping the caudal orientation of the laparoscope. From right flank laparoscopy central and dorso caudal approaches were used and from left flank ventro caudal and dorso caudal laparoscopic approaches were used for visualization. After making the entry in to the pelvic cavity by manipulating omental fold, the uterine body, intercornual region and bifurcation of the horns were easily visualized. Ovary, mesovarium, suspensory ligament, broad ligament were visualized by right and left flank laparoscopy by keeping the caudal orientation of the laparoscope. From right flank laparoscopy central and dorso caudal approaches were used and from left flank ventro caudal and dorso caudal laparoscopic approaches were the used for visualization. For making the entry in to the pelvic cavity manipulation of the omental fold with the help of grasping forceps is required.

The rumen was visualized by left flank laparoscopy by both cranial and caudal orientation of the laparoscope to cover most of its surface area. It was visualized by all the ports made in the present study. The laparoscope was directed parallel to the spine cranially and caudally to visualize most of the accessible rumen. The parietal surface of the rumen, atrium, dorsal sac, caudo dorsal blind sac, attachment of rumen to the spleen and gastro splenic space were visualized. The peritoneum was visualized from left and right flank laparoscopy. The vasculature pattern, colour and appearance of the parietal peritoneal layer were visualized.

The duodenum was visualized through right flank laparoscopy by the cranial orientation of the laparoscope. Dorso caudal and central port approaches were utilized for visualization of the duodenum. Ventral to the caudate process of the liver was the cranial part of the duodenum and the descending duodenum. Colon was visualized by right and left flank laparoscopy by keeping the caudal orientation of the laparoscope. From right flank laparoscopy central and dorso caudal approaches were used and from left flank ventro caudal and dorso caudal laparoscopic approaches were used for visualization. The colon could only be visualized by reflecting the omental fold and only the part of the descending colon at the level of the pelvic inlet could be visualized. The cecum was visualized by right and left flank laparoscopy by keeping the caudal orientation of the laparoscope. From right flank laparoscopy central and dorso caudal approaches were used and from left flank ventro caudal and dorso caudal laparoscopic approaches were the used for visualization. Only a small part of the blind end of the cecum could be seen just before the pelvic inlet.

Laparoscopy in cattle was found to be a promising tool for clinical diagnosis and can be utilized for diagnosing various affections of the abdominal cavity. Capnoperitoneum induced separation of organs substantiated with telescopic magnification aided in excellent diagnostic visualization. Different affections which were diagnosed through laparoscopy were traumatic reticulo peritonitis, intestinal intussusceptions, peritonitis, extra hepatic cyst, a cyst in the pelvic cavity, par ovarian cysts, inflammation of fallopian tube. Direct visualization of these abdominal and pelvic cavities helped to recognize and diagnose these conditions. Intraoperative gasless laparoscopy helped in diagnosis of Intussusception.

Laparoscopic assisted biopsy of different organs was one of the key findings of the present study, it helped to directly visualize the organ and to differentiate between healthy and unhealthy part so as to select the exact site of the biopsy. In this study, biopsy of the liver, spleen, right kidney and left kidney was harvested.

**Based on this study some salient conclusions were drawn-**

i. Laparoscopy in cattle was found to be a promising tool for clinical diagnosis and can be utilized for diagnosing various affections of the abdominal cavity. It allows exploration of major abdominal organs with an additional benefit of harvesting the site specific biopsies.
ii. For making an entry into the abdominal cavity Modified direct entry Hook assisted was devised and found to be most reliable methods due to its numerous advantages.
iii. Capnoperitoneum induced separation of organs substantiated with telescopic magnification aided in excellent diagnostic visualization.

iv. Laparoscopy helped in identification of even the smaller structures, rings, apertures and openings not normally seen during standard celiotomy approach.

v. Laparoscopy precludes the invasive and often time consuming exploratory surgical interventions.

vi. There was minimal exposure of the abdominal/pelvic cavities to outside atmosphere and the least visceral handling during laparoscopy thus minimal post operative care.

vii. In addition to the several diagnostic and therapeutic advantages, the technique has particularly a very important pedagogic value.

# Literature Cited


Alam MGS. 1984. Abattoir studies of genital diseases in cows. *Veterinary Record* 114: 195-196

Almeida J, Sleeman D, Sosa JL, Puente I, McKenney M and Martin L. 1995. Acalculous cholecystitis: the use of diagnostic laparoscopy. *Journal of Laparoendoscopic Surgery* 5: 227-231

Alsafy MAM, El-Kammar MH, Kassem MM, El-Gendy SAA, EL-Khamary AN. 2013. Laparoscopic anatomy of the abdomen and laparoscopic ligating loops, electrocoagulation, and a novel modified electroligation ovariectomy in standing mare. *Journal of Equine Veterinary Science* 33(11): 912-923

Anderson DE, Gaughan EM and St. Jean G. 1993. Normal Laparoscopic Anatomy of the Bovine Abdomen. *American Journal of Veterinary Research* 54: 1170-1176

Anderson DE. 2004. Laparoscopy. In: Fubini SL, Ducharme NG, editors. *Farm animal surgery*. Philadelphia: WB Saunders: p. 82–6

Archer DC. 2009. Chronic colic: diagnosis and treatment. In N. E. Robinson (Ed.), Current Therapy in Equine Medicine (pp. 198-202). Philadelphia: Saunders.

Babkine M and Desrochers A. 2005. Laparoscopic surgery in adult cattle. *Veterinary Clinics of North America: Food Animal Practice* 21: 251–279

Babkine M, Desrochers A, Boure L and Helie P. 2006. Ventral laparoscopic abomasopexy on adult cows. *Canadian Veterinary Journal* 47(4): 343-8

Beard W. 2004. Parainguinal laparocystotomy for urolith removal in geldings. *Veterinary Surgery* 33(4): 386–390

Beierer LH and Burgess DM. 2009. Laparoscopy - a new and rapidly advancing field in veterinary science. School of Veterinary Science, University of Queensland, Qld 4072, Australia. *Australian Veterinary Practitioner* 39(1): 10-25

Bernard C, Lambert RD, Beland R and Belanger A. 1984. Laparoscopic investigation of the bovine ovary in the periovulatory phase of the cycle. *Theriogenology* 22: 143–50

Bernheim BM. 1911. Organoscopy: cystoscopy of the abdominal cavity. *Annals of Surgery* 53: 764 – 767

Bhattacharya AR, Luktuke SN and Roy DJ. 1970. The incidence of normal and pathological conditions of she-buffalo genitatlia in different months. *Indian journal of animal Sciences* 40: 425-427

Bleul U, Hollenstein K and Kahn W. 2005. Laparoscopic Ovariectomy in Standing Cows. *Animal Reproduction Science* 90: 193 – 200

Blobner M, Felber AR, Hosl P, Gogler S, Schneck HJ and Jelen-Esselborn S. 1994. Effect of capnoperitoneum on postoperative carbon dioxide homeostasis. *Anaesthesist* 43(11): 718-22

Boure L, Marcoux M and Laverty S. 1997. Laparoscopic Abdominal Anatomy of Foals Positioned in Dorsal Recumbency. *Veterinary Surgery* 26: 1 - 6

Boure L, Foster RA, Palmer M and Hathway A. 2001. Use of an endoscopic device for laparoscopic resection of the apex of the bladder and umbilical structures in normal neonatal calves. *Veterinary Surgery* 30: 319 - 326

Boure LP, Pearce SG, Kerr CL, Lansdowne JL, Martin CA, Hathway AL and Caswell JL. 2002. Evaluation of laparoscopic adhesiolysis for the treatment of experimentally induced adhesions in pony foals. *American Journal of Veterinary Research* 63: 289 – 294

Boure LP, Kerr CL, Pearce SG, John Runciman R, Lansdowne JL, Caswell JL . 2005. Comparison of two laparoscopic suture patterns for repair of experimentally ruptured urinary bladders in normal neonatal calves. *Veterinary Surgery* 34(1): 47-54

Boyd WP and Nord HJ .2000. Diagnostic laparoscopy. *Endoscopy* 32: 153-158

Bracamonte JL, Boure LP, Runciman JR, Nykamp SG, Cruz AM, Teeter MG and Waterfall HL. Am. J. 2008. Evaluation of a laparoscopic technique for collection of serial full thickness small intestinal biopsy specimens in standing sedated horses. *Veterinary Research* 69(3): 431-439

Brink P. Schumacher J. and Schumacher J. 2010. Elevating the uterus (uteropexy) of five mares by laparoscopically imbricating the mesometrium. *Equine Veterinary Journal* 42(8): 675–679

Budras KD and Habel RE. 2003. BOVINE ANATOMY An illustrated text. Schlutersche GmbH & Co. KG, Verlag und Druckerei Hans-Bockler-Allee 7, 30173 Hannover, Germany ISBN 3-89993-000-2

Caron JP and Mehler SJ. 2009. Laparoscopic mesh incisional hernioplasty in five horses. *Veterinary Surgery* 38(3): 318–325

Chiesa, OA, Cullison R, Anderson DE, Moulton K, Galuppo LD, and von Bredow J. 2006b. Development of a technique for serial bilateral renal biopsy in steers. *Canadian Journal of Veterinary Research* 70: 87–93

Chiesa OA, von Bredow J, Smith M and Thomas M. 2009. One-port video assisted laparoscopic kidney biopsy in standing steers. *Research in Veterinary Science* 87: 133–134

Cokelaere SM, Martens A, Vanschandevijl K, Wilderjans H, and Steenhaut M. 2007. Hand-assisted laparoscopic nephrectomy after initial ureterocystostomy in a shire filly with left ureteral ectopia. *Veterinary Record* 161(12): 424–427

Cruz AM, Southerland LC, Duke T, Townsend HG, Ferguson JG and Crone LA. 1996. Intraabdominal Carbon Dioxide Insufflation in the Pregnant Ewe. Uterine blood flow, intraabdominal pressure, and cardiopulmonary effects. *Anaesthesiology* 85: 1395 -1402

Curet MJ, Vogt DA, Schob O, Qualls C, Izquierdo LA and Zucker KA. 1996. Effects of CO2 pneumoperitoneum in pregnant ewes. *Journal of Surgical Research* 63: 339 - 344

Curet MJ, Weber JDM, Sae A and Lopez J. 2001. Effects of Helium Pneumoperitoneum in Pregnant Ewes. *Surgical Endoscopy* 15: 710 - 714

Cuschieri A. 1999. Technology for Minimal Access Surgery. *British Medical Journal* 319, 1304

Davidson EB, Moll HD and Payton ME. 2004. Comparison of laparoscopic ovariohysterectomy and ovariohysterectomy in dogs. *Veterinary Surgery* 33: 62–69

Dupre G, Fiorbianco V, Skalicky M, Gültiken N, Ay SS and Findik M. 2009. Laparoscopic ovariectomy in dogs: comparison between single portal and two-portal access. *Veterinary Surgery* 38: 818–824

Edwards RB III, Ducharme NG and Hackett RP. 1995. Laparoscopic repair of a bladder rupture in a foal,” *Veterinary Surgery* 24(1): 60–63

Fantinatti AP, Daleck CR, Nuns N, Alessi AC, Dacostaneto JM, Vicenti FAM, Duque JC and Dossantos PS. 2003. Laparoscopy hepatic biopsy through cauteriazation. *Ciencia Rural* 33: 703-707

Fayrer-Hosken RA, Younis AI and Brackett BG. 1989. Laparoscopic oviductal transfer of *in vitro* matured and *in vitro* fertilized bovine oocytes. *Theriogenology* 32: 413–20

Fischer Jr AT, Lloyd KC, Carlson, GP and Madigan JE. 1986. Diagnostic laparoscopy in the horse. *Journal of the American Veterinary Medical Association* 189: 289–292

Fischer AT, Vachon AM and Klein SR. 1995. Laparoscopic Inguinal Herniorrhaphy in Two Stallions. *Journal of American Veterinary Medical Association* 15: 1599 - 1601

Fischer AT. 1999. Laparoscopically Assisted Resection of Umbilical Structures in Foals. *Journal of American Veterinary Medical Association* 214: 1813 - 1816

Fischer AT. 2002. Equine diagnostic surgical laparoscopy. W.B. Sounders Company.

Fransson B. 2014. The future: taking veterinary laparoscopy to the next level. (Special Issue: Endoscopy and endosurgery, part 2.) *Journal of Feline Medicine and Surgery* 16(1): 42-50. 37

Franz S. 1998. Laparoskopie beim Rind - Indikationen und Pathologische Befunde. Thesis. University of Veterinary Medicine of Vienna, Austria.

Franz S, Konig M, Gasteinern J and Baumgartner W. 2000. Laparoscopy in cattle. 3. Indications and pathological findings. [German. Laparoskopie beim Rind 3. Mitteilung: Indikationen und pathologische Befunde]. *Wiener Tierarztliche Monatsschrift* 87(5): 163-172

Franz S, Gentile A and Baumgartner W. 2006. Comparison of two Ruminoscopy Techniques in Calves. *Veterianry Journal* 172: 308 - 314

Fuhrmann U. 1991. Zur Laparoskopischen Untersuchung des Kalbes. Thesis. Faculty of Veterinary Medicine, Ludwig Maximilian University of Munich. Germany.

Fulton IC, Brown CM, and Yamini B. 1990. Adenocarcinoma of intestinal origin in a horse: diagnosis by abdominocentesis and laparoscopy. *Equine Veterinary Journal* vol. 22(6): 447–448

Galuppo LD, Snyder JR and Pascoe JR. 1995. Laparoscopic anatomy of the equine abdomen. *American Journal of Veterinary Research* 56 (4): 518–531

Galuppo LD. 2002. Laparoscopic anatomy. In: Fisher AT, editor. Equine diagnostic and surgical laparoscopy. *Philadelphia: WB Saunders Company* 7-27.

Gotz F, Pier A and Schippers E. 1993. The history of laparoscopy. *Color Atlas of Laparoscopic Surgery (ed. F. Gotz, A. Pier, E. Schippers, et al.)* 3 – 5

Grunert E. 1999. Gynakologische Operationen. In: Fertilitatsst orungen beim weiblichen Rind. Paul Parey Verlag, *Berlin, pp.* 381–395

Guidoni M, Guintard C, Ravier S, Betti E and Laval A. 2002. La laparoscopie de la cavite´ abdominopelvienne chez la vache. *Bull GTV* 14:87–91

Habermehl, N. 1993. Heifer ovariectomy using the Willis spay instrument: technique, morbidity and mortality. *Canadian Veterinary Journal* 34: 664–667

Hahn KH, Brune IB, Hesemann R, Oberlander C, Henke J and Erhardt W. 1997. Problems of Laparoscopy Using Capnoperitoneum: Controlled Ventilation, Circulation, Blood Gas and Body Temperature. *Tierärztliche Praxis*. 25: 192 - 197

Hendrickson DA. 2008. Complications of laparoscopic surgery. *Veterinary Clinics of North America Equine Practice* 24: 557–571

Hofmeyr CFB. 1987. The female genitalia. In: Hofmeyr, C.F.B. (Ed.), Ruminant Urogenital Surgery. *Iowa State University Press, pp.* 122–147

Holak P, Jałynski M, Peczynski Z, Adamiak Z, Jaskolska M and Pesta W. 2013. Diagnostic laparoscopy for small intestinal intussusception in a horse. *Pakistan Veterinary Journal* 33(1): 128-130

Hopkins HH and Kapany NS. 1954. A flexible fibrescope, using static scanning. *Nature*, 173: 39 – 41

Ho HS, Gunther RA and Wolfe BM. 1992. Intraperitoneal Carbon Dioxide Insufflation and Cardiopulmonary Functions. Laparoscopic Cholecystectomy in Pigs. *Archives of Surgery*. 127: 928-932

Ishizaki Y, Bandai Y, Shimomura K, Abe H, Ohtomo Y and Idezuki Y. 1993. Safe intraabdominal pressure of carbon dioxide pneumoperitoneum during laparoscopic surgery. *Surgery* 114(3): 549–554

Ivankovich AD, Miletich DJ, Albrecht RF, Heyman, HJ and Bonnet RF. 1975. Cardiovascular effects of intraperitoneal insufflation with carbon dioxide and nitrous oxide in the dog. *Anesthesiology*. 42: 281 - 287

Jacobaeus HC. 1911. Kurze ubersicht meine erfahrungen mit der laparothorakoskopie. *Munchener Medizinische Wochenschrift* 58: 2017 – 2019

Janowitz H, Praxis T, Lubbecke and Westfalen. 1998. Laparoscpic reposition and fixation of the left displaced abomasum in cattle. *Tierarztl prax ausg G Grosstiere Nutztiere.* [Article in German] 26 (6): 308-313

Janicek JC, Rodgerson DH, and Boone BL. 2004. Use of a hand-assisted laparoscopic technique for removal of a uterine leiomyoma in a standing mare. *Journal of the American Veterinary Medical Association* 225(6): 911–880

Jimenez Pelaez M, Bouvy BM and Dupre GP. 2008. Laparoscopic adrenalectomy for treatment of unilateral adrenocortical carcinomas: technique, complications, and results in seven dogs. *Veterinary Surgery* 37: 444–453

Kalk H. 1929. Erfahrungen mit der laparoskopie (Zugleich mit beschreibung eines neuen instrumentes). *Zeitschrift fur Klinische Medizin* 111: 303 – 348

Kaneko Y, Torisu S, Kitahara G, Hidaka Y, Satoh H, Asanuma T, Mizutani S, Osawa T and Naganobu K. 2015. Laparoscopic cryptorchidectomy in standing bulls. *Journal Veterinary Medical Science* 77(5): 631–635

Kassem MM, El-Gendy SAA, Abdel-Wahed RE, El-Kammar M. 2011. Laparoscopic anatomy of caprine abdomen and laparoscopic liver biopsy. *Research in Veterinary Science* 90: 9–15

Kassem MM, El-Kammar MH, Alsafy MAM.; El-Gendy SAA, Sayed-Ahmed A and El-Khamary AN. 2014.Gasless laparoscopic anatomy and renal biopsy of the kidney in the standing mare. *Internatioinal Journal Morphology* 32(4): 1234-1242

Kelling G. 1902. Uber oesophagokopie, gastroskopie und kolioskopie. *Munchener Medizinische Wochenschrift* 49: 21–24

Kelman GR, Swapp GH, Smith I, Benzie RJ and Gordon NL. 1972. Cardiac Output and Arterial Blood-Gas Tension during Laparoscopy. *British Journal of Anaesthiology* 44: 1155-1162

Keoughan CG, Rodgerson DH, and Brown MP. 2003. Handassisted laparoscopic left nephrectomy in standing horses. *Veterinary Surgery* 32(3): 206–212

Klein C, Franz S, Leber A, Bago Z and Baumgartner W. 2002. Methodik der Darmbioptatentnahme unter laparoskopisher Kontrolle bei Kalb und Schaf. *Wiener Tierarztliche Monatsschrift* 89: 291-301

Konig M, Franz S, Gasteiner J, Baumgartner W. 2000. Laparoscopy in cattle. 2. Laparoscopy in the fossa paralumbalis dextra. [German]. Laparoskopie beim Rind. 2. Mitteilung: Laparoskopie in der Fossa paralumbalis dextra. Veterinarplatz 1, A-1210 Wien, Austria *Wiener Tierarztliche Monatsschrift* 87(4): 105-110

Lambert RD, Sirard MA and Bernard C. 1986. In vitro fertilization of bovine oocytes matured in vivo and collected at laparoscopy. *Theriogenology* 25: 117–33

Lansdowne JL, Boure LP, Pearce SG, Kerr CL and Caswell JL. 2004. Comparison of Two Laparoscopic Treatments for Experimentally Induced Abdominal Adhesions in Pony Foals. *American Journal of Veterinary Research* 65: 681-686

Leber A. 2001. Untersuchung der physiologischen Lage der Bauchorgane mittels Laparoskopie beim kleinen Wiederkäuer (Thesis). University of Veterinary Medicine of Vienna, Austria

Lew M, Nowicki M, Jaynski M and Rychlik A. 2003. Laparoscope guided renal biopsy in dogs. *Medycina Weterynaryjna* 59: 307-310

Lin HC, Baird AN, Pugh DG, Anderson DE, Gaughan DM. 1997. Effects of Carbon Dioxide Insufflation Combined with Changes in Body Position on Blood Gas and Acid-Base Status in Anesthetized Llamas *{Llama glama). Veterinary Surgery* 26: 444-450

Luiz T, Huber T and Hartung HJ. 1992. Ventilatory Changes during Laparoscopic Cholecystectomy. *Anaesthesist* 41: 520–526

Lund CM, Ragle CA and Lutter JD. 2013. Laparoscopic removal of a bladder urolith in a standing horse. *Journal of the American Veterinary Medical Association* 243(9): 1323-1328

Mahmoud MH, Fahad AA, Mostafa MH. 2011. Pathologic Studies on Ovarian Abnormalities in Nagas (Camelus Dromedarius). *Scientific Journal of King Faisal University (Basic and Applied Sciences)* 12(1): 1432 – 265 - 276

Maiman TH. 1960. Stimulated optical radiation in ruby. *Nature 187: 493*

Marien T, Adriaenssen A, Hoeck FV and Segers L. 2001. Laparoscopic Closure of the Renosplenic Space in Standing Horses. *Veterinary Surgery* 30: 559-563

Maxwell DP and Kraemer D. 1980. Laparoscopy in cattle. In: Harrison RM, Wildt DE, editors. Animal laparoscopy. Baltimore: Williams & Wilkins; p. 133–56

Mayhew P. 2009. Techniques for laparoscopic and laparoscopic assisted biopsy of abdominal organs. *Compendium: Continuing Education for Veterinarians* 170-179

Mehl ML, Ragle CA, Mealey RH and Whooten TL. 1998. Laparoscopic diagnosis of subcapsular splenic hematoma in a horse. *Journal of the American Veterinary Medical Association* 213(8): 1171–1173

Mohammed T and Oikawa S. 2008. Efficacy and safety of ultrasound-guided percutaneous biopsy of the right kidney in cattle. *The Journal of Veterinary Medical Science* 70 (2): 175–179

Moyle PL, Kataoka MY, Nakai A, Takahata A, Reinhold C, Sala E. 2010. Nonovarian Cystic Lesions of the Pelvis. *RadioGraphics* 30(4): 921–938

Naoi M, Kokue E, Takahashi Y and Kido Y. 1985. Laparoscopic-Assisted Serial Biopsy of the Bovine Kidney. *American Journal of Veterinary Research* 46: 699 - 702

Nitze M. 1879. Beobachtung und untersuchungsmethode fur hanohre, harnblase und rectum. *Wiener Medizinische Wochenschrift* 29: 649 – 652

Neuhaus SJ and Watson DI. 2004. Pneumoperitoneum and peritoneal surface changes: a review. *Surgical Endoscopy* 18(9) 1316-1322

Palmer SE and McGill LD. 1992. Thermal injury associated with *in vitro* incision of equine skin using electrosurgery, radiosurgery and a carbon dioxide laser. *Veterinary Surgery* 21: 348

Pearce SG, Firth EC, Grace ND and Fennessy PF. 1997. Liver biopsy techniques for adult horses and neonatal foals to assess copper status. *Australian Veterinary Journal* 75(3): 194–198

Pearson MR and Sander ML. 1994. Hyperkalaemia Associated with Prolonged Insufflation of Carbon Dioxide into the Peritoneal Cavity. *British Journal of Anaesth*esiology 72: 602 - 624

Penide F. 2008. Unilateral ovariectomy by laparoscopy in mares. [French] *Le Nouveau Praticien Veterinaire - Equine* 5(17): 53-57

Peter AT, Levine H, Drost M, and Bergfelt DR. 2009. Compilation of Classical and Contemporary Terminology Used to Describe Morphological Aspects of Ovarian Dynamics in Cattle. *Theriogenology* 71: 1343-1357

Ragle CA, Southwood LL, Hopper SA and Buote PL. 1996. Laparoscopic ovariectomy in two horses with granulose cell tumors. *Journal of the American Veterinary Medical Association* 209(6): 1121–1124

Ragle CA. 2002. Laparoscopic Removal of Cystic Calculi. In: FISHER, A. T. Jr; Equine Diagnostic and Surgical Laparoscopy. Saunders, Philadelphia, USA 229 -234

Rao KS, Sreenu M, Raghavender KBP and Kishore PVS. 2013. Laparoscopic biopsy technique of liver and spleen in buffalo calves. *Buffalo Bulletin* 32(4)

Rathert P, Lutzeyer W, and Goddwin WE. 1974. Philipp Bozzini (1773 – 1809) and the lichtleiter. *Urology* 3: 113 – 118

Reichenbach HD, Wiebke NH, Modl J, Zhu J and Brem G. 1994. Laparoscopy through the vaginal fornix of cows for the repeated aspiration of follicular oocytes. *Veterinary Record* 135: 353–6

Rijkenhuizen ABM, Göhring L, and Lankveld DPK. 2003. Laparoscopic repair of a bladder rupture in 2 foals. *Pferdeheilk* 19: 9-15

Rijkenuizen ABM and Van Loon TJAM and Boswinkel M. 2008. Laparoscopic repair of a ruptured bladder in an adult mare. *Equine veterinary Education* 20(1)

Rocken M, Schubert C, Mosel G, and Litzke LF. 2005. Indications. Surgical Technique, and Long-Term Experience with Laparoscopic Closure of the Nephrosplenic Space in Standing Horses. *Veterinary Surgery* 34: 637 - 641

Rocken M, Stehle C, Mosel G, Rass J and Litzke LF. 2006. Laparoscopic- assisted cystotomy for urolith removal in geldings. *Veterinary Surgery* 35(4): 394–397

Rocken M, Mosel G, Stehle C, Rass J and Litzke LF. 2007. Left- and right-sided laparoscopic-assisted nephrectomy in standing horses with unilateral renal disease. *Veterinary Surgery* 36(6): 568–572

Rodgerson DH, Brown MP, Watt BC, Keoughan CG, and Hanrath M. 2002. Hand-assisted laparoscopic technique for removal of ovarian tumors in standing mares. *Journal of the American Veterinary Medical Association* 220(10): 1503–1507

Romero A, Rodgerson DH and Fontaine GL. 2010. Handassisted laparoscopic removal of a nephroblastoma in a horse. *Canadian Veterinary Journal* 51(6): 637– 639

Romussi S and Gualtieri M. 1994. Laparoscopic diagnosis in 13 cases of left abomasal displacement in cows. Proceedings 18th World Buiatrics Congress: 26th Congress of the Italian Association of Buiatrics, Bologna, Italy, August 29 September 2, 1994 Volume 2: 1231-1234

Rosenberger G. 1970. Kastration weiblicher Rinder. In: Krankheiten des Rindes. *Paul Parey Verlag*, Berlin 421–425

Rosin D. 1993. History. In: *Minimal Access Medicine and Surgery. Principles and Techniques* (ed. R.D. Rosin) 1 – 9. Radcliffe Medical Press, Oxford.

Rossignol F, Perrin R and Boening KJ. 2007. Laparoscopic hernioplasty in recumbent horses using transposition of a peritoneal flap. *Veterinary Surgery* 36(6): 557-562

Roy JP, Harvey D, Belanger AM and Buczinski S. 2008. Comparison of 2-step Laparoscopy-Guided Abomasopexy versus Omentopexy via Right Flank Laparotomy for the Treatment of Dairy Cows with Left Displacement of the Abomasum In On-Farm Settings. *Journal of American Veterinary Medical Association* 232: 1700-1706

Rupp GP and Kimberling CV. 1982. A new approach for spaying heifers. *Veterinary Medicine* 77: 561–565

Schambourg MM and Marcoux M. 2006. Laparoscopic intestinal exploration and full thickness intestinal biopsy in standing horses: A pilot study. *Veterinary surgery* 35: 689-696

Schellander K, Fayrer-Hosken RA and Keefer CL. 1989. In vitro fertilization of bovine follicular oocytes recovered by laparoscopy. *Theriogenology* 31: 927–34

Seeger K. 1977. Laparoscopic investigation of the bovine ovary. *Vet Med Small Anim Clin* 72:1037–44

Seeger KH and Klatt PR. 1980. Laparoscopy in sheep and goat. In: Harrison RM, Wildt DE eds. *Animal Laparoscopy, Chapter 6*, Williams and Wilkins; Baltimore, London.

Seeger T, Kumper H, Failing K and Doll K. 2006. Comparison of Laparoscopic-Guided Abomasopexy versus Omentopexy via Right Flank Laparotomy for the Treatment of Left Abomasal Displacement in Dairy Cows. *American. Journal of Veterinary Resarsch* 67: 472 – 478

Shivhare M, Dhurvey M, Gupta VK, Nema SP, Mehta HK, Jain R, Singh N and Shakya V. 2012. Infertility due to fallopian tube affections. *DHR International Journal of Biomedical and Life Sciences (DHR-IJBLS)* ISSN 2278-8301: 3(1)

Shoemaker RW, Read EK, Duke T and Wilson DG. 2004. In situ coagulation and transection of the ovarian pedicle: an alternative to laparoscopic ovariectomy in juvenile horses. *Canadian Journal of Veterinary Research* 68(1): 27–32

Semm K. 1992. *Pelviscopy: Operative Guidelines*. UFK, Kiel, Germany

Silva LCLC, Stopiglia AJ and Fantoni DT. 2002. Tecnica de biopsia hepatica em equino por laparoscopia. *Ciencia Rural* 32: 459–465

Sirard MA and Lambert RD. 1985. In vitro fertilization of bovine follicular oocytes obtained by laparoscopy. *Biology of Reproduction* 33: 487–94

Sisson S, Grossman JD and Getty R. 1975. Sisson and Grossman's- The anatomy of domestic animals. 5th edition. Philadelphia: Saunders.

Smith I, Benzie RJ, Gordon NLM, Kelman GR and Swapp GW. 1970. Cardiovascular Effects of Peritoneal Insufflation of Carbon Dioxide for Laparoscopy. *British Medical Journal* 3: 410-411

Smith LJ and Mair TS. 2008. Unilateral and bilateral laparoscopic ovariectomy of mares by electrocautery. *Veterinary Record* 163(10): 297-300

Sofi KA. 2015. Ultrasonographic and laparoscopic studies on genitalia of abandoned cows. Ph D Thesis. Department of gynaecology and obstetrics, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India.

Spaner SJ and Warnock GL. 1997. A brief history of endoscopy, laparoscopy and laparoscopic surgery. *Journal of Laparoendoscopic* & *Advanced Surgical Techniques and Videoscopy* 7(6): 369-73

Steiner A and Zulauf M. 1999. Diagnostic laparoscopy in the cow. *Schweizer Archiv Fur Tierheilkunde* 141: 397-406

Stewart SG, Johnston JK and Parente EJ. 2014. Hand-assisted laparoscopic repair of a grade IV rectal tear in a postparturient mare. *American. Journal of Veterinary Resarsch* 245(9): 1041

Sutter WW and Hardy J. 2004. Laparoscopic Repair of a Small Intestinal Mesenteric Rent in a Broodmare. *Veterinary Surgery* 33: 92-95

Tabet AF, Silva LCLC, Sinhorini IL and Zoppa ALV. 2005. Comparacao entre duas tecnicas de biopsia renal guiadas por laparoscopia em equ¨inos. *Brazilian Journal* of *Veterinary Research and Animal Science* 42: 150–156

Tams TR. 1990. Gastroscopy. In: Tams TR (ed.). *Small Animal Endoscopy*. *St. Louis, C V Mosby*, 89-166.

Tear M. 2011. Small animal surgical nursing. 2nd edition. Page 202

Trostle SS, White NA, Donaldson L, Freeman LJ, Hendrickson DA. 1998. Laparoscopic Colopexy in Horses. *Veterinary Surgery* 27: 56 - 63

Tung PH and Smith CD. 1999. Laparoscopic insufflation with room air causes exaggerated interleukine-6 response. *Surgical Endoscopy* 13: 473–5

Tuohy JL, Hendrickson DA, Hendrix SM, and Bohanon TC. 2009. Standing laparoscopic repair of a ruptured urinary bladder in a mature draught horse. *Equine Veterinary Education* 21(5): 257–261

Twedt DC. 1999. Laparoscopy of the liver and pancreas. In: TAMS, T.R.: Small animal endoscopy. *Mosby, St. Luis* 409-418

Veres J. 1938. Neues instrument zur ausfuhrung von brustoder bachpunktionen und pneumothorax behundlung. *Deutsche Medizinische Wochenschrift* 64: 1480 – 1481

Walesby HA, Ragle CA, and Booth LC. 2002. Laparoscopic repair of ruptured urinary bladder in a stallion. *American Journal of Veterinary Resarsch* 221(12): 1715–1741

Whitehair CK, Dasilva RB and Anes NK. 1988. Live biopsy in cattle. *Bovine Practice* 23: 144-147

Williams MD and Murr PC. 1993. Laparoscopic Insufflation of the Abdomen Depresses Cardiopulmonary Function. *Surgical Endoscopy* 7: 12 - 16

Wilson AD and Ferguson JG. 1984. Use of a flexible fiberoptic laparoscope as a diagnostic aid in cattle. *Canadian Veterinary Journal* 25: 229–34

Wishart DF and Snowball JB. 1973. Endoscopy in Cattle: Observation of the Ovary in Situ. *Veterinary Record* 92: 139 - 143

Witherspoon DM, Talbot RB. 1970. Ovulation Site in the Mare. *American Journal of Veterinary Research* 157: 1457-1459

Witherspoon DM, Kraemer DC and Seager SW. 1980. Laparoscopy in the horse. In: *Animal Laparoscopy* (ed. R.M. Harrison & D.E. Wildt): 157 – 167. Williams & Wilkins, Baltimore, MD.

Yanmaz LE, Okumus Z and Dogan E. 2007. Laparoscopic Surgery in Veterinary Medicine. *Veterinary Research* 1: 23-39

Zade PR, Manjulkar GP, Mehesare SP, Pawshe DB and Waghmare SP. 2007. Laparoscopy: advancement in veterinary practice. *Veterinary World* 6(1): 23-26

Zollikofer R. 1924. Zur laparoskopie. (In German). *Schweizerische medizinische Wochenschrift* 5: 264-265

**<u>Brief Resume of the Student</u>**

| | |
|---|---|
| **Name:** | Priyanka Thakur |
| **Father's Name:** | Sh. Nihal Singh |
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**Academic Qualifications:**

| **Qualification** | **Year** | **School/Board/University** | **Marks (%)** | **Division** |
|---|---|---|---|---|
| $10^{th}$ Class | 2005 | Govt. Sr. Sec. school, Arsoo (H.P Board) | 87.71 % | $1^{st}$ |
| $12^{th}$ Class | 2008 | Govt. Sr. Sec. school, Nirmand (H.P Board) | 77.4 % | $1^{st}$ |
| B.V.Sc & A.H | 2014 | COVAS, C.S.K.H.P.K.V, Palampur, Himachal Pradesh | 69.6 % | $1^{st}$ |
| M.V.Sc | 2016 | COVAS, C.S.K.H.P.K.V, Palampur, Himachal Pradesh | 7.87 % | $1^{st}$ |

Fellowships/Scholarships/Gold Medals/Awards/Any Other Distinction: Scholarship and Fellowship in MVSc

Publications:

Total: 1

- Research papers (in peered journals): 1
- Scientific Popular Articles: Nil
- Others: Nil

Visits abroad along with duration and purpose of visit: Nil

Any other Remarks: Nil