Veterinary Research 1 (1): 23-39, 2007

Laparoscopic Surgery in Veterinary Medicine

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Abstract: In recent years, laparoscopy has gained a great acceptance in veterinary medicine. Laparoscopic surgery is minimally invasive and traumatic in animals. For laparoscopy, the animal rapidly turns its normal physical condition. Laparoscopy allows safe biopsy in several organs such as kidney, liver, pancreas and intestine. It also assists some surgical procedures such as cryptorchidectomy, abomasopexy, colopexy, castration and adhesiolysis. To perform laparoscopy, the surgeon should know abdominal topography. Laparoscopy requires expensive instruments that can also be used to other endoscopic procedures. This study with application of laparoscopy in veterinary surgery with advantages and disadvantages.

Key words: Laparoscopy, biopsy, surgery, veterinary medicine, topography

INTRODUCTON

Laparoscopy is one of the least invasive surgical technique that employs a telescope-enclosed transabdominally to examine organs within the abdominal and pelvic cavities. Throughout laparoscopy, the laparoscopist can search the abdominal organs and peritoneal surfaces for evidence of disease and perform surgical procedures. The objective of this study is to discuss application of laparoscopy in veterinary surgery with advantages and disadvantages.

To examine the cervix, the Arabian physician Albukasým was probably the first to use reflected light. In 1853, Desormeaux improved using a combination of alcohol and turpentine on a candle to supply lighting via an open tube for endoscopy. One of the disadvantages in this approach was thermal trauma to the organs being examined. In 1901 George Kelling was firstly performed laparoscopy in the peritoneal cavity. Oxygen filtered via sterile cotton and a cystoscope to examine the abdominal contents of live dogs was used by George Kelling (Hendrickson, 2000;://www.equinelaparoscopy.com/whatis.htm, 2006; Ricardo *et al*., 2003).

Zollikofer recommended the use of carbon dioxide to acquire pneumoperitoneum, so as to decrease pain and thermal complications. Kalk was able to simultaneously pass instruments into the abdomen by using a new lens system (135° angle) and a dual-trochar technique. Fervers published the first laparoscopic interventions in the 1930s. Adhesiolysis and diagnostic biopsy of abdominal organs were performed by Fervers. Cold light fiberglass illumination was developed by Fourestier, Gladu and Valmiere in 1952. Laparoscopy became an essential part of gynecologic application in the 1960s and 1970s. The automated insufflators were developed by Semm in 1977 and insufflators increased the safety of laparoscopic examination (Hendrickson, 2000).

MATERIALS AND METHODS

Light source: Xenon, tungsten and halogen light sources are available. Xenon light has superiority over other sources of light. Xenon light is similar to the natural light and the colors of anatomic structures are very good for visualization. To perform laparoscopy in cattle, a 300-W xenon light source is suggested. Although light sources of less wattage (150 W) are not ideal, they can be used to perform laparoscopic procedures. Xenon light sources cannot be checked against halogen light sources because halogen shows significantly fewer lumens per watt (Keith and Richter, 2001; Hendrickson, 2000; Smith *et al*., 2005; Steve, 2000; Ricardo *et al*., 2003. Marie and Andre, 2005).

Light cable: The light source and the laparoscope are connected with light cables. Light cables carry cold and high-intensity light into the abdominal cavity. If a large-diameter (minimum 6 mm) light cable is used in laparoscopy, the abdominal cavity has a maximal illumination. Although a smaller diameter (4.5 mm) light cable is not ideal, it can be used to perform laparoscopic procedures under direct visualization. Optic fibers are delicate and for this reason the light cable should be

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handled with care. Optic fibers break with time and use, if it occurs the light cable should be replaced. When optic fibers break, they do not transmit light and black "holes" to become visible onto a white surface. The light cable should be replaced when the more than 20% of the optic fibers appear to be broken because visualization becomes deteriorate (Keith and Richter, 2001; Marie and Andre, 2005).

Laparoscope (Telescope): The telescope forwards light via fiber optic bundles to a focusing lens at the eyepiece. The laparoscopist can see abdomen directly through the eyepiece or connect video camera. The laparoscopes are classified according to diameter, length and viewing angle. Lengths vary from 13 to 60cm. Sizes are also variable within the range from 2.7 to 10 mm outside diameter. To obtain brighter images with a greater field of view, larger telescopes should be used. The telescopes viewing angles change between 0 and 70°. A scope with an angle of 0° (direct forward viewing) is more intuitional and using this telescope is not difficult, because of the object in front of the scope. If oblique scopes are preferred, viewing around corners or view relatively inaccessible region such as the dorsocranial aspect of the liver can be feasible. Through rotation of the scope, the field of view can be greatly improved. Oblique-angled scopes are complicated and require experience. A working channel is not found in most scopes, whereas "operating" scopes have a 5- or 6-mm channel for entrance of instruments into the abdomen. Operating scopes are often longer in order that instruments can be advanced through the channel. The limited capability to manipulate instruments passing through the channel is the disadvantages of an operating scope (Keith and Richter, 2001; Hendrickson, 2000).

Video laparoscopy: By means of video cameras the surgical field is seen onto a video monitor. Although video camera is not essential for the performance of diagnostic laparoscopy, it allows the laparoscopist to keep a distance from the operating field and also video camera allows to assistant doing the procedure as well. The CCD video camera mounted on the eyepiece of the scope can achieve video capabilities. CCD video cameras have high-resolution chips and they transfer the image electronically to a processor that the output of which is demonstrated on a high-resolution monitor. High-resolution images are magnified 5 to 15 times. Each of three-chip cameras contains primary colors (blue, red, green) and they provide superior image check against one-chip cameras (Keith and Richter, 2001; Hendrickson, 2000).

Trochar-cannula: The cannulas are used to place instruments into the body cavity. The cannulas are used for laparoscopy varying from 5 to 33 mm diameters. Reusable or disposable cannulas are available. A lot of cannulas have a Luer-Lock system to allow gas insufflation when instruments and telescope are in the abdomen. Disposable and nondisposable trochar-cannula systems are also available. The trochar has a security mechanism. The trochar has a pyramid cutting edge and a spring-loaded safety shield. As soon as the trochar to enter into the abdomen, the safety shield is pushed back into the cannula with an audible click. Thus, risk for trauma in intra-abdominal structures is minimized (Keith and Richter, 2001; Hendrickson, 2000; Ricardo *et al*., 2003).

Trochars are the components part of the cannulas and blunt or sharp trochars are existent. Sharp trochars are used for after insufflation, thus intestine or other organs injury risk is minimize, whereas blunt trochars are used in open laparotomy. Small laparotomy incision is made in the skin and blunt trochar is introduced into the abdomen through a cannula. This method decreases the risk for injury in the deeper structures. As a disadvantage of this method, because incision is too large, carbon dioxide escapes from the cannula (Keith and Richter, 2001; Hendrickson, 2000; Marie and Andre, 2005).

Surgical instruments: Different instruments are available for diagnostic and therapeutic laparoscopy. Almost all instruments used in open surgery are present as extended narrower versions of standard surgical instruments. In most surgical procedures, blunt metal calibrated probes, suction tips, cautery instruments, grasping forceps, "Spoon"-or "Clamshell"-style biopsy forceps, vascular clip applicators, stapling and suturing devices and retractors are used. Stapling equipment is used for vessel ligation, bowel resections and organ removal among other things (Keith and Richter, 2001; Hendrickson, 2000; Alberto *et al*., 2006; Laproscopy, 2004; Ricardo *et al*., 2003; Marie and Ander, 2005).

Insufflation system: To observe abdominal organs and inserted the trochars and cannulas safely, pneumoperitoneum should be established. This is accomplished by Veress needle with connection to a carbon dioxide insufflation tube. Veress needle has a blunt inside portion and sharp outside portion with spring loaded. As soon as the Veress needle enters the abdomen blunt portion protrudes beyond the cannula. The protruding trochar tip decreases the risk for injury in intra-abdominal structures (Keith and Richter, 2001; Routhuizen, 1985; Hendrickson, 2000; Smith *et al*., 2005; Ricardo *et al*., 2003;Marie and Andre, 2005).

Gas insufflation can be achieved with hand, but many possible complications do not occur when an automatic gas insufflator is used. A gas insufflator has an internal gas portion. The intra-abdominal pressure, the volume of gas utilized and the gas flow rate into the abdomen are recorded. When the intra-abdominal gas is not enough to perform the procedure, the gas is automatically refilled (Keith and Richter, 2001; Routhuizen, 1985; Hendrickson, 2000; Smith *et al*., 2005; Laparoscopy, 2004; www.equine laparoscopy.com; Marie and Andre, 2005).

One of the most gases used in an abdominal insufflation is carbon dioxide. Carbon dioxide has a wider margin of safety with respect to gas emboli, high solubility in blood and expired in the lungs. For this reason carbon dioxide is chosen over room air, oxygen and nitrous oxide. However, the pneumoperitoneum induced with carbon dioxide can cause opposite local and systemic effects such as embolism, hypercapnia, acidosis, or arrhythmia. Continuing an intra-abdominal pressure of 15 mm Hg diminishes the undesired side effects (Laparoscopy, 2004; Marie and Andere, 2005).

LAPAROSCOPY IN DOGS AND CATS

General technique of laparoscopy: Laparoscopy is commonly achieved under general anesthesia. If the bladder and stomach are empty, the examination can be performed safely. If the bladder is not empty, it should be manually evacuated to avoid accidental bladder puncture. Visualization of the liver diminishes when the stomach is full. The procedure and organ being examined determine the position of the patient and location of the various puncture sites (Keith and Richter, 2001).

The patient is positioned left lateral recumbecy at 45° angle. The ventral abdomen is prepared for surgically aseptic rules. Telescope is inserted the right flank and Veress needle is introduced in umbilicus. In laparoscopy the first step is induction of the pneumoperitoneum. The Veress needle is inserted near the umbilicus through a skin incision with a number 11 blade. When the Veress needle penetrates the abdominal wall, the inside portion is protruded beyond the sharp outside portion to avoid the trauma in abdominal organs. To correct intra-abdominal placement of the insufflation needle, a 12-mL syringe filled with about 8 mL of saline is connected to the Veress needle. If the syringe is in correct position, the negative pressure is aspirated. In comeback gas bubbles, bowel contents, urine, or blood should not be seen. If Veress needle is in correct position in abdominal cavity, the saline should flow with no resistance (Keith and Richter, 2001; Routhuizen, 1985).

When the accurate position of the Veress needle is corrected, flexible tubing is to combine with the Veress needle to the insufflator and insufflation of carbon dioxide at a flow rate of 1 L/min is begun. When the insufflation begins, rate flow pressure can be between 5 and 25 mm Hg. Then using an automatic insufflator the intra-abdominal pressure raises about 15 mm Hg. Trampoline effects on the palpation demonstrate an adequate pneumoperitoneum. Care must be taken, because overdistention may cause decrease in ventilation or venous return. When the adequate pneumoperitoneum degree is achieved, a 1-cm skin incision is made on the right side between the last rib and the flank for insertion of the laparoscope for examination of the liver. The incision region is collimated in a cranial direction for large animals and in a caudal direction for small animals, considering the size of the liver. If the telescope is inserted too close to related organs, examination can be more difficult. Trochars and cannulas are inserted into the abdomen with a twisting motion. Holding the cannula with the index finger throughout the shaft nearly 3 cm from the tip avoids accidentally insertion of the assembly too far into the abdomen. When the trochar enters the abdomen-induced pneumoperitoneum, whistle sound can be heard. Then the trochar is removed into the cannula and telescope passes through the cannula to the abdomen. The remote light source with fiber optic light cable is connected to the telescope to examine abdominal organs. If a video camera is used, it is connected to the telescope eyepiece. Abdomen is examined superficially and the entry site of Veress needle is visualized. Veress needle is removed directly visualization and gas line is connected to the first cannula. If accessory cannula is required, the skin incision is extended and additional cannulas inserted into the abdomen through this incision. This application is performed directly visualization to prevent abdominal injury. If there is significant ascites in the abdominal cavity, this is removed from the region beginning of the procedure. This is practicable with suction probe placed via the second cannula.

The abdominal cavity is examined by regular method. Frequently, once the telescope enters the abdominal cavity, the omentum is covered the scope, preventing good visualization. The omentum is inserted the telescope tip and omentum slowly withdrawing until the omentum falls off, or the blunt probe placed through an accessory cannula can be used to remove omentum onto the telescope. Probe also can be used for the abdominal structures examination and palpation. During biopsy procedures the tip of telescope may become dirty and clouded. To remove the dirt from the lens, tip of telescope can be slowly wiped against a clean surface such as kidney, liver, intestine and omentum. This may need to be repeated a few times, but it often clears the lens completely and allows continuation of the procedure. If

the lens remains dirty, telescope should be removed and telescope clean with sterile pad or gauze pad with alcohol. Before finishing procedure, biopsy sites should be controlled for hemorrhage. If bleeding is present, it should be controlled. If there is ascites in operation site, this should be removed from suction tube. Laparoscopist is controlled the abdomen before the instruments are removed from into the abdominal cavity.

The abdominal gas is evacuated by opening the valves on all cannulas. During the abdominal gas is evacuated, gently pressure should be applied to the abdomen. The trochar and cannulas portal sites are sutured in a routine manner (Keith and Richter, 2001).

Examination of the liver and pancreas

Indications: The laparoscopic assessment of the liver or pancreas indicates most of pancreatic diseases and hepatobiliary diseases. Laparoscopic examination frequently allows directly visualization of abnormalities detected by ultrasound. Owing to laparoscopy, the gallbladder can be palpated with a blunt probe and if the duodenum traces, common bile duct can be seen.

With laparoscopy, biopsy can be directly obtained from the liver and kidney. The standard of the biopsy sample obtained via laparoscopy is far superior to getting by needle biopsy or fine needle aspiration. Needle biopsy was poorly assessed inflammatory disease and vascular abnormalities as compared with laparoscopic biopsy. Geographic difference and the limited specimen dimension may declare failure in these cases. The biopsies of liver with guided-ultrasound can be traumatizing other structures or difficult to use, whereas the laparoscopic biopsies can be achieved. In addition, laparoscopic biopsies can access to all lobes and do not cause trauma to the other organs. Fine needle aspirations are also frequency untrustable in mixed cases. Furthermore, direct visualization of biopsy site improves clinician's skill to accord histological and gross findings. And if there is a heterogeneity in the liver such as nodular hyperplasia, inflammatory disease and certain cases of neoplasia can be determined via laparoscopic biopsy. Pancreatic biopsy in dogs and cats can be accomplished confidentially with laparoscopy (Keith and Richter, 2001).

Patient preparation: The ultrasound examination always should be done before laparoscopic examination. An ultrasound examination helps to characterize whether the liver has a local or diffuse lesions and determine the patency of the common bile duct, also permit the assessment for the exist of fluid-filled parenchymal structures. The existence of local lesions in areas is not easy to see through laparoscopy, which may affect patient positioning or the laparoscopic method. Furthermore, all of the abdomen can be evaluated if there is a disease. If ascites is present, it is frequently easier to evacuate this fluid with paracentesis before laparoscopy. The presence of fluid also can be detected by the visualization of pancreas and liver. Although the fluid would be a clear transudation, if this transudation has a small amount of blood, consequently, the visualization becomes blurry.

For examination of the pancreas and liver, the patient's position is left lateral oblique recumbency with a 45° angle. The insertion side of the telescope should be placed right flank and just ventrally the lumbar muscles and between the last rib and iliac crest. The insertion site of the telescope is adjusted in a cranial direction in microhepatic patients. The insertion side of the telescope is adjusted caudally in hapatomegalia patients because of spacious working area. This method also allows visualization of the gallbladder, common bile duct, right limb of the pancreas, duodenum, stomach and most of the liver. Only an amount of left lateral lobe might not be seen for this approach. The left limb of the pancreas is not often visualized with any approach due to overlying omentum, stomach and intestine. If the left lateral lobe of the liver is examined, the patient is positioned right lateral oblique recumbency. This approach also allows visualization of the spleen for splenic biopsy or splenic aspiration for culturing.

Technique for examination of the liver and pancreas: After the telescope and accessory cannulas are introduced into the abdomen, a blunt probe is placed into the abdomen for palpation and manipulating the liver. The probe is firstly used for scanning the omentum in a caudal direction. The color, pattern of lobes, surface texture, nodularity, size, margins and local abnormalities of the liver are recorded. And then, the blunt probe is used to evaluate of the liver dorsal surface. Then the gallbladder is examined. Its visualization and size are recorded. The blunt probe is used to determine the distension of the gallbladder. By using the blunt probe to gently lift the liver is examined for neck of gallbladder, cystic duct and common bile duct. The telescope is placed under the liver lobe for lifting, when a blunt probe is used to examine neck of the gallbladder. To see the common bile duct, the probe should be used to move by tracing of the cystic duct. At this level, hepatic bile ducts can be seen entering the common bile duct. Furthermore, the portal vein and caudal vena cava may be seen at this level. The common bile duct can be seen upon insertion into the duodenum. In obese animals, this can be very difficult. As much omentum as possible should be removed from the visualization of the liver.

If there is patency of the biliary system, hepatic biopsy is usually necessary to establish a diagnosis. If there is biliary obstruction, attempts should be made to determine the level of the obstruction and presence of a mass in the area of the bile duct. And, if a mass is seen, biopsy is generally achieved with spoon or clamshell forceps.

Examination of the pancreas can be achieved with a blunt probe to lift up the duodenum by hooking the mesenteric surface. Then, the probe is used to push the duodenum lateral and caudal direction, because pancreas lies the other side depending on the patient. When the pancreas is seen, environment structure is recorded with color and consistency. Color of normal pancreas is beige and pink. Pancreatitis is characterized by thickened pancreatic tissues and sometimes pancreas is not seen. Sometimes manipulation of the duodenum is very difficult. In these instances, laparoscopic Babcock forceps are used for successful manipulation of the duodenum.

Hepatic and pancreatic biopsy: With Spoon or Clamshell biopsy instrument, hepatic and pancreatic biopsy can be obtained via laparoscopy. These instruments have 5 mm diameters and get into the abdomen via an operating telescope channel or accessory cannula. These instruments minimize organ trauma and bleeding. Moreover, these instruments have generally electrocute ability. If these biopsy instruments are not available, needle biopsy instruments can be used for hepatic biopsy. Automatic needles such as monopty needles are preferred, because these needles are used for one hand and the other hand is used for telescope to count the visualization.

After the examination of abdominal cavity, acceptable sites of the liver re selected for biopsy. Dorsal or ventral side of the liver can be biopsied. Ventral side technically is easier for biopsy, if there is a hemorrhage, which can be easily determined and controlled. The biopsy forceps are placed into the liver with the jaws in open position and then jaws are closed and the hand gently twisting when the forceps pull apart the specimen to the liver. This usually causes less bleeding comparing to pulling the forceps straight out of the liver, which can tear large pieces of tissue. If specimens are desired from the deeper tissue than surfaces tissue, biopsy forceps are introduced into the abdomen closed position and then the jaws are opened in the biopsy sites, specimen removed by twisting motion.

To perform pancreatic biopsy, pancreas should be in the visualization. Similar biopsy forceps as hepatic biopsy are used for pancreatic biopsy. In some instances, holding the pancreas in place is difficult. In these instances, accessory cannulas can be used. One cannula introduced into the abdominal cavity to hold the pancreas in place, when the other cannula performing the biopsy procedure.

If there is an excessive bleeding in biopsy site, the blunt probe can be used to put gentle pressure on this area for few minutes. Electrocute can be applied, when the bleeding continues. Most biopsy forceps are equipped with electrocute ability. The clinician must be aware of the right amount of power to perform with electrocute. Otherwise, firstly low power is applied and then increased it as needed. It is important to perform suction before cautery to keep biopsy sites as dry as possible. Before the completing the procedure, the biopsy site is controlled with whether there is a bleeding or not (Keith and Richter, 2001).

Examination of the genitourinary tract

Indications: One of the most common indications of laparoscopy is renal biopsy in urinary system. Laparoscopy is used when a renal biopsy cannot be achieved with ultrasound or the patient operation is necessary for another reason. Generally, biopsies of the right kidney re obtained with laparoscopy. Because right kidney is placed more cranially, it may be difficult to push forward the needle safely via ultrasound. Laparoscopy provides direct visualization of the kidney; therefore it reduces the risk for trauma of surrounding tissues. If there is a major bleeding risk in a patient, laparoscopy is one of the confidential methods to obtain biopsy. Bleeding of the biopsy site is visualized via laparoscopy and if necessary, direct pressure is applied with a blunt probe for controlling the hemorrhage.

To examine mucosal surface of the bladder requires smaller telescops, for this reason mucosal surface is usually not evaluated through laparoscopy. However, mucosal surface of the bladder can be examined via laparoscopy. One indication of this is suspected of the bladder rupture. Sometimes, urethras can be examined via laparoscopy to relation between other structures.

In most cases laparoscopy allows the surgeon to examine reproductive tract. Laparoscopy can be used for ovarian activity, uterine size and evidence of tumor or neoplasia. If transcervical artificial insemination cannot be accomplished, transuterine route can be performed via laparoscopy. In male dogs, prostate can be seen through laparoscopy and guided biopsy can be obtained easily.

Technique for examination of the kidneys: Ultrasound examination should be performed before laparoscopy to evaluate the internal structure of the kidney. Relative contraindications of laparoscopic needle biopsies are renal cysts, urethral obstruction and hydronephrosis.

These can be detected with laparoscopy. The ultrasound allows to detect local lesions of kidney and also allows selections of kidney to be performed biopsy. Usually general anesthesia is used for biopsy of the kidney. To avoid accidental puncture of the bladder, it should be evacuated before the procedure. The patient is placed lateral recumbency opposite to the kidney being examined.

To introduce the telescope into the abdomen, cannula is placed a few centimeters caudal to the umbilicus and a few centimeters lateral to midline toward the side that is being examined. If hepatic and renal examinations are to be performed at the same time, this puncture generally is acceptable for both procedures. When the liver is examined, the animal is positioned at an oblique angle of 45° and when the kidney is examined, the animal is repositioned in lateral recumbency during the procedure. If right kidney is examined, the single puncture is necessary to introduce the telescope via cannula. If the left kidney examination is needed, the clinician should remove the cannula after evaluation of the liver and the patient is repositioned left lateral recumbency to examine left kidney. Left kidney is evaluated for position, texture and relation to adjacent tissues.

Examination of the kidney should be done for position, contour and relation to other structures. The right kidney should be placed in the caudal and nearly the caudate lobe of the liver. It is immediately lateral to the duodenum and pancreas. The left kidney is positioned to cranial and just lateral of the spleen. Both kidneys are generally covered with omentum. A blunt probe is introduced via accessory cannula that is used to scan the omentum to uncover the kidney. The normal kidney is pale purple color, smooth and oval shaped. Capsular blood vessels should be seen. In obese animals, perirenal fat generally prevents visualization of the kidney.

To obtain the kidney biopsy, generally biopsy needles such as Monopty or Asapty needles are preferred, because these instruments can be used one hand and the other hand can hold telescope for continuing the visualization. The needle is introduced the abdomen via a small stab incision in the skin using a number 11 blade. The needle is directly visualized and positioned just under the renal capsule or nearly the renal capsule. If the needle is introduced too far to the kidney, cortical tissue may be missed. The path of the needle should be planned parallel to the long axis. For histopathological tests, two or three specimen can be obtained. If there is a few hemorrhage, more samples can be taken for culture, electron microscopy, or immunofluorescence. If there is excessive bleeding, blunt probe is used to pressure to control bleeding in hemorrhagic site. The examination is finished as liver biopsy.

Examination of the bladder and reproductive tract: To examine urinary system and bladder, the patient is positioned in straight dorsal recumbency. The telescope is generally introduced into the abdomen, to cranial the umbilicus and near the midline, briefly just between the umbilicus and xyphoid. This approach allows visualization of the ovaries, uterine horns, uterine body, bladder and prostate. An accessory cannula can be introduced laterally to the a few centimeters of the telescope. A blunt palpation probe, forceps, or stapling equipment can be introduced into the abdomen via this accessory cannula. Palpation of the ovaries can be accomplished with this cannula. The ovaries can be palpated with this probe and examine follicular activity.

The bladder can be examined with a similar manner. The entry of the urethras can be visualized and the probe can be used for palpation of the bladder. Anfractuous serosal vessels should be seen on the surface of the bladder. If prostate biopsy is needed, the biopsy needle is introduced into the abdomen just nearly the prostate to obtain sample and then activated to cut biopsy.

Examination and biopsy of the gastrointestinal tract: Examination and biopsy of gastrointestinal system can be performed a limited degree through laparoscopy. In most cases, gastrointestinal system is examined via endoscopy or through open surgery. In some instances, only intestine biopsy is needed, this biopsy can be obtained through laparoscopy as noninvasively.

To examine intestinal system, patient's position is planned whether there is focal or diffuse lesion. If there is a focal lesion, the patient is positioned as close to the body wall as possible. If there is a diffuse lesion, the patient is positioned in the dorsal recumbency and telescope is introduced into the abdomen just near the umbilicus. Two accessory cannulas are introduced laterally to either side of the telescope. The Babcock forceps are introduced into the abdomen for this cannulas. The small intestines are then grasped with the Babcock forceps. Cannulas and forceps are removed from the abdomen, pulling the bowel out of the abdomen. When the bowel is outside of the body, biopsy is obtained as standard open surgery. Then, the intestine is properly closed and gently pushed back into the abdomen. In some instances, it can be difficult to replace the bowel into the abdomen. If this occurs, second Babcock forceps are used to gently pull to bowel into the abdomen via an accessory cannula (Keith and Richter, 2001).

LAPAROSCOPY IN CATTLE

Patient preparation: Presurgical diet is mandatory before performing laparoscopy. With diet, the rumen and large intestine contents decrease and the intestinal peristalsis reduces. Diet reduces the risk for abdominal organs perforating and improves the visualization. A 24-h diet is usually enough in dairy cows and thin beef cows. Roughage keeps back for 72 hs from heavy cows; they may be fed concentrated diet up to 24 h before the surgery. Diet is not necessary for calves less than 4 weeks olds before the surgery.

Performing rectal examination before a laparoscopic procedure in paralumbar fossa is generally necessary. This examination allows evaluation of the thickness of the body wall and localizes the abdominal structures and the portal sites and empty the rectum. When this examination is performed, the abdomen also is evaluated for any abnormalities, such as adhesions, masses, or dilated abdominal organs. If the laparoscopy is performed in standing position, it is advised that the cow be bathed before the procedure. Bath prevents contamination of the operating room and improves the sterility of procedure (Ricardo *et al*., 2003; John, 2006).

Patient restraint: To perform laparoscopy in standing position, docile animals can be placed in stocks, while aggressive animals should be placed in a squeeze chute. Exploratory standing laparoscopy on docile animals generally achieved with local anesthesia of the portal sites (8-10 mL of 2 % mepivacaine solution). Exploratory standing laparoscopy on aggressive animals usually is accomplished with sedation (The combination of xylazine 0.01 mg kg^{-1} intravenously and butorphanol tartrate 0.02 mg kg^{-1} in intravenously). When laparoscopy is performed on sedated animals placed in dorsal recumbecy, the nasal oxygen supplementation (15 L/min) is generally necessary. If the procedure is performed under general anesthesia, an orotracheal tube is placed immediately after induction and a positive-pressure ventilator is used to ventilate the animal before creating the pneumoperitoneum (Ricardo *et al*., 2003; John, 2006).

Basic laparoscopic surgical technique: Cows in standing position, two insertion sites are described for entry of the laparoscopic instruments. These sites are the vaginal fornix and the paralumbar fossa. To perform laparoscopic examination in cows in standing position, paralumbar fossa is suitable for entries of the cannulas and the telescope.

The cow's tail is tied opposite site of the surgery before surgical procedures. One or both paralumbar fossa are clipped and disinfected. Portal sites on the abdominal wall are infiltrated with a local anesthetic (8-10 mL of 2% mepivacaine solution per site).

A pneumoperitoneum can be achieved before or after the insertion of the laparoscopic cannula into the abdominal cavity. If the pneumoperitoneum is performed before the insertion of laparoscopic cannula into the abdomen, a 1-cm skin incision should be made and a 120-mm-long Veress needle, teat cannula, or 12F catheter is introduced into the abdominal cavity for this incision. Then laparoscopic cannula is connected to an insufflator and insufflation begins. If the pneumoperitoneum is performed after the insertion of laparoscopic cannula into the abdomen, a 1-cm skin incision should be made at portal site and then cannula introduced into the abdomen. After the insertion of the first cannula into the abdominal cavity, the trochar replaced with a 10-mm, 0 or 30° telescope with a video camera and fiber optic light cable connected. The intra-abdominal structures are rapidly examined whether there is a trauma caused by the cannula insertion. Tube connected with insufflator is attached the cannula and intra-abdominal pressure is arranged between 8 to 12 mm Hg (Ricardo, 2003; John, 2006).

The procedure of exploratory laparoscopy begins the right paralumbar fossa. Laparoscopic cannula is introduced into the middle of the paralumbar fossa, dorsally to cross of the internal oblique muscle. Laparoscopic instruments and palpation probes are introduced into the abdominal cavity via cannulas and their portal sites are generally located 4 to 6 cm right or left side the telescope. To avoid abdominal injury, cannulas should be introduced into the abdomen under telescope guidance. When forceps and scissors are used, the jaws are kept closed till the instrument attains the surgical site.

After the examination of the right paralumbar fossa, the left paralumbar fossa is examined. The left paralumbar fossa is usually occupied with rumen, for this reason the left paralumbar fossa provides limited exploration of the abdominal cavity. Laparoscopic cannula is introduced to caudodorsal direction for preventing injury of the rumen lumen. If cannula introduced in the rumen lumen accidentally, entry site of the cannula is enlarged dorsally and ventrally utilizing the sharp scissors. And then, a pair of Babcock forceps is used to grasp the rumen wall dorsal and ventral to the cannula. The rumen wall and cannula are removed from the abdomen by using the Babcock forceps. Rumen wall is sutured with routine pattern. The site is lavaged with 0.9% sodium chloride solution and replaced into the abdomen. The surgeon can continue laparoscopy using an open laparoscopic technique after

changing sterile gloves. When abdomen is examined the patient is positioned dorsal recumbency. Laparoscopic cannula's insertion side is 10 cm caudal to the xyphoid process and on the white line.

When the laparoscopy is completed, telescope is removed and carbon dioxide is evacuated through the open cannulas. When all gases are evacuated, the portal sites are sutured routine manner. If suture is applied before all gases are evacuated, subcutaneous emphysema around the surgical sites can occur and consequently causes postoperative discomfort. If the procedure is completed without complications nonsteroidal anti-inflammatory drugs and systemic antibiotics are necessary for only 24 h after the surgery (Ricardo *et al*., 2003; John, 2006).

Indications

Reproductive system: The reproductive system is the first investigated part of the bovine laparoscopy. Lambert described an endoscopic procedure through the right paralumbar fossa to inspect the ovaries and follicular aspiration. Bernard used laparoscopy for observing ovulation in heifers. Today, the insemination of small ruminants and embryo transfer collections are obtained with these techniques (John, 2006).

Biopsies: Biopsy of the kidneys is accomplished with Franklin-Silverman biopsy needle. Before the needle is introduced 5 cm below the transverse processes and behind the last rib, the right paralumbar fossa is surgically prepared for insertion of the telescope. The biopsy is obtained by using the sharp part of the needle. Samples an average of 1.5 mm in diameter and 16 mm in length are obtained.

Kleim described intestinal biopsy technique. This technique is performed in calves and sheep placed under general anesthesia in dorsal recumbency. The intestine is held with forceps and removed from the abdomen and then biopsy is performed as open surgery (John, 2006).

Postoperative uterine torsion: Major ischemias of uterine blood vessels frequently occur after serious torsion of the uterus. Although successful interventions are made to correct this condition, uterus may remain feckless and be exposed to necrosis. Consequently, in complicated cases laparoscopic exploration by the right flank can be advantageous to determine the condition of the uterus. The color of the uterus, swollen ovaries and presence of thrombosis should be evaluated by the operator (John, 2006).

Incorrect positioning of the abomasum: After the abomasum is replaced in standard surgical procedure, it does not return normal digestive functions because of inadequate fixation. If abomasum is replaced, functional stenosis may occur from malpositioning or suturing errors. Laparoscopy is necessary for position of the faulty organ. If the suture is accidentally placed the cranial duodenum creating a kink, the digestive transit will slow down and cause an abomasal reflux toward the rumen. Laparoscopy also allows the excising the suture and correcting this condition (Ricardo *et al*., 2003. John, 2006). Displaced abomasum is replaced with three surgical techniques by laparoscopy (John, 2006).

Technique for correction and fixation of a left displaced abomasum: The laparoscopic-guided toggle pin fixation is done as described in Janowitz technique. This technique consists of two stages. The first stage of the procedure is performed through left flank in standing animal. The operating site is prepared as standard manner. Portal sites are infiltrated with lidocaine. The telescope introduced into the abdomen (placed to middle of the left paralumbar fossa) via 8-mm cannula. 5-mm accessory cannulas are inserted in 11th intercostal space to evacuate accumulated gas into the abomasum and toogle pin is introduced into the abdomen through this accessory cannula. A Veress needle is introduced into the abdomen via a cutaneous incision 1 cm in length and then a pneumoperitoneum is created. An 8-mm cannula is inserted in the abdomen. Then trochar is replaced with telescope. Abdominal cavity is examined to determine whether there is a risk for continuing the procedure. A 5-mm cannula is then introduced into the abdomen in 11^{th} intercostal space under direct visualization. A 5-mm trocar is passed through this cannula and inserted into the greater curvature of the abomasum. The modified toggle (toggle with two suture materials) is inserted into the abdomen through this cannula and toogle is pushed into the abomasum with a blunt-ended trocar. The two suture materials are left in place in the abdomen and gas in the abomasum is evacuated via the trocar. After all instruments are removed, the incisions are closed in a routine manner.

The second stage of the procedure is performed when the patient is sedated (xylazine 40 mg intravenously) and positioned in dorsal recumbency. Cranial of the umbilicus and right paramedian region of the abdomen is prepared for surgery in a standard fashion. Portal sites are infiltrated with lidocaine. A 8-mm cannula (for telescope) is inserted into the abdomen right cranial to the umbilicus. The second cannula (5-mm) is inserted the abdomen 10 cm cranial to the first cannula. The two sutures are improved with grasping forceps and are removed via the second portal. Then, sutures are knotted together with the animal

positioned in right lateral recumbency to avoid extreme tension. Sutures are left place between 3 and 4 weeks (John, 2006).

Ventral laparoscopic abomasopexy: This technique is applied patient in dorsal recumbency. This method allows fixation of the abomasum. The cow is sedated (xylazine, 0,1 mg kg^{-1} intravenously) and positioned in dorsal recumbency. Cow's legs are tied with cables and the right hind limb slightly extended caudally. The xyphoid process to 10 cm caudal of the umbilicus and with a width of 20 cm each side of the ventral midline is surgically prepared.

Mini laparotomy about 1 cm is applied to the left of the umbilicus so as to laparoscopic cannula enters the abdomen. A 8-mm cannula is inserted in the abdominal cavity to cranially with a 45° angle via the abdominal wall before pneumoperitoneum creating. After the first cannula enters the abdominal cavity, abdomen infiltrates with insufflator.

During insufflation, rigid telescope (8 mm in diameter, 0° and 42 cm long) is introduced into the abdomen through first cannula. Telescope is attached with a 150-W halogen light source and a video camera. The abdominal insufflation continues until the cranial abdomen is certainly observable and the abomasum is no longer touching the ventral peritoneum. Abdominal cavity should be examined whether there is any abnormality.

A 10-mm cannula is introduced into the abdomen under direct visualization. Grasping forceps are inserted through this cannula. Grasping forceps are used to locate the abomasum and then to grasp the abomasum in the middle of its greater curvature, nearly 2 to 3 cm from the attachment of greater omentum. This site is fixation site.

Following skin incision, a 5.5-mm cannula is inserted into the abdomen. Needle holder is introduced into the abdomen through this cannula. Four 1-cm-long skin incisions are made throughout the abdominal fixation zone. These incisions are spaced 2.5 cm apart, reperpendicular to the ventral midline. Location between the umbilicus and the xyphoid process is the fixation zone. Fixation zone is 10 cm long and 3 to 5 cm to the right of the ventral midline.

Both surgeons are placed side-by-side just lateral right side of the cow. Grasping forceps and the needle are handled by surgeon 1. Telescope and needle holder are manipulated by surgeon 2. To perform abomasopexy, USP 2 polydioxanone suture material with a swaged-on curved needle is used. Straightening the needle is to make easy intracorporeal and extracorporeal manipulation of the needle. With one of the cutaneous incisions, the needle and suture material are introduced into the abdomen and then needle is grasped intra-abdominally using the needle holder. A pair of haemostatic forceps is used for holding free end of the suture material.

The serous and muscular layers of the abomasum are passed through the needle and suture material, running perpendicularly to the great curvature abomasum. The needle entry site in the abomasum is examined attentively whether there is a presence of gas and fluid leakage or not. Sutures are placed about 3 cm from the attachment of the greater omentum along the greater curvature of the abomasum. The needle is removed from with the same needle holder. The suture material is removed from the abdomen after a good contact between the abomasum and the abdominal wall. A pair of haemostatic forceps is used to hold the two ends of the suture material out of the abdomen. The exact position of abomasum is confirmed by pulling gently on the sutures, this also confirms any careless suture crossing during the procedure. The gas is exteriorized by opening the cannula. The sutures are knotted and cutaneous incisions are closed in a routine manner with polydioxanone material (John, 2006; David and Wilson, 2000).

Left flank laparoscopic abomasopexy: Christiansen developed the left flank laparoscopic abomasopexy technique for left displaced abomasum. This technique is the modification of the Janowitz technique. The difference is that the suture is brought ventrally, cranial to the umbilicus, with a specially designed long rod. The end of the rod is equipped with a retractable sharp needle where the sutures are placed in. All of the procedure is performed in standing position (John, 2006).

LAPAROSCOPY IN EQUINE

Endoscopic procedures of the gastrointestinal system: Abdominal Masses: One of the most common masses in equine is neoplasia and abscesses. The difference between neoplastic mass and abscess are difficult to determine. Lymphosarcoma, adenocarcinoma and leiomyosarcoma are the most common forms of abdominal neoplasia in horses. The determination of the mass type can be accomplished with direct endoscopic visualization of the abdominal cavity. If there is neoplastic lesion in the abdominal cavity, laparoscopy can be helpful to determine the anatomic evaluation of metastasis. Endoscopic biopsy instruments can be used to obtain biopsy of the mass. Endoscopy can be also performed to determine confirmation and location of intra-abdominal abscesses. Abscesses can be observed in parenchymal tissue such as the liver and spleen or near the intestinal system.

As piration of abscesses can be obtained carefully for gram staining and bacteriologic culturing.

This is accomplished with attaching a needle on the end of sterile artificial insemination pipette (Steve, 2000).

Spleen, liver, kidney: To obtain biopsy in these organs, patient is fasted for 24 h before the procedure. When the biopsy is performed on the standing position, patient is sedated (xylazine 0.01mg kg^{-1} intravenously) and, then portal sites are infiltrated with lidocaine. Biopsies can be obtained by using scissors or other biopsy forceps. Although hemorrhage from these biopsy sites is generally minimal, homeostasis can be achieved by using endoscopic bipolar cautery forceps (Steve, 2000).

Evaluation of the abdomen after surgery: Laparoscopy can be used for evaluation of the abdominal cavity after laparotomy. Standing and recumbent positions are suitable for performing this procedure. Selection of position depends on the location of adhesions. When the laparoscopy is performed in standing position, most of the urogenital system can be observed. Blunt instruments such as a Cherry dissector or Babcock forceps can be used to the adhesionolysis. If there is a hemorrhage in the operation side, endoscopic cautery can be used to control bleeding. The diagnosis and treatment of peritonitis can be determined via laparoscopy. Laparoscopy is generally useful to determine if there is a focal site of peritonitis. Definitive bacteriologic culturing is performed with an artificial insemination, when there is a fluid in the abdomen (Stave, 2000).

Colopexy: To perform this procedure, patient is positioned dorsal recumbency under general anesthesia. The teat cannula is introduced into the abdominal cavity at the level of the umbilicus after aseptic preparation and clipping the surgical site. When the cannula is introduced into the abdomen, the position of the teat cannula should be confirmed if it is in the peritoneal cavity or not. If the cannula is in the peritoneal cavity, the abdomen is insufflated with an insufflator until the level of intra-abdominal pressure reaches 15 mm Hg. To place cannula into the abdomen, a 1 cm skin incision is made just cranial to the umbilicus. Then trochar is replaced with telescope to observe placement of three accessory cannulas.

Fifteen centimeter lateral to the line alba in the left ventral abdomen is colopexy site. A 25-cm long parallel skin incision is made in colopexy site. Endoscopic Babcock forceps are placed into the abdomen by assistant to identify lateral tenia of the left ventral colon and retracts the forceps to the colopexy site. Suture starts extra-abdominally and then suture is grasped with endoscopic needle holders in the abdominal cavity. Then suture continues through the seromuscular layer of the colon across the width of the tenia. Suture is next passed through the internal and external rectus sheath to the outside of the abdominal cavity. This application continues, when the colopexy site is completely sutured. Accessory cannulas and colopexy site are closed as open surgery. In 10 to 14 days after surgery, patient returns normal physical activity and 90 days after surgery, a mature fibrous adhesion can occur (Stive, 2000; Marie *et al*., 2006).

Rectal tears: Rectal tears of the most aboral portion of the rectum and distal descending colon can be evaluated through laparoscopy. Severity and the location of the tear can be evaluated with laparoscopy in a standing position. Horses are sedated (xylazine - 0.8mg kg^{-1} intravenously) and the rectum is emptied before the procedure. The right paralumbar fossa is prepared aseptically. Placement sides of the cannula are infiltrated with lidocaine. Skin of midway between the last rib and tuber coxae about 12 cm ventral to the dorsal aspect of the tuber coxae is incised with stab. For insufflation of the abdomen, Veress needle is introduced into the abdomen through this incision. The position of the needle is examined with transrectal manipulation. After the insufflation, the Veress needle is replaced with cannula (12-mm diameter, 20 cm long). A second cannula (12-mm diameter, 10,5 cm long) is positioned 10 cm ventral to the first portal. A third trocar (6-mm diameter, 10,5 cm long) is positioned 2 cm caudal to the last rib. Laparoscopic scissors are used to make 3-cm incision in the rectum at different locations (30 to 50cm cranial to the anus). A suction/irrigation cannula (45-cm) is introduced into the abdomen to aspirate the blood and infection agent. Then, the abdomen is sutured with absorbable material attached to a curved needle. The abdomen is deflated through cannulas, before skin incisions are closed (Steve, 2000; Troy *et al*., 2000).

Endoscopic procedures of the urogenital system: A-Dorsally Recumbent: With laparoscopy, cryptorchidectomy, inguinal herniorrhaphy and castration can be performed in the dorsally recumbent horse (Donna, 2000).

Patient preparation and positioning: To perform laparoscopy, patient is fasted for 48 hours before the procedure. Horse is positioned in dorsal recumbency under general anesthesia. Trendelenburg position (head-up) is provided good visualization of the caudal abdomen (Standing exploratory laparoscopy, 2004; Marie and Andre, 2005; Donna, 2000).

Laparoscopic approach: The ventral abdomen is prepared for aseptic surgery. A 1-cm skin incision is performed at the umbilicus. The teat cannula is introduced into the abdomen through skin incision. Confirmation of the teat cannula is made. If the teat cannula is placed in the peritoneal cavity, the insufflation tubing is attached to the cannula. Then, the abdomen is distended to a pressure not exceeding 25 mm Hg. Teat cannula is replaced with cannula and telescope (10-mm diameter). Accessory cannula is introduced into the abdomen direct visualization (10 cm lateral to the midline and 10 to 15 cm cranial to the external inguinal ring on each side).

Indications:

Cryptorchidectomy: Cryptorchidectomy was one of the first procedure performed in the horse. Anamnesis and physical examination are mandatory as with any procedure. The patient is fasted for 48 h before the procedure. The procedure is performed under general anesthesia. The telescope and accessory cannulas are introduced into the abdomen as described previously. When the telescope directed caudally, the internal inguinal area is seen. If the internal inguinal anatomy is not disrupted with previous surgical manipulation, the abdominal testis is typically suspended from the vaginal process at the vaginal ring by its ligaments. The position of the abdominal testis is located just dorsal to the vaginal ring. The testis is seen in some instances, but most of the time, testis is not seen in the direct visualization. If the testis is not seen, traction can be performed to the ligament of the tail of the epididymis or the vas deferens with a Babcock forceps to bring the testis into view from under the bowel. Even if the traction is released, testis usually remains into view. Intracorporeal ligation is the preferred technique in laparoscopic cryptorchidectomy. A ligation loop is introduced into the abdomen through ipsilateral cannula. The testis is carefully grasped with an acute claw grasper placed through the contralateral instrument cannula. Proximal of the testis is tightened with ligating loop. The ligation is cut and endolaparoscopic scissors are used to transect spermatic vessels and vas deferens. If the patient is unilateral abdominal cryptorchid, the testis can be removed after enlarging the contralateral instrument cannula incision. If the patient is bilateral abdominal cryptorchid, the first testis is located in the lateral ligament of the bladder. The first testis is removed as previously described procedure. The other testis is free of its attachments and testis is removed under direct visualization through enlarged of one incision. When the testis is removed from the enlarged incision, the abdominal insufflation can be lost The surgeon can be used to insert fingers into the abdominal defect to prevent gas escape. Alternative cannula systems are used to prevent gas escapes. This cannula's allows maintenance of insufflation when the testis is removed from the abdomen.

Cryptorchidectomy in recumbent position has advantages as compared with standing position. It is easy to perform for examination because the patient is under general anesthesia. Both testes can easily be removed a single approach as compared with the standing position. Location of the testis in the standing position is easily detected as compared with recumbent position. However, manipulation is improved more in the recumbent position than in standing position (Marie and Andre, 2005; Donna, 2000).

Inguinal herniorraphy: Scrotal and inguinal hernias in foals are commonly observed as a congenital condition. The small intestine protrudes the abdomen through the vaginal ring, passes down the inguinal ring and then the small intestine is contained within the common vaginal tunics. One of the most common symptoms in inguinal hernia is scrotal enlargement. In some cases, the inguinal hernias have not a clinical sign, however, the more common anamnesis is abrupt abdominal pain. Generally, most surgeons advise unilateral castration in inguinal hernias. Sometimes, this method is unacceptable to the owner and an attempt to save the testis is made. Unfortunately, attempts to preserve testis can be difficult due to complications (Donna, 2000).

Laparoscopic scrotal herniorrhaphy in foals: The patient is positioned in dorsal recumbecy under general anesthesia. A teat cannula is introduced into the abdomen 3 cm lateral to the umbilicus and the abdomen is insufflated. When the abdomen insufflation is enough, the teat cannula is replaced with telescope. A 10 or 12-mm diameter accessory cannula is introduced into the abdomen 5 cm lateral to the ventral midline and 10 cm cranial to each external inguinal ring. Hernia is generally placed at normal condition, when the hindquarters are elevated, however, if this is not occur, the atraumatic grasping forceps can be used to apply gentle traction to return the herniated intestine into the abdomen. Castration is advised at the time of herniorrhapy and if the liveryman is in respection, bilateral castration is performed with herniorrhapy. The mesorchium and spermatic vessels are grasped and the testis is pulled into the abdomen by applying traction. Endolaparoscopic scissors are used to cut the ligament tail of the epididymis after coagulation. The mesorchium is broken down to develop a vascular

pedicle. A ligating loop is placed via the ipsilateral accessory cannula and the loop is manipulated with grasping forceps, which are introduced into the abdomen through contralateral accessory cannula. The loop is placed around the testicular vessels and vas deferens proximal to the testis. Testicular vessels, mesorchium and vas deferens are cut with endolaparoscopic scissors. The peritoneal margins of the vaginal ring are closed with endolaparoscopic staples. When both testis have been removed into the abdomen, abdomen is decompressed and the incisions in the abdominal fascia are closed with monofilament absorbable sutures and the skin is closed with routine fashion. The postoperative swelling is much less than normal scrotal herniorraphy and swelling is limited with portal sites. Scrotal and inguinal swelling do not occur. Exercise limitation is not necessary and foals can be returned normal physical condition in 24 h after surgery. Laparoscopic inguinal herniorrhaphy have several advantages. The herniated intestine can be seen without laparotomy. The umbilical structures can be seen. Both vaginal rings can be closed without the additional trauma associated with a second surgical approach, as is required with traditional herniorhaphy. The laparoscopic technique requires no dissection and staple closure of the vaginal ring is relatively easier than suture closure of the external inguinal ring (Donna, 2000).

Laparoscopic scrotal herniorrhaphy in mature stallions: Laparoscopic herniorrhaphy is indicated when preservation of the testis is desired. The ideal candidate would be the stallion with an asymptomatic hernia. Laparoscopic herniorrhaphy in stallions is performed under general anesthesia. When the hindquarters are elevated, the hernia frequently reduces spontaneously in the asymptomatic horse. When intestinal strangulation is available, gentle traction may be adequate to return the intestine to the abdomen, but in other cases, the vaginal ring needs to be enlarged by cutting it with endolaparoscopic scissors. When the hernia has been reduced, the peritoneum is elevated from around the vaginal ring with endolaparoscopic scissors with the aid of a dissecting forceps. A prosthetic mesh is positioned around the vas deferens and testicular vessels over the vaginal ring and is stapled in place with endolaparoscopic staples. The elevated peritoneum is closed over the mesh (Donna, 2000).

Laparoscopic castration: Castration can be performed all male horses. Most horses are castrated in one year old. Castration is generally performed with injectable anesthetics; however, sometimes this procedure can be performed in standing position. Traditionally, testes are removed through scrotal incisions. Low complication rate and quickly postoperative healing is major advantages of laparoscopic castration (`Troy *et al.*, 2000; Donna, 2000).

Laparoscopic castration of foals, juveniles and inguinal cryptorchids: The horse is positioned in dorsal recumbency under the general anesthesia. The ventral site is prepared in routine fashion. The abdomen is insufflated with an umbilical incision and the telescope is introduced into the abdomen before elevating the hindquarters into a Trendelenburg position. A 10 or 12-mm diameter accessory cannula is introduced into the abdomen under direct visualization 10 cm lateral to the midline 10 to 15 cm cranial to the external inguinal ring on each side. A Babcock forceps is introduced into the abdomen via an accessory cannula and a right-angle dissecting forceps is introduced into the abdomen via a second accessory cannula. The mesorchium and spermatic vessels are grasped. The testis is returned to the abdomen. Endolaparoscopic scissors are used to cut after the ligament to the tail of the epididymis is coagulated with electrocute. The ligating loop is introduced into the abdomen through the accessory cannula on the ipsilateral side and a grasping forceps is introduced into the abdomen through contralateral cannula. The testis is passed through the loop. The testis is grasped and testis is tightened in a proximal position with ligating loop. An acute claw grasper is introduced through tissue cannula to grasp testis. Endolaparoscopic scissors are used to cut the spermatic vessels and vas deferens distal to the ligature and the tissue cannula is used to remove the testis. The procedure is repeated on the either side. After completion of the procedure, the abdomen is decompressed. Instruments are removed and the fascial incisions and skin is closed with routine fashion.

Horses are observed for incision complications and allowed free exercise beginning 24 hours after procedure. The swelling is observed in portal sites after procedure. The scrotal swelling does not observe. Antibiotics are not routinely performed and phenylbutazone is performed orally at a rate of 2 to 4 mg kg^{-1} every 12 h (Donna, 2000).

Laparoscopic castration of stallions over 1 year of age: Laparoscopic castration can be performed stallions over 1 year of age, however, due to the larger testis size and decrease capacity of the vaginal ring to stretch, the vaginal ring must be enlarged to allow the testis to be returned to the abdomen. A right-angle dissecting forceps placed through the contralateral instrument cannula can be used to apply traction to the spermatic vessels. From the ipsilateral cannula, endolaparoscopic scissors are introduced into the abdomen and the fibrous vaginal ring is divided throughout its ventral border for a distance of about 2 cm. The scissors is replaced with a second

grasping forceps and testis is drew with its common vaginal tunic into the abdomen. After the ligament to the tail of the epididymis is coagulated with electrocute, it is divided with endolaparoscopic scissors and this relegates the testis to an intra-abdominal position. The testis is grasped with grasping forceps (placed through the instrument cannula on the contralateral side) and ligating loop (placed through the instrument cannula on the ipsilateral side) is manipulated into a position proximal to the testis and tightened. The region is controlled with hemorrhage and the edges of the vaginal ring are stapled with endolaparoscopic staples. The testis is removed from the abdomen after enlarging one of the accessory cannula incisions. The abdomen is decompressed and instruments are removed. The fascia and skin is sutured with routine fashion.

Postoperatively, horses are restricted to a stall with daily hand walking for 2 weeks. Antibiotics are not routinely performed and phenylbutazone is performed orally twice a day for 3 days at a rate of 4 mg kg^{-1} (Donna, 2000).

In situ ligation: Castration can be achieved by ligation and transection of the spermatic vessels and the ductus deferentis artery that escort with the vas deferens. The testis left in the abdomen undergoes vascular necrosis. Though this technique can be effective in any stallion, client cooperation and acknowledgment should be guaranteed preoperatively. Because there is no concern about a palpable testicular remnant in the inguinal cryptorchid, it is probably the ideal candidate in this case (Troy *et al*., 2000; Donna, 2000). The horse is positioned in dorsal recumbency under general anesthesia. The abdomen is prepared and draped for aseptic surgery. The abdomen is insufflated and telescope is inserted at the umbilicus. The hindquarters are elevated and a pair of 10- to 12-mm diameter accessory cannulas are placed 10 to 15 cm cranial to the external inguinal ring on either side of the abdomen. 5-mm accessory cannulas are introduced into the abdomen 2 cm medial to one of the larger instrument cannulas. A ligating loop is introduced into the abdomen through the 5-mm diameter cannula. A right-angle dissecting forceps is introduced into the abdomen through the contralateral side. This forceps is passed through the suture loop. An electrocute is used to coagulate distal of the spermatic vessels and vas deferens. The spremtic vessels and vasa deferens proximal to the coagulated tissue are transected using endolaparoscopic scissors. The ligating loop is placed and tightened proximal to the instrument. The region is controlled with hemorrhage. The abdomen is decompressed and fascial incisions and skin are sutured with routine fashion.

The testis can swell after the procedure and scrotal palpation can cause pain. Phenylbutazone is performed orally at a rate of 4 mg kg^{-1} twice a day for 3 days, followed by 2 mg kg^{-1} twice a day for 3 days. The patient starts exercise 24 h after the procedure (Donna, 2000).

B-standing position: Laparoscopy in standing position is usually used for the treatment and diagnosis of crytptorchidy in horses. Abdominal, partial abdominal and inguinal cryptorchids can be diagnosed and treated using standing laparoscopy. The diagnosis of other urogenital problems such as monorchism, anorchidism, testicular teratomas, ruptured bladder and inguinal hernias can be evaluated using laparoscopy in standing position. Previously, standing laparoscopy in the horse was used as a diagnostic tool to determine the side and location (abdominal or inguinal) of the testis. Now, standing laparoscopy in the horse is not only used in diagnosis but also used in treatment of cryptorchid testicles. Because the urogenital tract is obviously seen in standing laparoscopy, standing laparoscopy has an advantage over laparoscopy performed with the horse in dorsal recumbency. Standing laparoscopy allows to easily identified both inguinal rings and the corresponding mesorchium and vas deferens.

The surgeon performing the procedure must have adequate practice and knowledge about laparoscopy. Two knowledgeable surgeons are potentially required in cryptorcidectomy. The patient's behavior should also be evaluated when attempting to determine which procedure to perform. If an aggressive horse is only sedated to perform standing laparoscopy, it is not only difficult to perform procedure but also dangerous for the personnel and equipment. Standing laparoscopic cryptorchidectomy has advantages over dorsally recumbent laparoscopic cryptorcidectomies. These are better visualization of the inguinal region, more rapid return to performance and unnecessary performing general anesthesia. The inguinal region can be easily visualized without manipulation of the bowel. In addition, examination of hemorrhage after the ligation of the vessels is easier to determine in standing position (Troy *et al*., 2000; Hendrickson and David, 1996).

Patient preparation: The horses should be fasted for 18 to 48 h before the procedure. Fasting for 18 h is adequate for the experienced surgeon, whereas inexperienced surgeon, the horse must be fasted for 24 to 48 h before the procedure. The nonsteroidal anti-inflammatory drugs such as phenylbutazone (2.2 mg kg^{-1} orally every 12 h) or flunixin meglamine (1.1 mg kg^{-1} intravenously every 24 h)

is recommended. The selection of which antibiotics to use is depend on surgeon choice and should be considered depending on time of surgery and regional susceptibility to various microorganisms.

Stocks are used to restraining the horse. The tail is tied and wrapped to the either side of the operation region so that it cannot enter the surgical field. If the horse is unilateral cryptorchid, the related flank region must be clipped and prepared for aseptic surgery. If the horse is a right-sided cryptorchid, the left flank should be clipped though. If the horse is bilateral cryptorchid, the both flanks must be clipped and prepared for aseptic surgery. Xylazine (0.3 to 0.5 mg kg^{-1} intravenously) or detomidine (0.02 mg kg^{-1} intravenously) either alone or in combination with butorphanol (0.01 to 0.02 mg kg^{-1} intravenously) can be used in sedation of the horse. Another choice is to use intravenous sedation combined with caudal epidural sedation (Marie and Andre, 2005; Hendrickson and David, 1996).

Unilateral approach: The midway between the last rib and the distal of the tuber coxae is the incision site. A small incision is made through the skin. A 12-French trochar catheter is introduced into the peritoneal cavity. To avoid puncturing any vital organs, the trochar is directed caudally and ventrally toward the opposite Cox femoral joint. After abdominal catheter is placed correctly, a carbon dioxide insufflator connects to the catheter. 15 to 20 mm Hg is applied for distention of abdomen. The abdomen pressure is maintained at this level throughout the procedure. Distention decreases the risk of puncture in abdominal organs and helps to place instruments easily. The short trochars should not be used in standing position, because they can cause insufflation of the retroperitoneal space.

After the abdomen is distended, 10- to 11-mm wide by 15- to 20-cm long sharp trochar and cannulas are introduced into the abdomen through two more 1.5-cm skin incisions. Performing a slight stab incision into the external oblique muscle, trochar or cannula is easily penetrated into the abdomen. The first portal is introduced into the abdomen midway between the tuber coxae and last rib (about 6 to 10 cm dorsal to the initial stab incision). Telescope is introduced into the abdomen through this portal. The second portal is introduced into the abdomen 6 to 10 cm ventral to the initial stab incision.

The first trochar or cannula to be placed should be for the dorsal portal. After the placement of the first cannula, the trochar is replaced with telescope (the rigid 54-cm laparoscopic telescope). The telescope is connected with light source and camera. And then insufflator is connected with the first cannula. The 12-French trochar catheter can be removed from the abdomen and this site's incision is enlarged to introduce cannula or trochar. The other two trochars and cannulas can be introduced into the abdomen as described previously through the two ventral portal sites. These trochar and cannulas are introduced into the abdomen under direct visualization. And then, trochars are removed and the cannulas are used as accessory instruments portals. Firstly, inguinal region should be examined. The position of bladder and inguinal ring should be determined. If there is an intestine in the left inguinal region, Babcock forceps are introduced into the abdomen through accessory cannulas and can be used to push the intestine out of the way. The abdominal testis can generally be identified almost below the inguinal ring. The abdominal testis can also be placed between the inguinal ring and the bladder. If the testis is not seen easily, it can trace the mesorchium from the inguinal ring to the testis. When the testis is identified, it should be grasped with claw-grasping forceps and manipulated to ensure that all the testicular structures if present within the abdomen. Then, the testis is disengaged. The end loop is introduced into the abdomen through one of the instrument cannulas. 10-cm long knot protector should be introduced in the abdomen for feeding backwards the end loop. A 5-mm reducer is introduced in the abdomen through one of the cannulas. The 5-mm reducer feed into the knot protector and end loop. The knot pusher of the end loop is pushed into the abdomen till the loop of suture can be clearly determined. The testis is regrasped with an claw-grasping forceps that are placed back through the loop of suture. The loop must be passed around the testis. The mesorchium, mesoductus, ductus deferens and caudal epididymal ligament are entwined by loop. When the loop is placed as far proximal as possible, it is tightened. The knot protector and knot pusher are removed from the abdomen. The scissors are inserted into the abdomen one of the accessory cannulas. The long end of the suture is cut using 5-mm width laparoscopic suture scissors. These scissors are replaced 10-mm serrated scissors. The spermatic cord is cut 1 cm distal to the suture by using 10-mm serrated scissors. The spermatic cord is examined before the cutting, whether there is hemorrhage. If there is hemorrhage, another loop can be placed around the testis and cord. If there is no hemorrhage recorded, the cord can be completely cut. The incision between the instrument portals is enlarged to remove the testis from the abdomen. The cannulas are opened for decompression and then cannulas are removed from the abdomen. The incisions are closed with routine fashion.

There are some methods for manipulation and ligation of the testis. Injection of the spermatic tissue with local anesthetic (2% lidocaine or mepivacaine) before ligation and amputation of the testis is the most commonly used. This is accomplished by introducing either a 20- to 30-cm

18-gauge needle through the flank or a 10-French silastic urinary catheter inserted through an instrument cannula. If the local anesthetic is injected spermatic tissue, it decreases the movement of the horse during manipulation of the testis due to discomfort. Other ligation techniques are Endo-GIA and the endoclip. The testis should be manipulated and extended cranially to avoid bunching up of the tissues in both techniques. Then, the endo-GIA is placed transversely across the mesorchium and vas deferens. The endoscopic clip is generally performed through a multifire applicator. After identification of the mesorchium and vas deferens, the staple is placed across the tissue (Marie and Andre, 2005; Hendrickson and David, 1996).

Bilateral approach: Both flanks should be clipped and aseptically prepared for procedure. Because left-sided abdominal testes can be seen in higher prevalence, the surgery should first be preformed on the left side. The left testis can be removed from to the abdomen as described previously. Continuation of pneumoperitoneum must be monitored carefully, when performing surgery on both flanks, because escapes of gases make ligation of the other testis excessively difficult. To achieve this, the cannulas placed in the left side should be left in located place, with locked claw graspers holding on to the transected testis. If locking claw graspers are not present, an assistant can hold on to the testis while the operation is performed on the right side. If cannulas can be enough to maintain in both sides of the horse, both testes can be removed from the left side. This is achieved by firmly grasping the right testis with claw-grasping forceps. Then, it is passed ventral to the small colon or rectum. From the left side, the assistant should grasp the testicle with another grasping forceps. The testes are removed from the abdomen by combining the ventral two incisions. In addition, to facilitate removal of the testes from the left side, another trochar or cannula can be added in the last intercostal space on the left side. If this is not desired to perform, the ligated testis from the left side can be removed as described previously and the portal sites are sutured in routine fashion. And then, the abdomen is reinsufflated to perform same procedure in the right side. When the procedure is finished, the gas is decompressed and incisions are closed as routine fashion (Marie and Andre, 2005).

Inguinal testis: If the testis cannot be seen in the inguinal ring, the meorchium should be identified. Two grasping forceps are used to apply gentle traction to the mesorchium. This manipulation allows one to see the testis that is located abdominally. The inguinal testis is generally atrophied and this testis comes back into the abdomen by pulling through the inguinal ring. If the testis does not come back into the abdomen by gentling traction, the vaginal ring must be enlarged. The vaginal ring can be enlarged using 10-mm serrated scissors. When the testis is located into the abdomen, ligation, transection and removal of the testis is performed as described previously. If the vaginal ring is not enlarged excessively, it is not necessary to close. Endolaparoscopic staples can easily be applied, when the vaginal ring need to be closed.

For inguinal testis castration, an alternative technique is available. This procedure includes in situ destruction of the inguinal testis. This is accomplished by using a right-angled clamp. This clamp is performed to use clamping the vas deferens and the testicular artery and vein. After the tissue electrocauterization, the tissue is sharply transected and ligated with size o polydioxanone. This technique can be also performed the castration on a normally descended testicle of a juvenile horses (Marie and Andre, 2005).

Contra-indications of laparoscopy: Diaphragmatic hernia, extensive intra-abdominal adhesions, pyometra and severe cardiac dysfunction are contra-indicated in laparoscopy. Horses with strangulating or obstructive bowel disease that results in distended abdominal viscera should be approached cautiously, as the bowel can easily be penetrated when placing a trochar or cannula. Insufflation in diaphragmatic hernia can result in pneumothorax. In disease relation to obstructive intestine or strangulating that results in distended abdominal viscera, the trochar and cannula must be carefully introduced into the abdomen, because the intestine can easily be perforated when placing a cannula or trochar. Horses with lower airway respiratory disease under general anesthesia may be at higher risk for endoscopic abdominal procedures. For this reason, laparoscopy is contra-indicated in this condition (Routhuizen, 1985; Steve, 2000; Laparoscopy, 2004)

Complications in laparoscopic surgery: Major complications in laparoscopy are (1) patient and anesthetic selection, (2) trocar and cannula insertion, (3) pneumoperitoneum, (4) laparoscopic instrumentation and (5) specific operative procedures (Keith and Richter, 2001; Ludovic, 2005).

Patient and anesthetic selection: The patient's health risks, cost, time, the patient's behavior and specific condition determine the laparoscopic procedure (under general anesthesia or in the standing horse). The

application can be performed in standing position, if the patient is controlled. The application can be easily performed in standing position by using the analgesic and sedative combination. Using epidural anesthesia to perform laparoscopic surgery in standing position provides sufficient sedation. Calculating the correct dose of detomidine to perform the epidural anesthesia in horses is important. Excessive dose of detomidine can result in the horse becoming unsteady and fall into place in the stocks. The surgeon must know the volume of diluent to ensure that the drug injected epidurally reaches a specific sensory level and if the drug diffuse too far cranially, it causes hind limb ataxia. The central nervous system toxicity of lidocaine can be observed in horses. Approximately 6 g or 300 mL of a 2% solution is the maximum safe single infiltration dose that can be given to an adult horse.

When the horse is under general anesthesia and positioned in dorsal recumbency, normal respiratory and cardiovascular varieties can cause hypoxemia and hypercapnia. A decrease in the blood pH, an increase in the mean arterial pressure and a decrease in peripheral vascular resistance are the others variety of the cardiovascular system. Decreases in tidal volume and functional residual capacity are the others respiratory change. If intraabdominal pressures below 20 mm Hg, the cardiopulmonary system is least affected (Ludovic, 2005).

Trocar and cannula insertion: The gastrointestinal tract, genitourinary tract and major vessels can be injury, when the insufflation needle and subsequent trocar are introduced into the abdomen. The injury can occur during placement of the insufflation needle, which is placed without visual guidance. There are some techniques to avoid insufflation in subcutaneous, bowel, or retroperitoneal structures. Aspiration for blood or gastrointestinal fluid and injection of saline are the first technique. If gastrointestinal contents or blood are not found when aspirating and the saline is injected, the abdominal organs have not been penetrated. Intra-abdominal pressure is monitorized during the insufflation. If the pressure is not normally increasing, the placement of the needle should be controlled. Insufflation of gas should be done slowly, starting at 1 L min^{-1} and increasing slowly to the desired pressure of 12 to 15 mm Hg. The distension of abdomen should be symmetric. Asymmetric distention in the abdomen must be evocation the incorrect position of the insufflation needle. Before the insertion of the trochar and cannula into the abdomen, pneumoperitoneum must be created. Elevation of the abdominal wall while inserting the trocar helps the prevention of bowel penetration. While the trochar is inserted into the abdomen, the direction and force applied are important. The trocar should be inserted in the midline and directed caudally, thus avoiding the internal organs. Abrupt push or excessive force can cause intra-abdominal injury. When the telescope is introduced into the abdomen, abdominal organs should be evaluated carefully to determine injuries in the abdomen. The insertion of accessory cannulas has a lower risk of injury because they are placed with under direct visualization. When the cannula or trochar is introduced into the abdomen, the blood vessels within the abdomen can be injured. Before placement of additional trocars, the abdominal wall should be observed to determine the abdominal wall vessels.

The most commonly injured vessels for a ventral approach in laparoscopic surgery are the caudal epigastric artery and vein. The most commonly injured vessels for a lateral approach in laparoscopic surgery are the circumflex iliac artery and vein. The bleeding should be controlled to prevent hematoma. Ligation of the vessel, electrocute and application pressure prevents the hematoma of the rectus sheath.

Performing standing flank surgery, the trocar is carefully introduced. A trocar placed too high in the paralumbar fossa on the left side may graze the kidney, or if it is too low, the spleen may be injury. If the trochar is introduced into the abdomen in horses, cecum can be penetrated (Keith and Richter, 2001; Ludovic, 2005).

Pneumoperitoneum: Subcutaneous or retroperitoneal emphysema can occur, when the insufflation needle is not suitable position or the trocar site has a leakage from around. The subcutaneous air is generally painless and resolves spontaneously. If there is asymmetric abdominal distension and insufflation pressures higher than expected, the insufflation needle is incorrect position. Carbon dioxide is readily available, inexpensive and has a high diffusion coefficient, which may reduce the risk for a serious gas embolism. For these reasons, carbon dioxide is preferred gas for insufflation. Greater peritoneal irritation and subsequent postoperative pain are the major disadvantages. To decrease postoperative pain, the abdomen is decompressed after the procedure. This is achieved with pressing on the abdominal wall or using an aspiration cannulas (Keith and Richter, 2001; Ludovic, 2005).

Laparoscopic instrumentation: When the probe is within the peritoneal cavity, the tip should be kept in clear view of the video camera at all times, avoiding contact between the cautery tip and the adjacent bowel. Most complications in laparoscopy occur in learning phase. In some instances, using of laparoscopic instruments such as the electrocute or thermal injury from the laparoscopic light source cause complications. To prevent complications related with thermal injuries to the abdomen prolonged contact between the bowel and the end of the

endoscope should be avoided. To decrease the risk for abdominal injury from monopolar electrocute, the current should be at the lowest possible setting (Ludovic, 2005).

Cryptorchidectomy: Performing standing flank laparoscopic cryptorchidectomy has decreased the risks related to general anesthesia. The risk of incarceration of the bowel through the mesocolon can be occurred, when the both testis are removed with the same side in bilateral cryptorchidectomy. If the mesocolon is perforated, the potential for bowel incarceration can be decreased by keeping the perforation less than 1 cm in size, stapling the perforation, or just lifting the bowel to gain access to the opposite side (Standing exploratory Laparoscopy, 2006; Ludovic, 2005).

Advantages and disadvantages of laparoscopy: The most organs such as kidney, pancreas and liver can be biopsied without major surgery by laparoscopy. Laparoscopy can be performed in standing position without general anesthesia. Laparoscopy offers a unique view of the abdomen. Postoperative morbidity is low in laparoscopy and may save the horse from unnecessary laparotomy. In some cases laparoscopy will confirm that laparotomy indicated. Unlike laparotomy, laparoscopy can be performed frequently. Laparoscopy can be performed very quickly, which makes it the method of choice in liver dysfunction. The other advantage of the laparoscopy is very small skin incision.

The disadvantage of laparoscopy is that the instruments used in laparoscopy are expensive. However, the instruments can be used for some types of endoscopy. Skill level needed to perform the procedure is the other disadvantage. One of the major disadvantages of the laparoscopy is the restriction of the sense. Skills such as intracorporeal (within the body cavity) suturing necessitate comparatively practice to master (Rothuizen, 1985; Hendrickson, 2000; Standing exploratory Laparoscopy, 2006; Ricardo *et al*., 2003)

ACKNOWLEDGEMENT

The authors would like to thank Dr. Armagan Hayirli for editing this manuscript.

REFERENCES

Alberto Chiesa, O., Richard Cullison, David E. Anderson, Keesla Moulton, Larry D. Galuppo, Jurgen von Bredow. 2006. Development of a Technique for Serial Bilateral Renal Biopsy in Steers. Can. J. Vet. Res., 70: 87-93.

David G. Wilson, 2000. Dorsally Recumbent Male Equine Urogenital Endoscopic Surgery. Vet. Clin. North Am: Equine Pract., 16: 285-299.

Dean A. Hendrickson, 2000. History And Instrumentation of Laparoscopic Surgery. Vet. Clin. North Am.: Equine Pract., 16: 233-250.

Dean, A. Hendrickson and David G. Wilson, 1996. Instrumentation and Techniques for Laparoscopic and Thoracoscopic Surgery in The Horse. Vet. Clin. North Am.: Equine Pract., 12: 235-259.

Donna, L. Shettko, 2000. Complications in Laparoscopic Surgery. Vet. Clin.North Am.: Equine Pract., 16: 377-383.

http://www.equinelaparoscopy.com/whatis.htm. ivnu. 18:12.2006.

John, P. Walmsley, 2006. Diagnostic Laparoscopy in the Horse. Soc. Ital. Vet. per Equini, Sive-12.

Keith, P. Richter, 2001. Laparoscopy In Dogs And Cats. Vet. Clin. North Am.: Small Animal Pract., 31: 707-727.

Ludovic Boure, 2005: Med Vet, MSc, DES. General Principles of Laparoscopy. Vet. Clin. Food Anim. Pract., 21: 227-249.

Marie Babkine andre Desrochers, Ludovic Boure, Pierre Helie. 2006. Ventral Laparoscopic Abomasopexy on Adult Cows. Can. Vet. J., 47: 343-348.

Marie Babkine, Andre Desrochers, 2005. Laparoscopic Surgery in Adult Cattle. Vet. Clin. Food Anim. Pract., 21: 251-279.

Ricardo Mesquita Paschoal, Jose Travassos, Antonio Carlos Pereira Martins, Haylton Jose Suaid, Adauto Jose Cologna, Silvo Tucci, 2003. Is CO2 Gas Unsufflator Necessary for Laparoscopic Training in Animals. Acta Cir. Brasil., 18: 8-10.

Rothuizen, J., 1985. Laparoscopy In Small Animal Medicine. Vet. Quart., 7: 225-228.

Smith, C.L., B.A. Dowling and A.J. Dart, 2005. Recent Advances in Equine Abdominal Surgery. Vet. J., 170: 241-251.

Standingexploratorylaparoscopy. 2004 http://www. equinelaparoscopy. com/standingexploratory.htm. ivnu.18: 12.

Steve Trostle, 2000. Gastrointestinal Endoscopic Surgery. Vet. Clin. North Am.: Equine Pract., 16: 329-341.

Troy N. Trumble, 2000. A. Hendrickson, Standing Male Equine Urogenital Endoscopic Surgery. Vet. Clin. North Am.: Equine Pract., 16: 269-284.

Troy N. Trumble, 2000. Joanne Inglr-fehr, DVM, MS, DACVS; Dean A. Hendrickson, DVM, MS, DACVS. Laparoscopic Intra-Abdominal Ligation of the Testicular Artery Following Castration in a Horse. Javma, 216: 1596-1598.

What is Laparoscopy? 2004.