



# Minimal Access and Minimally Invasive Surgery in Veterinary Practice

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**Abstract:** Introduction: Laparoscopic surgery is a major component of the field of minimally invasive and minimally access surgery and is performed through an opening in the abdominal wall with a rigid endoscope allowing visual inspection of the peritoneal cavity and its organs. Laparoscopy has been used in veterinary medicine with any degree of frequency only for the last 25 to 30 years and is primarily centered on reproductive function studies in food animals and equine, nonhuman primate, and various zoo and exotic species. Although the indications for laparoscopy may be far more extensive in human medicine, it still has many potential applications for use in veterinary medicine. It is a procedure that can be performed with a high degree of safety. Indications: There are three indications of using the laparoscope in animals; the 1<sup>st</sup> is diagnostic, the 2<sup>nd</sup> is therapeutic and the 3<sup>rd</sup> is creating the excellent training model for minimally invasive surgery of human diseases. Contraindications: There are several absolute and relative contraindications for performing laparoscopy in human and animals. The absolute contraindications include acute or unstable cardiopulmonary conditions, presence of an uncorrectable or severe coagulopathy, cases in which extensive intraabdominal adhesions could have developed bowel obstruction, abdominal herniation and septic peritonitis. A relative contraindication must be balanced against the need for diagnosis and risks of alternative methods of diagnosis. Complications: The complication rate associated with laparoscopy depends on operator experience, accurate patient assessment and recognition by the clinician of appropriate indications and any possible contraindications, and quality of the laparoscopic equipment used. Conclusion: Owing to the minimal invasiveness and minimal access and short time of hospitalization and recovery of animals, laparoscopic techniques become more and more interesting not only for veterinary surgeons but also for owners of the animals.

**Keywords:** Surgery, Minimal Access, Laparoscopy, Animals

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## 1. Introduction

Laparoscopic surgery is a major component of the field of minimally invasive and minimally access surgery and is performed through an opening in the abdominal wall with a rigid endoscope allowing visual inspection of the peritoneal cavity and its organs. Laparoscopy has been used in veterinary medicine with any degree of frequency only for the last 25 to 30 years and is primarily centered on reproductive function studies in food animals and equine, nonhuman primate, and various zoo and exotic species. Over the past decade, although being slow, the laparoscopic

techniques show steady implementation of into veterinary surgical practice [1]. Selection of appropriate diagnostic tests in animals is essential for investigation of clinical disease and proper management and investigation of the cause of feline abdominal disease often requires several complementary diagnostic tests [2]. Laparoscopy is most commonly used now in small animal medicine to examine and perform biopsies of the liver, kidneys, pancreas, and prostate. It provides an excellent means for visualizing the surface of the liver as well as the pancreas. Ultrasonography as become the dominant procedure for imaging abdominal organs and for obtaining biopsy samples in a minimally invasive way [1, 2] and abdominal ultrasound is used frequently as a first-line

screening tool for abdominal disease [3]. Laparoscopy still plays a major role in clinical practice for many veterinary gastroenterologists, however, and many small animal practitioners are now beginning to perform laparoscopy in their general practices. To see an organ clearly during biopsy, to obtain biopsy samples readily from even a small liver, to observe directly the degree of hemorrhage associated with the biopsy, and to examine and obtain biopsy samples from the pancreas directly are major advantages of laparoscopy. Although the indications for laparoscopy may be far more extensive in human medicine, it still has many potential applications for use in veterinary medicine. It is a procedure that can be performed with a high degree of safety [4].

## 2. Indications

There are three indications of using the laparoscope in animals; the 1<sup>st</sup> is diagnostic, the 2<sup>nd</sup> is therapeutic and the 3<sup>rd</sup> is creating the excellent training model for minimally invasive surgery of human diseases [5]. The primary indications for laparoscopy in evaluation of diseases of the digestive system involve problems that necessitate examination and performing biopsy of the internal organs [4].

In veterinary medicine, diagnostic laparoscopy is used most often when other diagnostic methods do not allow a precise identification of causes of the animal's disease or when unnecessary exploratory laparotomy should be avoided. Diagnostic laparoscopy may also be used for staging different neoplasms when the methods of non-invasive identification of neoplasm development include a high percentage of false identification. Laparoscopy is the most sensitive method of identification of small metastases to the liver and peritoneum. During diagnostic laparoscopy, a biopsy may be performed and a liquid content of the gall bladder may be collected for bacteriological test [6]. Other intraperitoneal pathologies diagnosed by laparoscopic examination include intestinal torsion, intestinal intussusception, intestinal adhesions, intestinal impaction, mummified fetus, polycystic ovary, persistent corpus luteum, splenomegaly, splenic abscess [7].

As regard the therapeutic values of laparoscope, laparoscopic-assisted feeding tube jejunostomy placement and removal of gastric foreign bodies are performed with great success in dogs. Laparoscopic-assisted gastropexy is advocated as a prophylactic procedure to prevent gastric torsion that accompanies gastric dilation in large breeds of dogs. These procedures may be performed accompanying laparoscopic ovariectomy or ovariohysterectomy in females or with castration in male dogs. Dogs with chronic gastric dilatation and gastric volvulus may also be treated with laparoscopic surgery to derotate the stomach followed by gastropexy [8]. Laparoscopic resection of the gut is frequently performed in man, but rarely in animals. Potential reasons are the small body cavity, the high cost of stapling equipment, and the lack of experience with laparoscopic techniques. For these reasons, it will likely remain much simpler and faster to perform a laparoscopic-assisted

procedure if intestinal resection is necessary in animals. Laparoscopic cholecystectomy has become the standard of care for treatment of gallbladder disease resulting from cholelithiasis in man but has not been adopted in veterinary medicine [8, 9].

Attempt to reduce the learning curves of the laparoscopic surgeons in humans; several animal models for training and teaching laparoscopic surgery have been developed. The aim of creating various training animal models is to help surgeons acquire basic laparoscopic skills such as hand-eye coordination, depth perception, and knot-tying, which should always be acquired prior to organ- or procedure-specific skills. Inexpensive video box trainers are best suited for this purpose. However, advanced laparoscopic skills, such as dissection, cutting, coagulation, and stitching, require more sophisticated animal or human cadaver models. The perfect training model should teach the skills required and should be inexpensive, universally available, and anatomically and physiologically identical to an anesthetized patient [10]. Improvement in laparoscopic skills requires practicing, and it is mostly beneficial when live animal models are considered for use. Dogs and rabbits are used as the animal models for training laparoscopic surgeries with extensive efforts to be made to keep the animals alive after surgery as sacrificing animals is important and should be avoided from both ethical and technical stand points [11].

## 3. Training Models for Laparoscopy

A vast variety of simulators and models for laparoscopic training are available with different levels of validity and reliability. These models and simulators vary widely in their platforms whether physical or virtual reality, the performance measures used according to outcome based or movement based, and the demonstrated validation level [12]. Laparoscopic techniques are difficult to master, especially for surgeons who did not receive such training during residency and there is an algorithm has been provided for laparoscopy is to be conducted. In vitro and in vivo training models help surgeons acquiring their basic laparoscopic skills such as hand-eye coordination, depth perception, and knot tying. These laparoscopic training options vary from bench-top training courses with box trainers to virtual-reality simulators ("dry-laboratory" training) or live-animal models ("wet-laboratory" training) [13]. Physical simulators consist of a box trainer and laparoscopic instruments and the materials used in these simulators can provide texture and behaviour similar to real tissues [14, 15]. Virtual reality (VR) simulators are provided within the soft wear through computer systems and allowing objective measurements of trainee's hand placement and amount of pressure used. Most of the available of these virtual systems are expensive and do not have tactile feedback [16].

Following the rapid development of computer technology, nowadays special soft-wares allow virtual reality (VR) trainers to simulate many kinds of surgical procedures by assessing the performance in terms of completion time,

errors, and economy of motion and cautery. This has been proposed in some time, as the future of laparoscopic surgical training. However, up to now, due to technical limitations, the VR trainer cannot very realistically mimic a surgical situation. Because of this, live animal surgery still represents the best training models, offering a level of fidelity unmatched by any other form of simulation model [17].

The transition from the “dry lab” to the “wet lab” is considered an essential step of the training process of a laparoscopic surgeon and cadaveric or animal training models offer a wide range of training applications [12]. Although they provide the best presentation of clinical anatomy, human cadaveric models do not reconstitute optimal operative conditions in terms of bleeding control, tactile feedback on tissues, and visual conditions. A great variety of animal models actually are available and suitable for training purposes in laparoscopy and the perfect animal model for training should provide the skills required, be inexpensive, universally available, and anatomically and physiologically identical to an anesthetized patient [10, 18].

Animal models have also been used to improve advanced laparoscopic skills and these animals may be small or large animal models [19]. Using animal models is attractive for instructors and trainees and in order to reduce the learning curve in humans, several training models have been developed for teaching laparoscopic surgery: mouse, rat, rabbit, chicken, baboon, dog, sheep and pig [18].

Mice have been studied extensively and are ideal for immunologic or oncologic studies; however, their size makes them far too small to assist in the development of laparoscopic procedures [20]. Rats have been used previously for transperitoneal laparoscopic research. This rat model somewhat larger model also is inexpensive and easily handled [10, 21]. The rabbit model also is relatively inexpensive and has the advantage of offering more working space and, thus, is more realistic. The model also has been validated for acquiring basic skills such as knot-tying, stitching, and dissection as well as cutting and coagulation [22].

Large animal models are used widely in industrialized countries and have been validated for almost all surgical protocols such as canine and porcine models according to the anatomic similarities between the human abdominal cavity and these models. The relatively large body cavities in these animal models, they offer a better working space compared with the smaller models. Furthermore, tissue characteristics and hemostasis control are very similar to humans. However, these models are much more expensive, especially because of their housing and handling requirements. They also are not universally available because of ethical or national legal restrictions [10, 18]. The anatomy of the pig is comparable to that of humans and thus constitutes a useful “living model” for enhancement of laparoscopic skills and the trainees can practice a wide range of procedures and deal with their complications in vivo. The “pig-living model” is of paramount importance in the laparoscopic training process. Only if a procedure can be performed without any difficulty in the pig model should one start performing the same

procedure in humans. The trainers should consider that the trainees may develop a falsely elevated impression of their ability in such wet lab courses [23]. Interesting researchers used sheep and lambs as models for laparoscopic maneuvers [24, 25]. It was reported that basic laparoscopic skills scores obtained with the training for evaluation of laparoscopic skills of trainees were associated with extent of their laparoscopic experience and that training with a canine abdominal model could increase skills scores for individuals without previous laparoscopic experience [26].

## 4. Contraindications

There are several absolute and relative contraindications for performing laparoscopy in human and animals. The absolute contraindications include acute or unstable cardiopulmonary conditions, presence of an uncorrectable or severe coagulopathy, cases in which extensive intraabdominal adhesions could have developed bowel obstruction, abdominal herniation and septic peritonitis. A relative contraindication must be balanced against the need for diagnosis and risks of alternative methods of diagnosis. The relative contraindications usually include either ultrasound-guided biopsy using sedation or general anesthesia. With administration of proper patient support and use of the safest possible sedation and anesthetic protocols (e.g., ketamine and diazepam or propofol and the general anesthetic agent isoflurane or sevoflurane), many elderly or compromised patients can tolerate laparoscopy with minimal or no problems. Ascites can complicate laparoscopy as the main problem of presence of ascitic fluid involves clouding of the field of view. When ascites is present, it is usually best to remove as much of the ascitic fluid as possible before the procedure. This is best accomplished using either diuretics, if the ascites is mild and the procedure is not scheduled to be done for several days to a week, or paracentesis, on the day before or the day of the procedure if the ascites is moderate to severe [4].

## 5. Complications

The complication rate associated with laparoscopy is usually operator-dependent that depends on the surgeon experience. Also, complication rate of using laparoscopy is dependent on accurate patient assessment and recognition of appropriate indications and any possible contraindications governed by the clinician, and quality of the laparoscopic equipment used. As an invasive procedure, laparoscopy is remarkably safe. Most surveys in human and veterinary medicine indicate that, as is the case with most procedures, errors and complications of laparoscopy are more common when the technique is still being learned. Complications during laparoscopy can be avoided with a high degree of success when the operator uses a systematic approach and careful attention to detail. Potential major complications that can occur include air embolism (related to abdominal insufflation), cardiopulmonary arrest, pneumothorax (from diaphragmatic puncture by a misguided instrument), damage to internal organs, bleeding, and

infection. Because laceration of a major vessel can occur when attempting to obtain biopsy samples from a small liver with a needle instrument, it is recommended that grasping forceps be used instead in this situation. In fact, this is the instrument that I routinely use to obtain liver samples in almost all liver biopsy cases. Patients with end-stage liver disease are at risk of decompensating at any time and in association with even minor procedures [1, 4].

## 6. Conclusion

Laparoscopy as a technique of both minimal invasive and minimal access approach provides possibilities of performing numerous diagnostic and surgical procedures. Owing to the minimal invasiveness and minimal access and short time of hospitalization and recovery of animals, laparoscopic techniques become more and more interesting not only for veterinary surgeons but also for owners of the animals. Laparoscopy is a simple, safe and efficient technique to perform surgical operations in animals. Operating with laparoscopic techniques provides an alternative for conventional methods.

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