Considering all of the challenges faced by veterinary practices, it hardly seems worthwhile to consider adopting a new technology that involves capital expenditure, additional expense and learning curve and where the benefits of such an approach are difficult to document. (Freeman L., 1999) Today, I hope to present a practical approach to minimally invasive surgery (MIS) from historical and futuristic perspectives that will help veterinarians in considering whether to adopt this new technology in their practices.

Value of MIS

The benefits of minimally invasive surgery in human medicine are well documented in terms of the clinical benefits of faster recovery time, reduced length of stay, fewer complications, less pain, and better cosmetic outcomes. The economic benefits of these approaches are also evident from third party payers being willing to reimburse doctors and hospitals for these procedures. (Roumm, 2005) Over the past 20 years, less invasive techniques have been adopted in virtually all of the surgical specialties. Specialized quality of life instruments are used to document that laparoscopic surgery provides better postoperative QoL in many clinical situations. (Korolija, 2004) By studying the rise in inflammatory mediators after surgery, several authors have shown that MIS techniques result in better preservation of the immune system (Sylla, 2005) and these observations are backed up by fewer adhesions (Dubcenco, 2009) and lower postoperative rates of respiratory and urinary tract infections in patients undergoing MIS.

Human patients (i.e. our clients) believe in the value of MIS. Evidence from human medicine suggests that patients are willing to accept increased risk and/or spend more money out of pocket to have an improved cosmetic outcome with less invasive procedures. (Li, 2011) Improvements in cosmetic outcome have primarily driven the animal research and clinical trials in NOTES (natural orifice translumenal endoscopic surgery) and SILS (single incision laparoscopic surgery). (Hagen, 2008) (Lamade, 2011) At this time, there are several veterinary practices that no longer offer traditional ovariohysterectomy procedures. The veterinarians in these practices educate their clients on the benefits of MIS and believe strongly that client demand the same care for their pets that they demand for themselves. By understanding the benefits of laparoscopic surgery, clients then prefer the minimally invasive approaches and are willing to pay the additional costs for their pets.

Practical MIS

There are 3 very practical laparoscopic procedures that veterinarians should consider as the foundation for veterinary MIS: laparoscopic liver & solid organ biopsy, laparoscopic spay & gastropexy, and laparoscopic-assisted procedures. Each of these procedures offers the novice basic skills in learning MIS
procedures and can be accomplished safely, capturing the benefits of MIS without an excessive learning curve. Liver and solid organ biopsy establish the skills of abdominal access, visualization, tissue manipulation, and enable one to obtain a tissue sample that is larger than can be obtained with ultrasound guided FNA or Tru-cut biopsy. (Mayhew, Techniques for laparoscopic and laparoscopic-assisted biopsy of abdominal organs, 2009) Laparoscopy allows visualization of lesions that can’t always be identified with ultrasound, and will enable the observation and control of postoperative bleeding. Most liver, spleen and pancreas samples can be obtained with visualization provided by a 5 mm laparoscope through a port placed at the umbilicus and one other port placed for insertion of a 5 mm cup biopsy forceps. Optionally, Gelfoam pedgets can be introduced prior to the biopsy and used to assess and manage post biopsy hemorrhage. Cup biopsy forceps are used to take one or more samples for analysis. A typical liver biopsy is 5 samples: 3 for metal analysis, 1 for culture, and 1 or more samples for histology. Kidney biopsies are usually obtained with a tru-cut needle inserted percutaneously.

The usual laparoscopic spay is an ovarietomy procedure as there is no increased complication rate with the ovarietomy alone versus removing both ovaries and the entire uterus. (Gower, 2008) Since an ovary must be present to secrete progesterone to prime the uterus for subsequent development of pyometra, as long as both ovaries are completely removed, there is no increase in the incidence of postoperative infection with laparoscopic ovarietomy. The procedure requires an energy source such as bipolar electrocautery or Harmonic scalpel for efficiency in ligating the ovarian pedicle; however, these devices are readily applicable in open surgery as well as laparoscopic procedures. Two 5 or 10 mm ports are placed, typically on midline near the umbilicus and midway between the umbilicus and pubis. The animal is tilted to expose each ovary and grasping forceps are used to elevate the ovary to the body wall, where it is suspened with a percutaneously placed suture or special hook. The energy device is used to ligate and transect the ovarian pedicle and proper ligament, leaving the ovaries suspended until they are removed at the end of the procedure. If necessary, the port site can be enlarged slightly to facilitate removal of a very large ovary. If there is evidence of uterine disease during visual inspection of the ovaries and uterus, an additional port is placed and the entire reproductive tract is removed, usually by taking down each of the broad ligaments with the energy device and exteriorizing the body of the uterus through the caudal port site. The uterine body is ligated externally with sutures in a laparoscopic-assisted technique.

In veterinary medicine, surgeons have more widely used laparoscopic assisted techniques than in human surgery. In my opinion, this is because the optical cavity is much smaller and the body wall is much thinner than encountered in human surgery. As procedures are performed less commonly, veterinarians do not have the opportunity to practice laparoscopic suturing. Laparoscopic assisted procedures are performed much more quickly than totally laparoscopic ones. The three most common laparoscopic assisted techniques are gastropexy for prevention of GDV, cystotomy for retrieval of urinary calculi that are too large for hydropropulsion or laser lithotripsy, and multiple, full thickness intestinal biopsy for situations where endoscopic biopsy is less rewarding. Laparoscopic assisted gastropexy is performed with 2 ports, one of which is enlarged to ~ 5 cm to incorporate suturing the seromuscular layer of the stomach to the transverse abdominis muscle. (Rawlings, Prospective
evaluation of laparoscopic-assisted gastropexy in dogs susceptible to gastric dilatation, 2002) The external fascia, subcutaneous tissue and skin are then closed routinely over the gastropexy site. Among several techniques for laparoscopic assisted cystotomy, we bring the bladder to the body wall through a 10 mm port site, make an incision into the bladder, and use a cystoscope and a stone basket to retrieve small calculi. (Rawlings, Endoscopic Removal of Urinary Calculi, 2009) Depending on the size and number of the calculi, our methods are adjusted to include flushing, insertion of an additional instrument for stone retrieval, and enlarging the incision to accommodate very large stones. Following flushing and final inspection, the bladder is closed with sutures placed externally and then returned to the abdomen for final inspection before port site closure. With superior vision provided by the cystoscope, we may be less likely to leave a stone behind than with traditional open surgery, but this remains to be studied. In cats, laparoscopic assisted intestinal biopsy is performed by initially placing 2 ports on midline for visual inspection of the abdomen and liver biopsy. The midline incision is then enlarged between the 2 ports and a wound retractor is placed. From this incision, biopsy samples of the stomach, pancreas, duodenum, jejunum, and ileum and lymph nodes can be obtained by exteriorizing the tissue and performing traditional open surgical biopsies. After each biopsy, the affected tissue is returned to the abdomen and the intestine is continued to be traced to the next biopsy site. Following final inspection, the abdomen can be lavaged through the incision site. The wound retractor is removed and the incision closed routinely.

After mastering basic skills and, with additional training, veterinarians then progress to more difficult laparoscopic procedures and thoracoscopy. The most widely used thoracoscopic procedures are creation of a pericardial window to manage chronic pericardial effusion and thoracoscopic assisted lung biopsy procedures. As these techniques require modifications in anesthetic delivery, in-depth discussion is outside the scope of this overview.

The costs:

By wise shopping, veterinary practices can obtain a camera, light source, light guide cable, insufflator, laparoscope, monitor and recording device at reasonable cost, in the neighborhood of ~$20-30K, or less for used equipment. An energy source device ranges from $10-20K. Reusable and disposable trocars and instruments are both available and each practice must judge the cost of each, based upon their practices for equipment cleaning and sterilization. Most practices charge for the additional supplies on a case-by-case basis. The equipment manufacturers have economic models and can advise prospective buyers in assessing the costs per case. As with any new procedure, there is a learning curve with MIS. (Freeman, Evaluation of the learning curve for natural orifice translumenal endoscopic surgery (NOTES): Bilateral ovariectomy in dogs, 2011) Initially, procedure times are longer; however, with increasing experience, operative times approach those of traditional surgery. In contrast to open procedures where solo surgery is common, MIS procedures generally require an additional assistant to hold the camera and an operating room assistant to open equipment, manage the connections to the tower,
trouble-shoot problems, and control the operating room lights. Although an increase in potential complication rates was experienced in human surgery when laparoscopy was first introduced, the potential for serious complications is avoided by careful technique in port placement, introduction and retrieval of instruments, and in avoiding over-inflation of the abdomen. There are several courses at ACVS, University of Georgia, and Colorado State that teach these techniques and how to avoid complications. The most common reason for conversion from diagnostic laparoscopy to laparotomy in dogs and cats has been studied. (Buote, 2011)

The benefits:

In veterinary medicine, it has been difficult to collect sufficient data to definitively document the benefits of less invasive surgery over traditional techniques. We see trends towards less pain and less requirement for postoperative analgesia and faster return to activity in dogs undergoing laparoscopic OE or OHE compared to open approaches. (Davidson, 2004) (Culp, 2009) (Hancock, 2005) One recent study demonstrated a trend towards less surgical site infections in dogs and cats undergoing MIS techniques compared to open surgery. (Mayhew, Prospective comparison of surgical site infection rates in clean and clean-contaminated wounds after minimally invasive versus open surgery, 2011) Veterinarians enjoy the benefit of enhanced visualization during the procedure and the challenge of learning new skills and techniques. Some practices advertise their capabilities for MIS to generate revenue and/or gain an edge over competition.

The future of MIS:

NOTES and SILS are two recent advances in human surgery that bear observing for potential application in veterinary medicine. The SILS techniques have advanced more rapidly, primarily because they have been enabled by new equipment. Single incision laparoscopy involves placing a single port at the umbilicus through which 2 or 3 instruments can be inserted. The instruments used are articulating, meaning that they can be inserted parallel to each other and then triangulated inside the abdomen to converge on a distant target. The laparoscopes have a flexible tip, which can be directed for viewing outside the plane of instrument insertion. In this way, SILS cholecystectomy, hysterectomy, and gastric bypass operations can be performed through a single port at the umbilicus. Veterinarians are now studying the SILS port for laparoscopic ovariectomy but to date, compelling advantages of this technology in veterinary medicine are not available. Because the regulatory path for the SILS instruments did not require extensive clinical studies, manufacturers were able to market these devices more rapidly.

The NOTES, or natural orifice procedures, involved using a flexible endoscope through a natural orifice such as the stomach or vagina to view the procedure. Additional instruments were then brought into the abdominal cavity through the working channels in the endoscope or through another percutaneous port. There are numerous technical challenges in making new equipment for these procedures and the FDA required extensive clinical studies, which effectively prevented many of these products from being
marketed in the US. To date, there have been several thousand, primarily transvaginal cholecystectomy, procedures performed in South America.

We have explored the feasibility of the NOTES approaches in animals, developing a technique for performing transgastric ovariectomy and transgastric gastropexy in dogs (Freeman, Comparison of pain and postoperative stress in dogs undergoing natural orifice transluminal endoscopic surgery, laparoscopic, and open oophorectomy, 2010) and transvaginal ovariectomy in horses. (Pader, 2011) In dogs, our experience with the transgastric NOTES procedures suggests that the operative times are much longer than the laparoscopic techniques and that postoperative stress and pain are similar to laparoscopy. Veterinary colleagues in Brazil and Iran have explored the feasibility of transvaginal OHE in dogs with positive outcomes in reducing the number of ports needed for laparoscopic surgery. In horses, the operative times for transvaginal ovariectomy are similar to laparoscopy and the NOTES animals are spared a large incision in the body wall for retrieval of the ovary. However, both NOTES and SILS techniques require specialized equipment, and until these products are widely available, the application of these approaches in animals will be limited.

**Conclusion**

“Now the welfare of the patient is our first consideration, not the welfare of our pockets, or our fame as an operator. In order to conserve that welfare in our surgical work, we must always keep in mind that every wound . . . is like a sensitive plant. It responds to gentle treatment and resents brutality. It is, moreover, in our own interest to be gentle, for we shall find that we get full compensation for the value received: our wounds will heal better, our results will be better, our reputations will be better, and we shall have better satisfaction with ourselves and our work.”


**References:**


