DEVELOPMENT OF RIGID LAPAROSCOPY TECHNIQUES IN ELEPHANTS AND RHINOCEROS

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Abstract

Diagnostic and surgical laparoscopy has become a routine procedure in human and veterinary medicine and has similar potential uses in zoological medicine. Surgical telescopes and fiberoptic cables allow the veterinarian to look inside body cavities of the patient and specialized instruments provide the ability to perform a wide variety of diagnostic and surgical procedures. Rigid laparoscopy is considered minimally invasive surgery and is associated with a more rapid post-operative recovery rate and an improved prognosis as compared to conventional surgical techniques.[3] Laparoscopic surgery is commonly being utilized in horses and other zoo animals for a variety of abdominal surgical procedures including tubal ligation and ovariectomy.[7,8,12] Recent advances in technology now provide the ability to perform laparoscopy in the largest mammalian species maintained in zoological collections.[11]

A variety of disease problems and reproductive disorders have been documented in the rhinoceros and elephant. Due to their size and anatomy, many of the standard diagnostic tests available in human and veterinary medicine are not routine in these animals (radiography, advanced imaging techniques, liver biopsy, abdominal tap, etc.) at this time. Although conventional abdominal surgery has been performed in rhinoceros and elephants[1,5,10] survival rates have been extremely low. Laparoscopy can provide a variety of additional diagnostic options, and may also provide an avenue for performing surgical procedures that would otherwise be impossible in these animals.

A multi-institutional collaboration has been organized to address common goals with regard to enhancing diagnostic capabilities and improving surgical techniques in elephants and rhinoceros. Specifically, we are aiming to:

- Develop laparoscopic techniques and equipment for use in rhinoceros and elephants, which can be used to significantly expand our diagnostic and treatment capabilities in these large mammals.
- Improve international conservation efforts in both rhinoceros and elephants by helping improve animal health and welfare of these species in captive and free ranging situations.

This collaborative effort has been organized to critically review current equipment, techniques and uses with the ultimate goal of overcoming some of the inherent difficulties with laparoscopy in these large vertebrates. This includes further development and modification of equipment, investigation of surgical techniques, and expansion of clinical applications.

Cooperation in the development of innovative surgical equipment for the anatomic variety of our zoological species is necessary for the advancement of zoological medicine. Karl Storz Veterinary Endoscopy of America (KSVEA, Goleta, California 93117, USA) was instrumental in the initial development of this specialized equipment at the San Diego Wild Animal Park and by generously providing research and development for our continuing investigations. The availability of appropriately sized equipment has limited the application of laparoscopic techniques to animals of a size consistent with the intended species of its production. The largest laparoscopy equipment commercially available is marketed for use in equine medicine (57 cm telescope and accessories). This system has been used with limited success in rhinoceros[11] and elephants. In many cases, to adequately visualize and manipulate visceral organs, a longer telescope and associated instrumentation is required. We continue to work closely with KSVEA on the production of specialized equipment (Table 1). Standard light source, fiberoptic light cable and electronic insufflator units manufactured for use in domestic large animals have been used successfully in megavertebrates. Due to its compact size and versatility, the authors suggest the use of a portable, battery operated laparoscopy kit (Techno Pack, KSVEA) (monitor, light source, camera and digital recording device) especially under field conditions.

To date we have evaluated the utility of specially designed laparoscopic equipment in approximately seven elephants and four rhinoceros. Experiences from these limited cases have identified several technical and procedural challenges, which need to be overcome if megavertebrate laparoscopy is to be successfully performed.[11] Some of these challenges are summarized below:

Technical challenges:

- Equine laparoscopic equipment too fragile and/or short for certain surgical applications in rhinoceros and elephant
- Size and disposition of megavertebrates (> 1000 kg)
- Thick, non-pliable, pachydermatous skin puts unusual pressure (and risk of damage) on equipment
- Insufflation and illumination of large abdominal cavity
- Great depth to visualize and physically reach/manipulate large organs
- Thick, redundant, fibro-elastic peritoneum which is difficult to puncture during surgical attempts to enter the abdominal cavity
- Influence of patient positioning: unable to use conventional laparoscopic positioning techniques in these species
- Both rhinoceros and elephants are hindgut fermentors and have very large and extensive lower intestinal tracts. Gas dilation of these bowel loops combined with limited positioning options, can make laparoscopic visualization of certain organs a problem

Procedural challenges:

- Cost of developing new and specialized laparoscopic equipment is high; duplicate equipment is not available at this time
- Charismatic nature of megavertebrates makes it difficult to perform surgery on such important and high exposure species

- Limited clinical cases for testing equipment due to the relatively low number of megavertebrates in zoological facilities
- Use of laparoscopy in zoo mammals may be out of the comfort zone for many veterinarians and curators due to lack of experience with this instrumentation
- Lack of published surgical procedures in these species
- Inability to perform laparoscopic procedure in “surgical suite” as with most other species
- Risks associated with megavertebrate anesthesia and sedation including difficulty in providing safe anesthetic procedures, proper restraint, and safety of personnel

A multidisciplinary, systematic approach has been initiated to critically review current instrumentation and procedures with the objective of overcoming these technical difficulties.

The initial phase of our project has been to develop laparoscopic techniques and equipment (Table 1) for use in rhinoceros and elephants by utilizing individuals that may have died of natural causes, or live animals with medical conditions that warrant abdominal surgery. We have already had the opportunity to perform laparoscopic surgery on both live and deceased white rhinoceros, black rhinoceros, African and Asian elephants. From our initial studies, it is apparent that laparoscopy in these megavertebrates is possible and may greatly enhance our ability to care for and manage these animals in captive and free ranging situations. The authors have received some funding and institutional support that allows us to travel to institutions which may benefit from the use of this equipment and/or our experience. We are also interested in those zoological institutions which may find themselves dealing with a terminal case in an elephant or rhinoceros, to please contact us directly and to consider allowing laparoscopy to be conducted on the animal prior to a post-mortem examination.

Ultimately, we envision the results of our studies on captive animals to be applicable to the management and conservation of elephants and rhinoceros in the wild. A variety of medical disorders are commonly reported in black and white rhinoceros. Many of these medical conditions are difficult to diagnose, monitor and treat. Furthermore, there is a paucity of information on the incidence of these disease conditions in free ranging populations. The use of minimally invasive laparoscopic techniques will greatly enhance our diagnostic abilities in this species and would be extremely valuable to the understanding of medical conditions of captive and free ranging rhinoceros and to conservation efforts overall.

Throughout many parts of Africa, wildlife professionals are seriously concerned about the negative effects large elephant herds are having on the native flora and fauna within parks and reserves.[2,6,9] The historical rangelands of the elephant have become interrupted by national borders and artificial barriers. Habitats surrounding wildlife parks are increasingly being converted to agricultural lands. The encroachment of human populations has caused a dramatic increase in the number and severity of human-elephant conflicts.[2,9] These conflicts are commonplace in many parts of East and Southern Africa. Although there have been a variety of plans to reduce human-elephant and elephant environment impacts, little overall success has been achieved in most countries.[9]

Historically elephant population control has primarily been limited to culling and translocation of small groups.[2,6] Immunocontraception has been attempted with a small population of elephants but is not currently realistic in many situations.[4,6] In wildlife parks where large herds of elephants exist there is currently no effective, humane method of population control.

One of our long-range goals is to develop laparoscopic techniques, such as ovariectomy and tubal ligation, in free ranging African elephants that can be used to sterilize reproductive females. Once these techniques have been developed, it is our intention to train local wildlife veterinarians and health professionals to perform laparoscopic sterilization of elephants in the field and thus provide local wildlife officials with a tool to help manage elephant populations. It is our hope this will improve conservation efforts across Africa by reducing human-elephant conflicts and helping to save critical ecosystems.

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Table 1. Current laparoscopy equipment specifically manufactured for use in megavertebrates.[a]

Instrument	Description
Rigid telescope	1.24 m x 1.0 cm, forward, oblique, rigid, 30 degree
Trocar Cannula	67 cm x 0.5 cm, pyramidal tip 64.5 cm x 1.0 cm, double-walled
Trocar Cannula	60 cm x 1.0 cm, pyramidal tip 56.6 cm x 1.5 cm, double-walled
Cup biopsy forceps	1.0 m x 1.0 cm
Babcock grasping forceps	1.0 m x 1.0 cm
Metzenbaum scissors	1.0 m x 1.0 cm
Palpation probe	1.0 m x 1.0 cm, with cm markings
Palpation probe	1.0 m x 0.5 cm, with cm markings

[a] All equipment was specially manufactured by Karl Storz Veterinary Endoscopy of America (KSVEA, Goleta, California, USA) and is not commercially available at this time.