ABSTRACT

The indiscriminate destruction of natural environments is the main event responsible for reduction of some wildlife population. Nevertheless, the greater amount of captive individuals can lead to new pathologies, so far unknown, which may appear in consequence of inadequate management over nutritional and/or psychological aspects, such as physical restraint or low mental stimulation. Management errors are the main causes of morphofunctional alterations in captive birds. Diagnostic can be performed by other ways, however, technically difficult may be present and there is a lack of data regarding most species. Recent data, specially regarding macroscopic aspect of internal organs, arise from post-mortem studies performed in necropsies, from taxidermied animals or, yet, from museum collections. In other hand, endoscopy allows not only macroscopic evaluation of internal organs, but to collect samples from live birds for different kind of studies, such as histopathology and cultivation, becoming an important tool for diagnostic on more recent years. It also can be used for another reasons, as for sexing species that do not show apparent sexual dimorphism.

Keywords: avian, endoscopy, sex determination, biopsy.
INTRODUCTION

The destruction of natural environments may play an important role regarding the reduction of wildlife population. Activities such as mining, commercial flotation, turning lands into pasture and farms, soil burning for agriculture and illegal commerce had contributing for the disappearing of wild species. Regarding birds in South America, a lot of species are facing a serious risk of extinction (RIDGLEY and TUDOR, 1994), and this scenario did not change over the years (IUCN, 2016). Brazil has one of the world’s greatest diversity in avian species, with 1590 different species from 23 orders and 86 families (SICK, 1997). The Brazilian Institute of the Environment – IBAMA – regulated (ordinance 16/1994) the captive maintenance of avian species that are under risk of extinction, for purposes of handling, conservation and research. Zoos, ecological parks, sorting centers and scientific breeders assume great importance, by enhancing actions that aim to understand the totality of eventual changes (behavioral or morphofunctional, by disease) that may affect individuals handled ex situ, as well as your conservation, replacement, release and reintroduction on environment.

On this scenario, to breed birds in captivity becomes a necessity for preservation, as the maintenance of these animals creates an important genetic database, and offer conditions for the development of researches that aim their conservation (GASPARINI et al. 1997) and comprehension. However, large populations kept in captivity can lead to the appearance of diseases, caused by inadequate handling, such as nutritional and psychological, by physical restriction, and by low mental stimulation to which these individuals are subjected. Mismanagements are considered primary causes of morphofunctional changes in captive birds, a lot of them still misunderstood, and sometimes not even known. Liver and kidneys are on the list of organs that are more affected by diet, hydric ingestion, parasites, fungus or toxins (MACWHIRTER, 1994; KOLLIAS, 1995).

Clinical diagnosis of diseases that affect birds are performed by clinicians, however, the lack of reference values for most species, the little knowledge regarding their physiological conditions and technical difficult (MACWHIRTER, 1994; SCHIMIDT et al. 2003) can make this process challenging.

Current information, specially about macroscopic aspects of organs, are originated from post mortem studies performed on necropsies, from taxidermy, or, yet, from museum collections (CASTRO, 1997). Ultrasonography guided biopsy in birds is difficult and an inaccurate method, as air sac conformation makes organ visualization harder (WAGNER and KIRBERGER, 2001). In other hand, open procedures are time-consuming, too much invasive and painful.

Nevertheless, techniques minimally invasive, as endoscopy and videosurgery, are good options for macroscopic studies (TAYLOR, 1993). Moreover, they allow the collection of material from live birds for physiological and histological studies (TAYLOR et al. 1994; TAYLOR, 1997; MOLLER et al. 2004).

In face of these problems and noticing the importance of videosurgery and videodiagnostic in birds, this review brings topics related to the issue, focusing on materials, anatomy and access, besides the main diagnostic routine situations in birds.

Equipment for videosurgery in birds

Endoscopic equipment has been used in Medicine since 50’s and 60’s decades. From the 70s, techniques were adapted for use in Veterinary Medicine in many situations, allowing since simple diagnostic procedures, until more complex ones guided by video (TAYLOR, 1993; TAYLOR et al. 1994; MOLLER et al. 2004). Endoscopes used in Veterinary Medicine were developed from pediatric cystoscopes. They have small diameter (3mm), enabling its use in birds, allowing exploration of thoraco abdominal region (TAYLOR, 1993).

Rigid endoscopes (Figure 1) were the first ones to be used and had as an initial purpose, visualization of gonadal structures, allowing identifying birds as males and females, as a great number of species do not present apparent sexual dimorphism (TAYLOR et al. 1994). Evolution of endoscopes resolution, its lenses and the light source are factors that enhance its applicability (LIERZ, 2005).

The emergence of new endoscopes with working channels, allowed that clamps, scissors and another cut and apprehension equipment could be safely introduced until the endoscope bottom, avoiding iatrogenic injuries and allowing sampling and material removing (MURRAY et al. 2008).

Currently there is a great equipment variety, that may be rigid or flexible, angled or straight, and with diameters varying from 1.2 until 10 mm, facts that increased considerably the number of practical possibilities for diagnostic routine, not only for birds, but for many other species. The equipment routinely used for avian patients are optics of 1.9 mm and 0o, 2.7 mm and 30o, and 4 mm and 0o (LIERZ, 2005).
Rigid endoscopes tend to be the best choice for initial approach, with the one with 2.7 mm, 30° and 19 cm length promoting a bigger exploration angle. The one with 1.9 mm of diameter provides good images for most procedures and patients. The one with 4 mm of diameter provides images with superior quality; however, this diameter can be too big for some avian species. In a second moment, flexible endoscopes may be used, being indicated for proventriculus, gizzard and oviduct visualization. The one with 3 mm of diameter is more useful, as it has three ports to accommodate the lens, the optic fiber light and a working channel for instruments. The semi rigid endoscopes of 1.2 mm of diameter are ideal for very small patients or for introduction in small orifices (LIERZ, 2005).

The straight endoscopes (0°) are good for simple special orientations, as ear canal, oral cavity, trachea and material harvest for culture, and they have a superior quality for photo documentation. The ones angled 30° create an oblique angle that allows a wider visualization when rotated on its own axis (TAYLOR et al. 1994; LIERZ, 2005).

Anatomy and approach in birds

Safety and efficacy of endoscopy in birds depend on the comprehension of air sacs anatomy (DUNCKER, 1971; MCLELLAND, 1989; HERNANDEZ-DIVERS, 2004). Most birds have nine air sacs, being two anterior thoracic, two posterior thoracic, two cervical, two abdominal and one interclavicular (Figure 2) (DUNCKER, 1971).

Conformation of thoracic and abdominals air sacs allows coelioscopy in birds. Preferential access is through anterior and posteriorthoracicair sacs, aswell asby abdominalones. Insufflation is unnecessary, once air sacs promote pneumoperitoneum at coelomic cavity (DUNCKER, 1971; HARRISON, 1978; EVANS, 1982; JONES et al. 1984; MCLELLAND, 1989; TAYLOR, 1993; TAYLOR et al. 1994; HERNANDEZ-DIVERS, 2004). Birds do not have diaphragm and count with a wide pleural space capable to maintain negative pressure inside the cavity (DUNCKER, 1971). Although the air sacs system is useful for endoscopic exploration, its complexity can trigger complications. Air sacs have very thin and fragile walls (precluding dissecting), which hamper the understanding of their tridimensional organization and conformation, and thus, turning them into a challenge for veterinarians, anatomists and researchers (MCLELLAND, 1989; TAYLOR et al. 1994; TAYLOR, 1997).

Videosurgery routine for sexing monomorphic birds

In the mid-60s, coeliotomy was the most common technique used for sexing monomorphic birds, along with other evaluations not very effective, such as morphometric measures of weight, tail length, size, plumage and sex specific behaviors (MARTIN et al. 2000). Such activities generated high stress levels due to manipulation.

For coeliotomy surgery, a considerable incision is performed behind the last rib, pulling it caudally to get access to coelomatic cavity. During the inspection for gonadal visualization, a few organs may be injured, which can lead to internal bleeding that can be fatal in some cases (BERTHOLD, 1969). Lameness at the side of the surgery is reported as common on post-operative period and, in cases where animals share the cage with others, they were frequently attacked (ROHWER, 1975). BERTHOLD (1969) reported that until 10 days after the procedures, animals still presented low locomotion activity and weight loss. Few studies were performed analyzing survival rates in free-living animals sexed by coeliotomy on field, but it is believed that they may cause harmful effects, since these animals have to search for their own food, sustain their social position and defend their territory. Therefore, common complications that occurred after such procedures as pain, infections and emphysemas (once it was harder to perform the technique without breaking any air sacs), may compromise the development of these activities (FIALA, 1979).
As an alternative to such procedures, the advance on laparoscopic techniques allows gonadal visualization with minimal tissue injury, being necessary only a small incision that allows the introduction of instruments, such as a 2.7 mm arthroscopic, for most of birds, or the one with 1.9 mm for smaller ones. A study performed by RICHERN (1989), encompassing 304 laparoscopic procedures for sexing in ravens (Corvus spp.), both young and adults, including free-living and captivity animals, did not show any difference between groups analyzed, reporting that the practice of laparoscopy did not influence on normal behavior of the species at the post-operative period. It was not observed differences regarding weight loss or eating habits. Actually, the young birds kept the weight gain. Problems related to infections affected only nine animals. Emphysema was not identified as a complication of laparoscopy. Mortality related to anesthesia was not reported as well.

Average time to perform the procedure is short. It is reported that a well-trained team can perform the entire procedure, since anesthesia until the end of the procedure, in only three minutes. This demonstrates that this is a quick, safe and effective procedure to sexing monomorphic birds. The approach for sexing must be done introducing the optic between the two last ribs, connecting it to a cold light source (Figure 3) (RICHERN, 1989).

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Programs for breeding birds in captivity, for commercial reasons, or conservationist ones, increased the need for gender identification of these individuals, boosting clinical application of endoscopy (JONES et al. 1984). However, the most recent practice for avian sexing, as effective as laparoscopy, is gene identification, which are amplified for PCR, constituting non-invasive method that requires few material, as a feather, or a blood drop, or the egg shell membrane (JENSEN et al. 2003; VUCICEVIC et al. 2012). Although, in centers where such technology is not available or where resources are sparse, laparoscopy can still contribute as an important diagnostic tool (DUARTE, 2015, personal communication).

Avian videosurgery routine

Indications for diagnostic videosurgery in birds are dyspnea, sneezing, crop burns and trauma. Likewise, when radiographic exams show changes in air sacs, lungs and organomegaly. Another indication may be when biochemical changes are found, such as increased uric acid levels and bile acids, and persistent leukocytosis, and yet, when reproductive disorders with suspicion of infertility and in cases of polyuria and polydipsia. According to MURRAY and colleagues (2008), endoscopy allows the realization of effective liver and kidney biopsies because of the possibility to view the injuries prior to the harvest with minimal injury to patients. Endoscopy had also been used to evaluate kidneys of free-living birds of prey (MÜLLER et al. 2004). Other researchers have also studied biopsies techniques in bird’s kidneys (TAYLOR et al. 1994; MURRAY et al. 1997).

Approach by caudal air sac has been recommended for most procedures, based on accurate reference points, which are reproducible for a wide variety of species, as Passeriformes, Psittaciformes, Columbiformes, Galliformes, Anseriformes, Accipitriformes and Strigiformes (TAYLOR et al. 1994). The access point is located where the semimembranosus muscle crosses the last rib. It can be easily located, except in individuals with moderate or marked fat reserves. To this end, the leg should be pulled forward, facilitating the approach, once femoral muscles won’t interfere with the exposed side of the body (EVANS, 1982) (Figure 4).
Using lateral approach, the endoscope gets into the caudal air sac, near its caudal border. By accessing it from left side, the surface of lung lateral septum can be viewed cranially. Directing the endoscope to two to three o’clock positions, the union of caudal thoracic and abdominal air sacs can be visualized. The endoscope progression by these air sacs will enter it into the abdominal air sac. At four to six o’clock positions in the ventrolateral edge, gizzard and proventriculus will be visualized. The liver’s lateral edge may be located in position between seven and eight hours, above the gizzard. From nine to ten hours, the confluence of cranial and caudal thoracic air sacs is found (MURRAY et al. 2008).

Not infrequently, captive birds may develop amyloidosis, uric gout, xanthomas and hepatic lipidosis. The last one (the most common) occurs due to the excessive calories intake, inadequate fat metabolism, changes on liver enzymes, and oxidative damage secondary from birds nutritional status. Birds with hepatic lipidosis usually die without previous signs. Dehydration and nutritional imbalance have been associated with kidney disease in birds; when prolonged, dehydration can cause permanent kidney failure. Diets containing 0.7% calcium (ideally 0.3%) are associated with kidneys’ metastatic mineralization (CASTROS, 1997; WAGNER and KIRBERGER, 2001). Furthermore, diseases of bacterial nature, viral, fungal, parasitic, toxic, besides vitamin deficiency, can be considered. In parrots, nutritional diseases can be secondary to systemic diseases such as liver or kidney diseases (WAGNER and KIRBERGER, 2001) and may eventually generate metabolic and biochemical disorders that will produce non-infectious diseases (KOLLIAS, 1995).

Multidisciplinary approach of birds’ liver and kidneys compiling macroscopic or morphological, biochemical, cytogenetic and epigenetic aspects, is desired. Veterinarians uncommonly perform the diagnosis of conditions that can affect the organs, either due to technical difficulties or lack of reference values for the species, or due to the little knowledge of physiological conditions to them, hampers the admission of appropriate conducts (MACWHIRTER, 1994; CASTRO, 1997; SCHIMIDT et al. 2003).

Coordinate the endoscope and the biopsy instrument may prove to be a challenge. The advent of work shirts, which are provided with endoscopes, simplified the procedure, allowing biopsy forceps’ approach without changing the field of view. Smaller sizes of biopsy forceps are generally used, to avoid severe bleedings. Endoscopic guided biopsies allow sampling organs under direct visualization. Usually, lungs, air sacs, liver, kidneys, spleen, gonads, proventriculus, gizzard, thyroid gland, mucous membranes of the esophagus, crop and cloaca’s biopsies are possible using tweezers through a working channel. Aspirations of cysts, biopsies, marrow biopsies, or wash samples are possible using a long needle (LIERZ, 2005).

For general changes in an organ, a biopsy should be performed by its edge. Contraindications to taking biopsies are similar to those for endoscopy. Endoscopic procedures, in particular tissue biopsies, may lead to changes in blood composition, thus, performing blood collection to complete blood count should be performed before the procedure (TAYLOR et al. 1994; LIERZ, 2005).

**Figure 4** – Image showing a bird positioned for left lateral coelioscopy. The left pelvic member is pulled forward and fixed at this position for body side exposition. The endoscope is positioned right behind the last rib and ventrally to the muscle (adapted from HERNANDEZ-DIVERS S.L, 2005).

**Anesthesia in birds for videosurgery**

Anesthesia is an important and challenging aspect in birds’ medicine, and essentially can be achieved in two ways: by injection or inhalation anesthetics.

According to MURRAY and colleagues (2008), injectable agents such as ketamine, xylazine, midazolam and diazepam, are not capable to produce anesthetics plans as effective, safe and stable as isoflurane for endoscopic procedures. Advantages of using these agents are related to the fact that they are practical to use, especially in situations on field, to be unnecessary to use specific equipment, relatively low cost, and easiness of administration. However, disadvantages include the necessity of metabolism for elimination, dose-dependent cardiorespiratory depression, potential difficulty in reversing the effects of drugs in emergency situations, prolonged and potentially more agitated recovery and lack of adequate muscle relaxation (CURRO, 1998).

Nevertheless, RICHNER (1989), reports excellent results using only ketamine at a dose of 35 mg.kg-1 for laparoscopic sexing in ravens (Corvus spp.), and this may be a more practical option. Inhalation anesthesia is the preferred technique for performing
most of procedures in birds. Isoflurane is the anesthetic of choice, because it has already been proven to be clinically safe and an effective anesthetic in different species. Due to its low blood’s solubility coefficient and effectiveness gas exchange on birds’ respiratory system, induction, recovery and changes in anesthetic depth are fast (CURRO, 1998). Moreover, several studies with different species report that isoflurane produces cardiovascular and respiratory stability, and that the depression caused by it on these parameters is a dose-dependent factor (JOYNER, et al. 2008; ESCOBAR et al. 2011; KIM et al. 2011; GRANONE et al. 2012).

CONCLUSION

Endoscopy in birds appears to be a feasible technique with several practical applications, since it allows sexing procedures up to minimally invasive interventions. Its use in Brazil has been widely disseminated and applied not only in veterinary hospitals, but also in private clinics and wild birds’ breeding centers. The endoscopy has a great potential in birds’ medicine, making this a great field for the development of researches, with the aim of spread its use and to expand the applications in the routine of diagnostic and therapeutic routine.

PERSONAL COMMUNICATION

José Maurício Barbanti Duarte. Via de Acesso Prof. Paulo Donato Castellane, s/n, CEP 14.884-900, Jaboticabal, SP. E-mail: barbanti@fcav.unesp.br.

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