Avian Reproductive Tract Surgery

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Introduction

A basic understanding of general surgical principles should be understood prior to avian surgery. Although there are many anatomical and physiological differences between birds and mammals, surgical techniques are very similar. Due to small patient size and anatomical differences (avian air sacs for example), microsurgical instrumentation with magnification with focused light is often necessary for efficient bird surgery. Because of physiologic variations (compared to mammals, birds exchange oxygen on inspiration and expiration and can frequently go into cardiac arrest following relatively brief apnea), anaesthetic techniques in avian species are very different and are discussed at another session during this conference.

Doolen listed several principles that hold very true to maximize avian surgical success.[1] First is to minimize hemorrhage. The second is to minimize tissue trauma. Third is to minimize anaesthetic time. Fourth is to minimize anaesthetic and metabolic complications. Last, provide post-surgical support and analgesia. These seem simple enough, but are very important to understand and practice during all avian surgical procedures.

If interested in avian surgery, actively pursue continuing education. One of the best continuing education courses is at one's own hospital in the form of necropsy patients. If permitted by the owners, perform as many necropsies as possible to gain experience and exposure to avian anatomy, tissue handling and microsurgical instrument use. Also attend continuing education courses conducted by the Association of Avian Veterinarians, American Association of Zoo Veterinarians, Mid-Atlantic States Association of Avian Veterinarians or other groups supporting avian medicine and surgery. Several texts listed in the 'Recommended Reading' section at the end of this paper give excellent descriptions of numerous avian surgeries. Publications such as the *Journal of Avian Medicine and Surgery* provide numerous well-referenced papers on surgical techniques, in addition to medical topics.

Also familiarize yourself with the numerous potential surgical 'tools'. These 'tools' include radiosurgery, microsurgical instruments, endoscopes, high powered microsurgical loops with light, operating microscopes, laser units and other items that have become commonplace with avian surgery. Consult with surgical instrument companies, colleagues and the continuing education resources listed above.

During the presentation, the author will discuss his most commonly used instruments and 'tool's used with avian surgeries. Although little information exists on suture material in birds, chromic catgut, polyglactin 910, polydioxanone (PDS), monofilament nylon and monofilament stainless steel have been evaluated in rock doves (*Columba livia*). [2] In a separate study of polygalactin-910, chromic catgut and polydioxanone used in cloacopexy surgery in pigeons, the authors concluded that inflammation and fibrosis were most prominent with polygalactin-910. [3] Because of the degree of inflammation and fibrosis, the authors felt that polygalactin-910 would be more appropriate for cloacopexy as a means to promote adhesion formation at the surgical site. [3] From this information and the author's experience, PDS is slowly absorbed and causes minimal tissue reaction making it suitable for both internal and skin closure use. [2] For the purposes of this discussion, PDS will be used for all monofilament, absorbable sutures in bird surgeries.

The following and last section on Avian Reproductive Tract Surgery has been (primarily) taken directly from Echols MS. Surgery of the avian reproductive tract. Sem Avian Exot Pet Med 2002;11:177-195.

Anatomy of the Avian Oviduct

The oviduct, or salpinx, develops from the left Mullerian duct and can be divided into 5 regions. The cranial-most region is the infundibulum, which engulfs the ovulated ovum. The infundibulum is the site of fertilization. Next, the ovum moves into the largest region, the magnum. The magnum produces albumin, which surrounds the developing egg. As the ovum progresses caudally it enters the isthmus where the inner and outer shell membranes are formed. The egg is 'plumped' with water and solutes, calcified to form a shell and pigments are deposited during is prolonged stay in the shell gland or 'uterus'. The shell gland transfers the complete egg through the uterovaginal sphincter and into the vagina. The uterovaginal area contains sperm-storage tubules allowing many species to store viable spermatozoa for prolonged periods of time (greater than 21 days in turkey hens). The vagina terminates at the cloaca and coordinates with the shell gland to ultimately expel the egg.

The oviduct is suspended within the coelomic cavity via a dorsal and ventral ligament. The cranial, middle and caudal oviductal arteries running in the dorsal mesentery, supply blood to the oviduct. The origins of each vessel vary between species but some generalization can be made. The cranial oviductal artery arises from the left cranial renal artery, aorta or external iliac artery. The middle oviductal artery comes from the left ischiadic artery or its branch, the medial renal artery. Finally, the caudal oviductal artery arises from the left internal iliac artery or the pudendal artery. The veins draining the cranial oviduct empty into the caudal vena cava (via the common iliac vein), while those draining the caudal oviduct enter the renal portal or hepatic systems.

Salpingohysterectomy

Salpingohysterectomy is the surgical removal of the oviduct, infundibulum to uterus, is indicated for chronic egg laying and any oviduct disease that cannot be medically managed and is reported as the 'therapy of choice for overproduction of eggs'. Every attempt should be made to understand the bird's overall health status prior to surgery, as the patient should ideally be stable. Birds with septic yolk peritonitis generally carry a poor prognosis. Patients with underlying health problems such as various lung, liver and kidney diseases, can also complicate surgery. Otherwise healthy salpingohysterectomy candidates typically do well and surgery is often straightforward especially when the oviduct is small and inactive. Oviductal hypertrophy occurs secondary to elevated estrogen levels during sexual activity and can take up most of the left side of the intestinal-peritoneal portion of the coelomic cavivity. This oviductal hypertrophy includes increased vascularity and risk of bleeding during surgery. If the patient is stable, time permits, and increased reproductive tract vascularity is suspected, the author will 'condition' the bird prior to surgery. 'Conditioning' includes improving nutritional status (if necessary) and attempting to turn off the bird's sexual cycle as described under 'Egg Binding and Dystocia'. This process may take weeks to months and often results in decreased vasularity and lower patient morbidity.

In the author's experience, a left lateral approach offers the best exposure to the female avian reproductive tract, but a ventral midline approach can also be used. Perform a left lateral celiotomy. After incising through the left abdominal air sac, the ovary and oviduct are readily visible. Gently retract the cranial oviduct (infundibulum area) out the incision and hemoclip or cauterize suspensory ligament vessels as needed. The closer the bird is to laying, the larger the vessels present. Depending on the size, the cranial, middle and/or caudal oviductal artery(ies) may need to be hemocliped or cauterised. Once visualised, hemoclip the base of the oviduct just proximal to its junction with the cloaca. Excise the oviduct.

Well-developed preovulatory follicles (F1 and F2 ± F3 and F4) may pose a risk for intra-abdominal ovulation and can usually be easily removed. Use sterile cotton tipped applicators to 'push' the mature follicles off the ovary. If the follicle has a well-developed vascular pedicle, use hemoclips and then excise the follicle. One study in domestic chickens demonstrated a pause in laying that increased with the number of follicles removed compared to sham operated hens.

Cystic follicles should either be aspirated (drained) or removed. If the follicle is accidentally incised, yolk will leak into the abdomen. Simply 'mop up' excess yolk and other fluid if present. Collect culture and samples for histopathologic evaluation as needed.

Recently, an endoscopic approach to salpingohysterectomy of juvenile cockatiels has been described. Endoscopy has long been used as a sex determination and biopsy tool, but gross endoscopic surgery in birds is relatively new. A left lateral coelomic endoscopic approach (left leg pulled caudally) was performed on juvenile (3-11 month old) cockatiels. Once visualised, the supporting ligament of the infundibulum was carefully pulled laterally toward the coelomic entry site using flexible endoscopic grasping forceps (Karl Storz Veterinary Endoscopy, Inc., Goleta, CA, USA). This action broke down the supporting structures (ventral and dorsal suspensory ligaments of the cranial oviduct and uterus) and separated the salpinx (oviduct) from the overlying kidney, caudal vena cava and left ureter. Next, a cotton-tipped applicator was placed in the cloaca and was used to better visualize the uterus-cloacal junction and ensure the salpinx was 'peeled' from the surrounding tissues. The salpinx was exteriorised and then crushed and cut with microsurgical forceps and scissors, respectively, at the point of exit from the coelomic cavity, just cranial to the uterovaginal sphincter. The endoscope was replaced to check for hemorrhage and closure was routine.

The endoscopic salpingohysterectomy has several distinct benefits and limitations. As indicated in the study, this procedure was acceptable in the juvenile birds due to a poorly developed blood supply of the oviduct and that if attempted in mature, egg producing cockatiels, may result in fatal hemorrhage. Additionally, this procedure required an endoscope and two surgeons. Although the endoscopic surgery was limited to young birds, there was minimal hemorrhage and could be performed safely and quickly (estimated to take less than 10 minutes with experience) and offers an option for juvenile salpingohysterectomy.

Caesarian Section and Reproductive Tract Sparing

Caesarian section is indicated when the bird's reproductive capabilities need to be spared and is typically limited to egg binding with an otherwise normal, or minimally diseased oviduct. Depending on the location of the egg, a caudal left lateral or ventral midline approach is used. The oviduct should be incised directly over the bound egg and away from prominent blood vessels. After removing the egg, inspect the oviduct for other abnormalities and collect biopsies and cultures as needed. Close the oviduct in a single simple interrupted or continuous layer using fine (4-0 or smaller) absorbable suture material. Abdominal closure is standard. The author recommends resting the hen from reproductive stimuli for two to four weeks or longer as dictated by culture and/or histopathologic results.

Anatomy of the Avian Ovary

A right and left ovary and oviduct are present in the embryologic stages of all chicks, but the right half regresses due to the action of Mullerian inhibiting substance prior to hatch. Although a persistent right oviduct with or without a functional right ovary is present in some birds, most birds only have a left female reproductive system. The brown kiwi is an exception and normally has a functional left and right ovary. Interestingly; about 480,000 oocytes develop by hatching in the chicken. Of these, about 2,000 can be seen as a mass of small ova and only 250 to 500 reach maturity and ovulate within the lifespan of domestic species and even fewer mature in wild species. The follicles of the ovary are arranged hierarchically. The largest follicle (F1) will ovulate on the next day, the second largest (F2) the following day and so on.

The ovary is attached to the cranial renal division and dorsal body wall by the mesovarian ligament and receives its blood supply from the ovarian artery, which originates off the left cranial renal artery or directly off the aorta. Baumel notes that accessory ovarian arteries may also arise from other adjacent arteries. The ovarian artery will further divide into many branches with the greatest blood flow directed to any large preovulatory follicles present. Ovarian veins unite into main anterior and posterior veins that drain into the overlying vena cava. As more specifically described by Baumel, multiple left ovarian veins may exist and drain into the cranial oviductal vein, which then enters the common iliac vein and finally into the caudal vena cava. In the author's experience, the cranial oviductal vein is too short or poorly developed to recognize grossly. Instead, multiple short veins seem to enter the common iliac vein over the length of its contact with the dorsum (base) of the ovary.

Surgery of the Avian Ovary

Partial and 'complete' ovariectomy

Ovariectomy in hens has proven to be a challenging and oftentimes high-risk procedure. Ovariectomy has been used in many poultry studies and mention of this procedure can be found throughout the literature. Unfortunately, most papers poorly describe the specific details of the ovariectomy or its complications. One study in chickens, noted that ovariectomised birds 'lost considerably more blood than sham-operated hens'. Another turkey study excluded birds that were incompletely ovariectomised, but did not mention how many. Terada et al described ovariectomy by 'destroying ovarian tissue by local application of small pieces of dry ice'.

Although it has been stated that the short stalk of the cranial renal artery is what makes ovariectomy difficult, the author suggests that the intimate and lengthy attachment to the overlying common iliac vein is what makes this procedure risky.[40] As discussed under 'Anatomy of the Avian Ovary', multiple small veins often connect directly into the common iliac vein. It is often venous, and not arterial, bleeding from a lacerated common iliac vein that usually causes life-threatening hemorrhage during ovariectomy. As with the oviduct, the ovary can dramatically change in size and vascularity with sexual and egg laying activity. As a result, every attempt should be made to medically or behaviorally 'turn off' the bird's reproductive activity to reduce the vascularity to the ovary. Oftentimes, diseases requiring ovariectomy do not allow attending clinicians time to 'condition' the avian patient prior to surgery.

Ovariectomy should be reserved for ovarian diseases such as cancer, chronic recurring cysts, persistent follicular activity, oophoritis and other diseases that cannot be managed medically and are life-threatening without further treatment. While some birds such as cockatiels appear to stop ovulating after the salpingohysterectomy, other species such as ducks may continue chronic and possibly life threatening ovulation necessitating hormonal therapy or ovariectomy.

A cranial left lateral celiotomy often provides the best exposure to the left ovary. It is important to clean the surgical field of fluid and debris to best visualize the ovary and its vasculature. Surrounding organs may need to be gently pushed aside using moistened cotton-tip applicators or other non-traumatic instruments.

The first step to ovariectomy is to debulk its mass, regardless of size. The goal of this first step is to be able to visualize the ovarian attachment to the overlying common iliac vein and any other vessels present. If the ovary is inactive or juvenile, very little debulking is needed. If present, remove large preovulatory follicles as discussed under 'Salpingohysterectomy'. Aspirate and drain any cystic follicles present being careful not to spill contents into the coelomic cavity, especially if there is concern of oophoritis. When aspirating follicles, guide a small gauge (23-25 g) butterfly catheter needle into the most visibly avascular portion to reduce hemorrhage and have an assistant provide distant suction. Using this aspiration technique, a significant amount of an active and/or cystic ovary can be debulked. As a note, blood filled follicles may represent previously ruptured blood vessels from an invasive mass and warrants caution when attempting debulking.

Once the fluid component is minimised, progressively clamp or hemoclip the ovarian mass closer to its base. When used properly, Angled Debakey neonatal vascular clamps are atraumatic, will rest in the surgical site without obstructing view and seem to provide some hemostasis to the ovarian mass. Once a section of the mass is hemocliped or clamped, surgically excise or cauterize and remove the ventral-most ovarian segment. Reassess the mass and move the clamp (or place new hemoclips) closer to the base and repeat the excision process. This process is repeated until the overlying vasculature is clearly identified and the course of the common iliac vein can be seen.

Once the mass has been debulked, several options exists for complete or partial ovariectomy. Altman reports effectively using an electrocautery ball electrode to coagulate ovarian follicles in immature females. The same procedure results in ovarian regeneration and subsequent ovulatory activity in mature hens. The author has noted that some juvenile bird ovaries can be gently 'peeled' in toto from caudal to cranial off its dorsal attachments with no or minimal bleeding. In these cases, the caudal end of the ovary is grasped with angled hemostats and pulled in a cranial direction with a clear separation, and minimal effort, from the dorsally located common iliac vein. If attempting this procedure, stop if any resistance is noted to prevent tearing the overlying vein.

Another technique with juvenile or sufficiently debulked ovaries is to place hemoclips in the potential space between the ovarian base and the common iliac vein. Gently lift the caudal pole of the ovary and place a small to medium hemoclip from caudal to cranial across the ovarian vascular supply. Although difficult without good exposure, a last hemoclip can be placed from cranial to caudal in the same manner in attempt to ligate the more cranially located ovarian artery. With the blood supply adequately clamped, the ovary can be gently shaved off with precise radiosurgery using an Ellman B 'loop' series or blade electrode (Ellman International, Inc., New York, NY, USA) or left to die without a blood supply. Altman describes this method as 'a difficult, high-risk procedure' but the author has successfully performed ovariectomies in adult hens using this technique. Obvious complications include hemorrhage when trying to remove the hemoclipped ovary and inadequate, blind, placement of the hemoclips.

The author has used another approach when the ovarian attachment to the overlying common iliac vein is too long to hemoclip or there is erosion into the overlying vessel and the entire ovary must be removed for the bird's survival (as with otherwise untreatable cancer). Debulk the ovarian mass as described above. Once clearly identified, hemoclip the common iliac vein just caudal to the ovary and cranial to its junction with the caudal renal vein. Next, hemoclip the common iliac vein just cranial to the ovary and caudal to its junction with the caudal vena cava. If done properly, the ovarian artery and common iliac veins are effectively clamped allowing one to carefully dissect the entire ovary from the overlying vessel(s). If needed, the ventral wall of the common iliac vessel can be safely removed. There is the real potential of damaging the left adrenal gland, significantly altering blood flow through the renal portal system and the cranial renal division and causing physical damage to the overlying kidney and lumbar and/or sacral nerve plexus(es).

With all of the above described ovariectomy procedures, it should be understood that none have been satisfactorily studied in pet bird species and that each caries a significant risk to the patient. With each procedure, closure is routine.

Anatomy of the Avian Testicle

Avian male reproductive anatomy consists of three main gross structures, the testes, epididymis and ductus deferens. The paired testes are located ventral to their respective left or right cranial renal division. The mesorchium connects the testes to the dorsal body wall. The left testicle is typically larger than the right in most young birds, but this relationship can change as the bird ages. In seasonal breeders, such as some passerines, the testes can increase 300 to 500 times in size and should not be interpreted as neoplasia. In addition to size, the color of the testicles can also change with fluctuating hormone levels ranging from black in the sexually immature or inactive cockatoos to white or yellow in the chicken.

The epididymis is located at the testicular hilus, or dorsomedial aspect of the testes. The ductus deferens continue from the epididymis as highly convoluted tubes running lateral to and alongside the ureters and then terminate at the urodeum as a papillae ventral to the ureteral ostium. Budgerigars and passerines have a ‘ball of tissue’ (seminal glomus) at the distal end of the ductus deferens that serves as sperm storage and forms a prominent projection (cloacal promontory) that can be used to sex some birds.

The testicular artery arises from the cranial renal artery and provides most of the arterial blood supply to the testes. An accessory testicular artery may arise directly from the aorta. The venous drainage is returned either directly to the caudal vena cava or forms a common stem with the adrenal veins. Kremer and Budras found that two testicular veins empty directly into the caudal vena cava of Peking drakes (*Anas platyrhynchos*). Given the diversity within the class Aves, it is likely that multiple variations of the testicular vasculature exist.

Surgery of the Male Avian Reproductive System

Castration

Avian castration is infrequently discussed, especially in comparison to salpingohysterectomy, suggesting that male reproductive tract diseases are relatively uncommon. Although caponization is common in the poultry industry (performed between 1 to 2 weeks of age), routine castration is rare in pet birds, especially psittacines. As a result, there is little information regarding the behavior altering effects of castration in pet birds. Hagelin castrated Gambel’s (*Callipepla gambelii*) and scaled (*C. Squamata*) quail and found that castrates had reduced or eliminated courtship behaviors and lower rates of male-male threats. However, the castrates maintained ornate plumage and exhibited overt aggression and frequently won contests when actually engaged. Yearling European starlings (*Sturnus vulgaris*) castrated when non-reproductively active were shown to be significantly more aggressive than non-castrated controls.[4] The authors concluded that ‘nonreproductive aggression in yearling male starlings is independent of gonadal sex steroids and suggests it even increases following castration’.[4] These results suggest that these persistent ‘male’ behaviors were either already learned at the time of castration, resulted from hormones other than testosterone or another source of testicular hormones was still present. It is known that some species have an appendix epididymis extending from the epididymis into the adrenal gland that may secrete androgens following castration.

Until further studies are available, castration should be used judiciously to alter avian behaviors, especially in adult birds and should always be considered secondary to more conservative methods of behavior management. However, castration has real benefit with testicular cancer, abscesses/granulomas, cysts and other conditions that may not respond to medical management alone.

Several methods of castration have been forwarded and include simple extraction (caponization), laser ablation, intracapsular suction, and en bloc surgical excision. Even with early age caponization, testicular regrowth is well documented. This supports the need for complete testicular removal, which is why the author prefers en bloc surgical excision.

Use a cranial left lateral approach or ventral midline incision with transverse flap to evaluate the testes. Due to the cranial location, the lateral celiotomy is often extended cranially by cutting the last two ribs to improve exposure to the testes. Depending on the species, puncture through the caudal thoracic and/or the abdominal air sac(s) to expose the left testis. The right testis may be exposed through the same incision by cutting through the midline junction of the corresponding air sacs or the process may be repeated with a right lateral celiotomy. With gentle traction, pull the testis ventrally and hemoclip the dorsal blood supply. If two can be placed, then incise between the hemoclips and remove the testis. Otherwise, use electrocautery to carefully free the testis from the hemoclip and vascular cord. The cautery should destroy any remaining testicular cells attached to the hemoclip but be careful to not damage the overlying blood vessels, kidney or adrenal gland. Alternatively, if the testicular blood supply is small, a hemostat can be temporarily used in place of a hemoclip and the testis pulled free. Leave the hemostat on the vascular stump for 1-2 minutes prior to release. Use direct pressure hemostasis as needed. Diode laser excision can also be used through this approach and may be performed without the need for direct hemostasis. Closure is routine.

Vasectomy

Vasectomy is a useful to produce ‘teaser males’ and aid in population control and has been described in small passerines and budgerigars. In anaesthetised budgerigars, a 3 mm incision, 7 mm lateral to the cloacal sphincter (vent), was used for the initial approach. Careful dissection was made through the abdominal musculature and fat. An operating microscope was used to find and aid in the removal of a 5 mm section of the vas deferens. Only the skin incision was closed. The authors recommended performing left and right vasectomy 2 weeks apart. Two of 12 birds died post-operatively and one was found to have pre-existing disease. The only other complications were post-operative tenesmus for 2 days and accumulation of droppings around the vent in 3 of the remaining 10 birds. The procedure was successful (no semen upon collection attempts) in 9 of the 10 surviving birds.

Anaesthetised Bengalese (*Lonchura striata*) and zebra (*Taeniopygia guttata*) finches have been vasectomised similarly to the procedure described above. In the anaesthetised finches, a 3 mm incision 5 mm lateral to the cloaca was made using an operating microscope. The muscle and fat were incised to locate the seminal glomera (glomus). It was noted that the seminal glomera of the Bengalese finch was ‘obvious and highly accessible’, and that of the zebra finch was ‘less obvious and in some cases difficult to locate’. The vas deferens was carefully separated from the ureter and ‘one or more pieces’ were removed with no ligature. The skin was closed. The authors performed single (14 days apart) and bilateral vasectomies successfully. The procedure was successful in 12 of 12 Bengalese and 14 of 15 zebra finches.

In larger species, the vas deferens is found zig-zagging lateral to the ureter and can be transected endoscopically or via celiotomy. A left, and sometimes right, lateral coelomic approach is(are) used. Care must be taken to not damage the ureter. In roosters vasectomised just distal to the epididymus, cessation of spermatogenesis occurred within 5 to 7 days. The method described above has not been studied nor has the long-term success been documented.’

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