Principles of Surgery

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Anatomical Features Unique to Birds

Respiratory System

Birds do not possess a diaphragm. They breathe by the active expansion of the chest. Thus anything which impedes this expansion can help cause asphyxia. So the surgeon must be wary of hand placement, of positioning heavy instruments on the chest, and of using heavy drapes.

Birds possess air sacs, and these allow good visualisation of internal organs, but also provide no barrier to foreign matter from spreading throughout the respiratory system. Beware abdominal flushing or ascites - the patient can drown! Birds have pneumatic long bones to reduce body weight. Part of the medullary cavity of each humerus communicates directly with the clavicular air sacs. Again, care must be taken when repairing fractures of the humerus to prevent any necrotic or infected matter being washed from the proximal fragment into the air sacs where it could cause air sacculitis, pneumonia, or even asphyxia.

Skeletal System

Birds possess long bones with brittle thin cortices, and relatively large medullary cavities, some of which link directly to the respiratory system. Practically, this limits the use of plates and screws to repair fractures. First, there is the problem of anchoring any implant securely and second there is the matter of the weight of the plate itself.

Birds have very little soft tissue covering their limbs, making the incidence of compound fractures very common. This also increases the risk of vascular impairment, non-union of fractures, and neurological damage.

Birds fly. Distal wing structure is critical for precise flight. Permanent damage or deformity arising from trauma or surgery can impair a bird's full return to normal. This is very important when considering surgery of birds of prey. If a raptor can't regain full flight or the grasping ability of its feet, its return to the wild will be a death sentence. Care must also be taken to avoid damage to the periosteum of the ulnar and metacarpal bones. The primary and secondary flight feathers attach to the periosteum. Damage to it can mean loss or deformity of the main feathers for flight.

Integument

Birds' skin is thin and transparent. There is virtually no subcutaneous connective tissue. This enables the surgeon to visualise underlying structures and to locate blood vessels. These can then be either avoided or ligated before sectioning, minimising haemorrhage. Lack of a thick subcutis obviates the need for a subcutaneous layer of sutures in most cases.

Birds have feather tracts or pterylae. Incisions are best made between these tracts, and care should be taken if some skin needs to be excised. Deviation of feathers or feather tracts can deform the birds smooth contours, interfere with limb movements, cause irritation and result in feather plucking.

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Birds have poor cutaneous blood and nerve supplies, except to feather follicles, feet, cere and eyelids. Thus simple wounds can often be sutured with minimal discomfort and with minimal restraint, especially in pigeons. Wounds usually heal rapidly.

Some Other Features

- Birds don't have teeth.
- Birds lack an epiglottis
- Birds have crops which are often closely adherent to the skin of the neck and which can be incised easily by accident.
- Birds have inflammatory cells (heterophils) which lack any proteases. This means they don't liquefy necrotic tissue. Birds therefore usually form caseous abscesses or granulomas which need to be curetted thoroughly, and often flushed for several days.
- Birds have a higher body temperature than mammals. They lose heat rapidly whilst under general anaesthesia. So hypothermia is a real risk for birds both during and after surgery. However this higher temperature seems to give them some defence against bacterial pathogens and post-operative infection is usually not a problem.
- Birds' gonads are located high in the abdomen, closely attached near the spine. Surgery here is heroic and usually results in massive haemorrhage and quick death.

Instrumentation

Some helpful items for avian surgery include:

i) **Magnification and good illumination**

The "Voroscope" provides different amounts of magnification combined with a light source. It is relatively inexpensive and very useful during normal examinations in small animals as well.

ii) **Radiosurgery (electro-cautery)**

The "Ellman Surgitron" has become a crucial item for most avian surgeons. It cuts, coagulates or combines a cutting and coagulating function during surgery. It can be fitted with electrodes, scalpel blades or bipolar forceps to achieve good levels of haemostasis, whilst operating.

iii) **Opthalmic instruments**

Because of the small size of the avian patient fine delicate instruments are preferred. Iris scissors, forceps, needle holders etc. Eyelid retractors become excellent abdominal retractors in avian patients.

iv) **Suture materials**

3/0 - 6/0 synthetic absorbable sutures are used for most techniques. Swaged on needles are essential to prevent tearing of fine avian tissues. Skin incisions are usually closed with absorbable sutures as rapid feather regrowth can make suture removal a headache. If a non-absorbable skin suture is used try to use one whose colour contrasts with the nearby feathers.

Stainless steel wire is needed to support acrylic glues in beak repairs. Remember the force with which a cocky can bite! Remember that beaks grow continually. If the germinal layer of the beak is damaged then the beak will be permanently damaged and will need regular repairs.

Tissue glues and dental acrylics are helpful at times. The main drawback is their cost and short usable time span. Beware of the fumes of some "super-glues". Most are toxic and can kill your patient if inhaled.

v) **Drapes and swabs**

Drapes must be lightweight so as not to impede the patients respiration. They are best transparent to enable the bird's depth of anaesthesia to be assessed. Swabs can be used in small birds. Some vets use plastic gladwrap.

Specially designed surgical drapes for birds are sold in the USA, but are not available here.

Autoclaved cottonwool buds make useful swabs.

vi) **Warmth**

Heating pads are essential during any prolonged procedures. Hot water bottles can be used. The provision of warmth post operatively is very important. This can range from a simple desk lamp-in-draped-cage arrangement to specifically designed heating cages, incubators, even a fully heated bird hospital. I have had built a small walk-in room (cupboard!) which I keep heated to around 32°C by a coil heater.

vii) **Fluid administration**

Fluids should nearly always be given at the time of surgery. Bolus administration IV or SC is the most simple method. However a 25g IV catheter can be used with the "Springfusor 10 Syringe Infusion Pump" to give a controlled flow throughout an operation. This is a cheap mechanical device originally designed to infuse small quantities of drugs to patients on IV drips. More expensive electrical infusion pumps (used in hospitals to administer epi-dural anaesthetics, for example) can also be used.

viii) **Anaesthetic equipment**

Avian surgery has been revolutionised with the advent of Isoflurane®. Any vaporiser capable of delivering Iso is fine. A range of different masks are necessary for induction. They should be transparent to enable visualisation of the patient. Plastic soft-drink bottles, cut in half and fitted with a latex examination glove make good masks for larger birds. The standard opening for the top almost exactly fits the usual anaesthetic adaptor. Cut down syringe cases, plastic dispensing vials - use your imagination.

I intubate all birds from galah size up. Uncuffed e-t tubes should be used as birds have complete tracheal rings. Mallinckrodt produces tubes in .5mm increments from 2.00mm - 5.00mm. I cut them down to shorten them, hopefully reducing dead space.

Monitors . The AP-Alert can be used on birds over 200gms in weight. However the best monitor is probably an experienced assistant. Do NOT rely on monitoring the GA whilst operating yourself. You will soon find yourself floundering after frantically flapping feathers or worse not having to bother with any haemostasis. Once a bird stops breathing cardiac arrest is not far away!

ix) **Miscellaneous**

Dental drills fitted with burrs are excellent for trimming beaks. "Dremel" drills, model hobbyist drills, are a cheap alternative. These drills can also be used to remove rings. I prefer to trim beaks and remove rings when the birds are knocked out. Remember the beak is a

very vascular and sensitive organ. It is also worthwhile to have a photo handy to compare how a normal beak looks. Often the lower beak is the problem and needs trimming as well. And ask yourself WHY is this beak overgrown in the first place. Healthy birds have normal beaks. An overgrown beak may be indicative of underlying liver pathology, malnutrition, parasites, or even PBFD!

The Patient Itself

Here surgical principles can be broadly grouped under three headings: pre-operative; surgical; and post-operative.

Pre-operative

Before undertaking any surgery the patients ability to withstand the surgery should be evaluated. Furthermore, the outcome of the surgery should be anticipated and maybe the procedure may need to be modified. Speed is fundamental to patient survival - sure, it may be better to pin the cocky's leg but if the duration of the procedure will be greatly increased and a successful outcome doubtful then it may be better overall to simply amputate the foot, losing a foot but saving a life.

Is the patient a pet, or a wild bird that will have to fend for itself again on release? Unless normal function is fully restored to wild birds they will soon die on release, and euthanasia may have to be considered. However a caged pet parrot doesn't need to fly and can happily cope with only one wing.

Different species can tolerate different degrees of incapacitation. Parrots with their grasping beaks can more easily compensate for the loss of a leg than can a chook.

Is the bird valuable, either genetically or financially? It is certainly easier to pullout all the stops in treating costly birds, but don't forget the valuable mutation who if a limb was lost would be unable to stand for mating, and therefore be worthless to an aviculturist. Yes you do have to weigh the worth of spending time and effort on a patient if you'll only be lumbered with a bad debt at the end. Knowledge, experience and explaining to the client all that is involved will help minimise this unfortunate aspect of avian practice.

So having decided it is indeed worth operating and what procedure is to be done, next comes assessment of the current state of the patient, and the decision of when to actually proceed.

A thorough clinical examination should be performed, assessing the health of the patient:

Body condition.
Respiratory recovery time after handling.
Faecal examination.
PCV and total serum Protein.
Blood chemistries.
Radiographs if indicated.

Any abnormalities should be treated and surgery deferred.

Guidelines:

- If the PCV < 20%, surgery should be postponed, or a blood transfusion provided.
- A total serum protein of less than 2mg/100 mL is a sign of impending trouble.
- If blood glucose < 200mg/dL defer or infuse 2.5% glucose during surgery. Birds have limited glycogen storage capacity and surgical shock can cause hypoglycaemia.
- Uric acid levels > 30mg/dL - defer if possible. Suspect renal disease or dehydration.
- AST(GOT) > 650 IU/dL - postpone.
- LDH > 600IU/dL - postpone.
- Cholesterol > 700mg/dL - postpone
- Lipomas. These are commonly encountered tumours, usually found on obese birds fed fat rich diets. Beware, fat on the outside, fat on the inside. These birds will often have fatty infiltrated livers - a death sentence using halothane, but also often causing clotting problems. Test the bleeding time by plucking a blood feather or toe nail clip.
- Other signs of hepatopathy include overgrown beaks and discoloured feathers.
- Ascites. Commonly seen in patients with egg peritonitis. Surprisingly large volumes can be found in chooks and ducks and if removed at the time of surgery can severely compromise the patient, causing hypovolaemic shock. These birds are best treated with needle aspiration and systemic antibiotics for up to 2 weeks before operating.

If your examination reveals any problems these are best treated. Lipomas can be treated by dieting the bird, or using thyroid hormone in the drinking water for a few weeks. Respiratory problems may warrant antibiotics, multivitamins etc. Clotting defects may need vitamin K. If the faecal exam reveals parasites then worm the bird. The aim is to minimise the stress on the bird before undertaking surgery.

Fasting. There are different opinions regarding fasting before surgery. Certainly small birds should only be fasted minimally if at all. Vomiting is not a problem but passive reflux of crop fluid can be aspirated. Some vets recommend fasting large birds for 6 to 12 hours, small ones for 3 to 6 hours. Other vets only fast birds if intending to operate on the G-I tract. Fluid filled crops should be aspirated before surgery.

Pre Operative Drugs. Tranquillisers are not usually used. Atropine is contraindicated, causing increased viscosity of secretions and increasing the chance of blockage of small gauge E-T tubes and air ways.

Skin Preparation. Feathers may be:

a. Removed by plucking, carefully, a few at a time in the direction of growth. Rough plucking can easily tear the bird's skin.

b. plastered down with a water soluble gel. Don't use oily preparations, as these can destroy the insulative property of the feathers or poison the bird during preening.

Skin disinfection is achieved with dilute chlorhexidine, used sparingly. Alcohol should be avoided as it can cause excessive chilling of the patient.

Speed. The shorter the procedure the better for patient survival. Make sure everything is prepared and any necessary equipment is on hand now, and does not have to be searched for. Be Organised. Be Quick. Be Successful.

Surgical

Anaesthesia.

Choice of Anaesthetic. When choosing which anaesthetic to use the practitioner must weigh up several considerations: immediate and long-term safety to the patient, ease of administration, speed of induction and recovery, safety of vet and staff, and, most importantly, familiarity with the various agents. Most avian practitioners firmly believe that when these factors are weighed up, the only anaesthetic which meets the bill is Isoflurane®.

Isoflurane is safe in critical patients; there is an appreciable time gap between onset of apnoea and cardiac arrest; there is no organ toxicity; there is rapid recovery with little or no "hang-over" effect; no known toxic effects to operating room staff; non-explosive with excellent muscle relaxation. It is also very insoluble leading to very rapid induction and recovery times. Its disadvantages are respiratory depression (although less than halothane) and its cost (approx $130 per 100 mL).
Halothane can also be used, but has the disadvantages of longer recovery, a "hang-over" effect, and increased risk to operating room staff. Under halothane anaesthesia respiratory arrest and cardiac arrest are almost simultaneous. Isoflurane is only 0.3% metabolised as opposed to 15% for halothane.

Ketamine-Xylazine in combination can also be used. Given iv it produces rapid induction and recovery. However IM administration leads to a prolonged, often violent recovery with hypothermia. The following doses are given as a guide only (from Dr. Bob Doneley's notes). The dose given is the volume of Ketamine; an equal volume of Xylazine is given at the same time.

	IM	**IV**
Budgerigars	0.01	0.005
Cockatiel	0.02	0.01
Rosella	0.07	0.035
Galah	0.05-0.1	0.025-0.05
Cockatoo	0.12-0.15	0.06-0.07

Monitoring

It is almost impossible to properly monitor a bird and operate at the same time. It is essential therefore to have an experienced person present to watch the anaesthetic. Anaesthetic planes can be monitored by:

- Rate and depth of respiration. This should be slow and deep. If too deep the respiratory rate will be slow and irregular.
- Heartrate - stethoscope, especially oesophageal types. Dopplers are difficult to use in birds.
- ECG - excellent if available. As a bird gets deeper, the T-waves become smaller and may totally disappear. As the depth further increases the R-wave will increase in magnitude and the S-wave is reduced.
- Palpebral Reflex.
- Corneal Reflex. Loss of this signals a deep plane.
- Movement- Wing flutter is often an early indicator that the patient is becoming light. However an excellent plane of anaesthesia for most proceedures is where wing tone has just

disappeared.
- Eyelids. Usually closed at light planes .

The goal is to maintain the lowest possible level of anaesthesia to achieve adequate restraint.

Air Sac Anaesthetic Administration

Useful when operating on the head, trachea or syrinx. Also can be life saving in emergency cases of seed aspiration. The approach used is the same as for surgical sexing: right lateral recumbency with the leg extended caudally. A small skin nick is made anterior to the leg about mid-femur, and access is easily and rapidly made to the left caudal abdominal air sac, by blunt dissection with fine scissors or haemostats. A shortened endotracheal tube is then inserted.

Body Temperature Control

Birds rapidly lose heat during operations due to removal of feathers, application of excess alcohol, contact with cold operating surfaces, continual flow of cool anaesthetic gases, and as a normal response to anaesthesia.

Hypothermia causes prolonged recoveries, delayed return of normal physiological function and even cardiac arrhythmias. It is time-dependent under GA and becomes significant after even 20 minutes. A loss of 5°C can be fatal.

Body temperature can be monitored by a conventional thermometer inserted in the cloaca, but this takes 3-5 minutes to give an accurate reading. In the USA (and human hospitals here) tympanic scanners are now being used which give a reading in 5-6 seconds.

Apart from speed, heat loss is minimised by heating pads, the use of warmed fluids for IV administration, skin preparation and lavage and avoiding alcohol swabbing. Heat lamps and hot water bottles can also be used. Keep in mind that heating pads often need 15 minutes to warm up. Use towels to cover cold surfaces. Post-op warmth is also essential.

Haemostasis

Haemostasis is crucial in birds even though being able to suffer a 10% loss in blood volume. In a budgie this means only 4 to 5 drops! Any more will likely cause death. Avian blood vessels are relatively thin-walled and surrounded by less perivascular tissue. They are prone to move and retract from view. Even after radiocoagulation some may relax and begin to leak blood. Ligation provides the most secure method of haemostasis. Often tumours are closely adherent to underlying musculature. Although they can be dissected free, the muscle surface usually continues to ooze blood. Ligation is no use here. Cautery, either radio or heat, is necessary.

Steps to improve haemostasis include:

- Radiosurgery - "Ellman Surgitron". The use of bipolar forceps enables one to dissect and cauterise at the same time.
- Cautery
- Magnification and good Lighting enables visualisation of blood vessels. Avoid them or ligate them before proceeding.
- Replace lost blood or counter shock with the administration of warmed fluids either during or immediately on completion of any procedure. It has been suggested that all birds suffering disease or trauma can be assumed to be at least 10% dehydrated. Be careful of fluid overload . The maximum acute fluid load that can be tolerated by healthy patients is 90 mL/kg/hr. In a cockatiel this would be a maximum of 9 mL per hour or 0.15 mL per minute.
- Fluids can be given intravenously, intraosseously or subcutaneously. Unless hypoglycaemic use lactated Ringers.

Post-operative

Whatever the means used to minimise heat loss, at the end of the procedure the bird will be experiencing some degree of hypothermia. It needs some form of direct heating. Heated recovery cages are another essential part of successful avian surgery. Initially the bird should be kept at 30°C. Perches should be removed or lowered to prevent injury. The cage should be located in a quiet area of the hospital, but where it is easily monitored. Food is offered once the patient is fully recovered from the anaesthetic. The bird should be checked regularly during the next few hours for dyspnoea, haemorrhage, return of appetite etc.

Antibiotics should only be used where there is a specific indication such as with open contaminated wounds, or where there has been intra-operative contamination of the surgical field.

Patients should be hospitalised overnight following all but the most minor procedure. I only discharge patients when I am convinced that they are eating well and maintaining body weight. Daily weighing of all avian patients before treatment should become part of your routine daily assessment.

Analgesics

Research in the area of avian pain has been minimal, and it has been assumed that birds have a great capacity to deal with pain. This is an area of growing awareness in veterinary therapies. One study involving the use of Butorphenol in budgies found that this drug was safe to use up to the level of 3mg/kg. The recommended dose of Butorphanol is 0.2 to 0.4 mg/kg.

The same trial also tested Flunixin meglumine at the recommended dose in birds of 1-10 mg/kg SID IM,IV. It caused vomiting soon after administration in five out of six birds trialed. Also, it is most effective against inflammatory pain rather than surgical pain and therefore perhaps not warranted post-surgery in birds. Aspirin has been recommended at a dose of one 500 mg tablet dissolved in 250 mL drinking water. Both these non-steroidal agents have the potential to cause severe gastrointestinal upsets and may prolong clotting time. They should only be used with caution if at all.

Suggested Further Reading

1. Avian Medicine: Principles and Application. Ritchie, Harrison and Harrison (editors). Wingers Publishing Inc. 1994.

2. Avian Medicine. Proceedings 178. The Post-Graduate Committee in Veterinary Science, The University of Sydney. 1991.

3. Exotic Animal Medicine In Practice (Vol. 1). The Compendium Collection Veterinary Learning Systems Inc. 1991.

4. Clinical Avian Medicine and Surgery. Harrison and Harrison (editors). W.B. Saunders Company. 1986.