Novel Technique for Scapulohumeral Amputations in Avian Species: A Case Series

Latney, L.,[1*] Runge, J.,[1] Wyre, N.,[2] Larenza-Menzies, M.P.,[3] Neville, C.[1] and Briscoe, J.[4]

[1] Department of Clinical Studies-Philadelphia, University of Pennsylvania School of Veterinary Medicine 3900 Delancey Street, Philadelphia, PA, 19104, USA.

[2] Zodiac Pet & Exotic Hospital G/F #4 Gordon Road Tin Hau, Hong Kong, China.

[3] University of Veterinary Medicine Vienna (Vetmeduni Vienna), Veterinärplatz 1, A-1210 Vienna, Austria.

[4] United States Department of Agriculture, Animal and Plant Health Inspection Service, 4700 River Road, Unit 84 Riverdale, MD 20737, USA.

* **Corresponding author:** Dr. La'Toya Latney, Matthew J. Ryan, Veterinary Teaching Hospital, University of Pennsylvania School of Veterinary Medicine 3900 Delancey Street, Philadelphia, PA, 19104, USA. Email: llatney@upenn.edu

ABSTRACT

This case series describes a novel technique for scapulohumeral amputations in three avian patients. A 28-year-old year old Umbrella cockatoo (*Cacatua alba*) presented with an open fracture of the left wing secondary to osteolysis caused by a humeral air sac adenocarcinoma. A 7-year-old Peregrine falcon (*Falco peregrinus*) presented with a chronic malunion fracture of the left humerus secondary to self-trauma which occurred after left metacarpal and radio-ulnar amputations. Finally, a 31-year-old Moluccan cockatoo (*Cacatua moluccensis*) with humeral head lysis and humeral air sac adenocarcinoma. Due to the extensive humeral disease, total wing amputations was indicated in each case. A novel surgical and local anesthetic approach was developed to perform scapulohumeral disarticulations with limited disruption of the clavicular air sac, limited vascular damage, nerve injury, and presumed decreased post-operative pain. Lidocaine and bupivacaine brachial plexus nerve blocks were used intraoperatively, and all birds recovered uneventfully from surgery. None of the cases exhibited post-operative pain as evidenced by immediate return to function, immediate recovery of normal behavioral repertoires, absence of pain on palpation of the surgical site and pectoral musculature. Extensive follow-up for all cases revealed no disease recurrence or surgical complications. This case series provides a detailed description of novel approach to scapulohumeral disarticulations that improves avian surgical welfare.

Keywords: Full Wing Amputation; Birds; Avian; Surgery; Intra-Operatively Nerve Block; Analgesia.

INTRODUCTION

Complete wing amputation procedures are indicated as the last surgical option when infectious disease, neoplastic disease, severe radial nerve paralysis, or when chronic malunion fractures compromise the systemic health of the patient. The following report describes a case series that underwent such procedures for those surgical indications.

Case 1

A 28-year old, captive bred, 580 g Umbrella cockatoo (*Cacatua alba*) presented to a Veterinary Hospital (University of Pennsylvania School of Veterinary Medicine) with a history of being found in the cage with incidental bleeding occurring from the left wing. Physical examination findings revealed 8% dehydration, pink mucous membranes and moderately decreased ulnar wing vein perfusion in the contralateral wing. Evaluation of the left wing revealed an open, comminuted fracture of the distal humerus. The patient was otherwise in overall good body condition.

Immediate supportive care consisted of supplemental fluid therapy (50 ml/kg SC q12h; Normosol Abbott Laboratories, North Chicago, IL, USA), including buprenorphine (0.03 mg/kg IM q12; Abbott Laboratories, North Chicago, IL, USA), and meloxicam (0.5 mg/kg IM q12hrs; Boehringer Ingelheim Vetmedica/Merial, St. Joseph, MO, USA) and ceftazidime (100mg/kg IM q8h; Abbott Laboratories North Chicago, IL, USA). The left wing was irrigated with sterile saline and cleaned with a dilute chlorhexidine solution. A wet-to-dry bandage was applied, and the wing was stabilized using a "figure of eight" bandage. The bird was placed in an incubator (ambient temperature 26°C) with supplemental oxygen (2 L/hour) and continued to eat and drink on its own while hospitalized.

Twenty-four hours after admission and stabilization, complete blood cell (CBC) count revealed a significantly decreased packed cell volume, (PCV 20%: Reference Range (RR): 42-55%) (1) and a regenerative anemia evidenced by a marked reticulocytosis (118,000 absolute count, or 8%) (1). A slightly elevated total white blood cell count (26.4 x 10^3/µl, RR: 4-10 10^3/µl) and a marked relative heterophilia (91%, RR: 45-80%) were noted (1). Biochemistry results were unremarkable (1).

Forty-eight hours after initial hospitalization, whole body radiographs were acquired. On ventrodorsal radiograph, a left distal humeral fracture was visualized. The medullary cavity of the proximal portion of the humerus was radio-opaque, suggesting that the humeral air sac contained a soft tissue or fluid opacity (Figures 1). Abnormal gas densities were appreciated in the proventriculus and ventriculus, suggestive of a possible ileus. Other radiographic findings were within normal limits. Repeated packed cell volume revealed a significant increase from 20% to 30% (RR: 42-55%) (1).

After careful radiographic evaluation, a complete left wing amputation was elected as the radio-opaque humeral air sac lesions where strongly suggestive of neoplasia. Four days after hospitalization and stabilization, the bird was taken to surgery. Surgical disarticulation of the left scapulohumeral joint and amputation is described below. The patient's anesthetic recovery was uneventful and the bird was eating and drinking within two hours of surgery with no evidence of post-operative pain on palpation. The bird was discharged 24 hours post-operatively with a compounded chloramphenicol suspension (50mg/kg PO q12h for 14 days; Rhone Merieux, Athens GA, USA) and meloxicam (0.5mg/kg POq12h for 4-5 days).

Follow up at 7 days post-operatively revealed a complete recovery from the prior anemia, normal healing at the incision site, and the absence of pain on palpation of the surgical site and pectoral region. The owner reported a complete return to normal behavior. Histopathology of the wing confirmed humeral air sac adenocarcinoma, with neoplastic cells contained within the bone. Radiographs taken 2 months post-operatively revealed an absence of disease recurrence. Follow-up at 7 months after surgery revealed no recurrence of disease, normal behavior, and no pain on palpation of the operative site or corresponding pectoral musculature. A recheck examination performed at 3 years after surgery was unremarkable and the owner reported normal behavior and no pain or difficulty with ambulation since amputation.

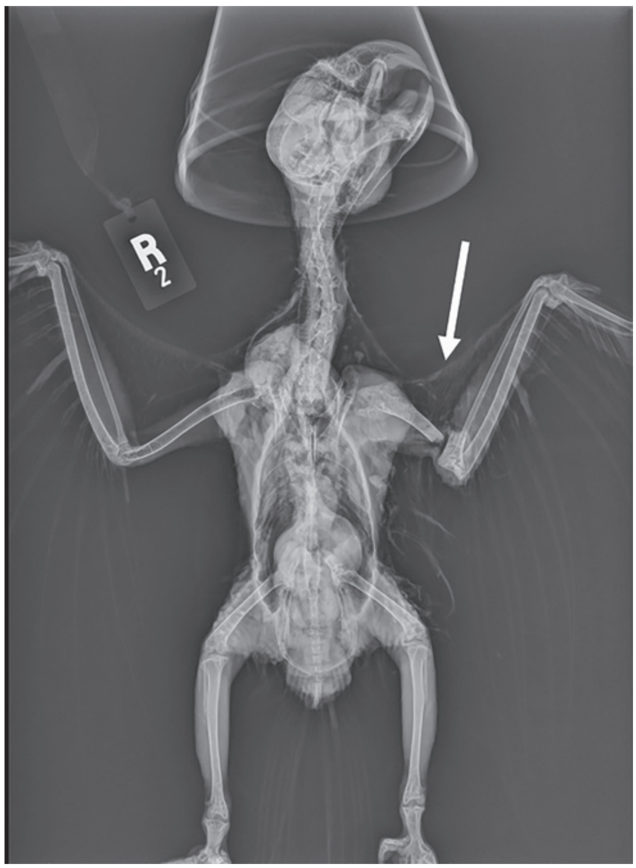

Figure 1: Umbrella Cockatoo. Digital radiograph, ventrodorsal view. Arrow notes humeral fracture.

Case 2

A 7-year old male captive Peregrine falcon (*Falco peregrinus*) presented to the veterinary hospital with a non-healing skin lesion at the distal humeral amputation site of the left wing. In an effort to treat a wing frostbite, previous metacarpal and radio-ulnar amputation procedures were performed by the referring veterinarian at 6 months and 2 months previously, respectively. Aggressive flapping secondary to stress led to continual damage at the initial surgery site. On presentation, the patient was 520 grams, well hydrated, bright, alert, responsive and overall in good body condition. Physical examination abnormalities included mild feather loss along the left stifle, and exposed granulation tissue along the amputation site. Muscle atrophy was noted along the proximal aspect of the left humerus with significantly decreased range of motion in the shoulder joint. A CBC count revealed a mild elevation in total protein (4.7 g/dL, RR: 2.1-4.3 g/dL) (2). The biochemistry results revealed elevations in creatine phosphokinase (5772, RR: 283-1431 U/L) (2). Whole body radiographs revealed a malunion of a chronic, caudoventrally displaced proximal humeral fracture of the left wing (Figure 2). A small amount of focal sclerosis and proliferative bone was noted at the distal end of the left humerus.

After careful evaluation of the radiographs and surgical history, a complete left wing amputation was planned. The patient was treated with meloxicam (0.5 mg/kg IM q12h) 24 hours prior to surgery. Surgical disarticulation of the left scapulohumeral joint and amputation of the left wing was performed as described below. The patient's anesthetic recovery was uneventful. The patient ate within 12 hours of surgical completion and showed immediate ability to perch and ambulate after complete wing amputation. The bird was maintained on meloxicam (0.5 mg/kg PO q12h for 5 days) to provide analgesia, and trimethoprim sulfamethoxazole (30 mg/kg PO q12hr for 10 days; Alpharma Inc., Fort Lee NJ., USA), and itraconazole (10 mg/kg PO q12hr for 10 days; Janssen Pharmaceutical Products, Raritan NJ, USA) post-operatively to prophylactically treat any subclinical bacterial

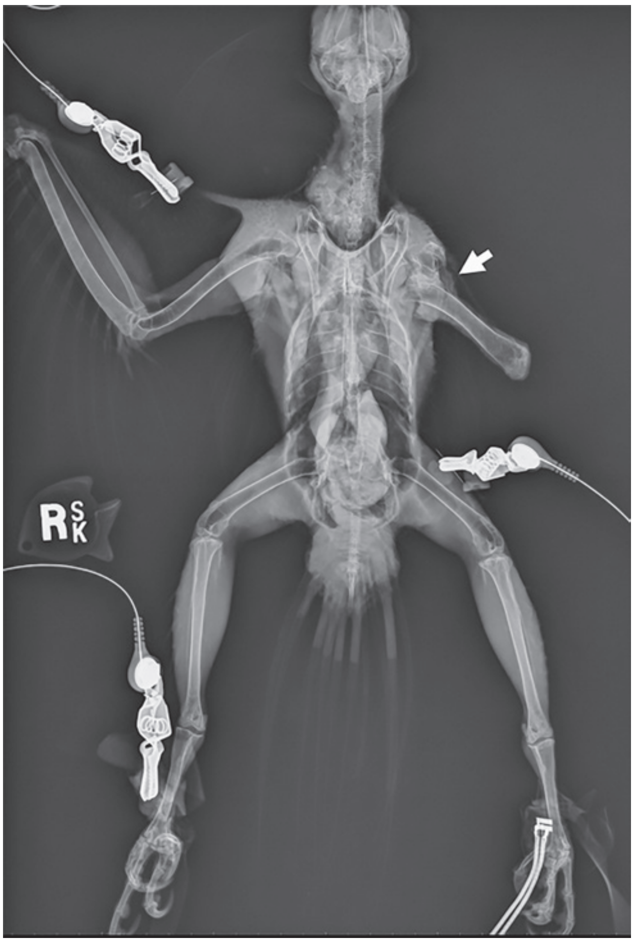

Figure 2: Peregrine falcon. Digital radiograph, ventrodorsal view. Arrow notes chronic malunion humeral fracture.

Figure 3: Moluccan Cockatoo. Digital radiograph, ventrodorsal view. Arrow notes humeral head lysis.

and/or fungal infections (3-5) that could flourish secondary to anesthesia-induced immunosuppression (6-10).

Follow-up at 14 days revealed a healing incision site, no pain on palpation of the surgery site or pectoral musculature, and a return to normal behavior. At 5 months after surgery, recheck examination was unremarkable. Recheck at 3 years after surgery confirmed no difficulty with ambulation despite wing amputation, no pain on palpation of the site and pectoral musculature and a return to normal behavior, with normal return to function as a teaching animal in a rehabilitation facility.

Case 3

A 31-year-old Moluccan cockatoo (*Cacatua moluccensis*) presented to the veterinary teaching hospital with progressive lysis and sclerosis of the right proximal humerus, soft tissue opacity of the medullary cavity of the humerus, and a soft tissue attenuating mass-like lesion in the location of the right clavicular and interclavicular air sacs. The lesion was first documented 5 months previously as an incidental finding on radiographs. Due to the progression of the lesion as seen on radiographs and computed tomography, amputation was determined to be the best treatment option (Figure 3). On presentation, the patient was bright, alert, responsive, and in good body condition. Physical examination findings revealed a weight of 645 grams, adequate hydration, good ulnar wing vein perfusion, and had evidence of feather destruction to the retricies, remiges and pectoral covert feathers. There was no decrease in range of motion or pain on palpation of the humerus. A complete blood cell count from 2 weeks previously showed a heterophilia (80%, RR: 15-64%), a lymphopenia (9%, RR: 29-83%) (1). A biochemistry panel from 2 months' prior showed no abnormalities (1).

The patient was treated with meloxicam (0.5 mg/kg IM q12hrs) and premedicated with buprenorphine (0.03 mg/kg IM) 24 hours prior to surgery. Surgical disarticulation of the left scapulo-humeral joint and amputation of the right wing was performed as described below. The patient's anesthetic recovery was uneventful. The patient ate within 4 hours after surgery, and did not reveal any ambulatory defects. The bird was maintained on meloxicam for 5 days to provide analgesia and trimethoprim sulfamethoxazole (30 mg/kg PO q12hr for 10 days) to prevent post-operative skin infections. Histopathology confirmed humeral air sac adenocarcinoma and repeat computed tomography imaging 6 months post-operatively revealed a normal right clavicle within no disease in the clavicular air space. Total patient follow up has been maintained for 3 years, and there has been no recurrence of disease, normal return to behavior and no pain on palpation of the surgical site and corresponding pectoral musculature.

SURGICAL APPROACH & DESCRIPTION

The patients were premedicated with midazolam (0.4 mg/kg; Roche Pharmaceuticals, Nutley NJ, USA) prior to gas induction of 5% sevoflurane in oxygen delivered via face mask in oxygen (1 L/min) delivered via a tight face mask with the precision vaporizer set at 4-5% utilizing a non-rebreathing Bain system (Patterson Scientific, Wisconsin, USA) on a small animal anesthesia machine (Narkomed GS, Telford, PA, USA). Once anesthetized, the patients were intubated with uncuffed endotracheal tubes, and maintained on 2-3% sevoflurane (Vapor 19.1, Telford, PA, USA) during the procedure while maintaining intermittent positive pressure ventilation. A 26G IV catheter was placed in the medial metatarsal veins immediately after endotracheal intubation and an infusion of Crystalloids (Lactated Ringer's solution; 10 mL/kg/h) was delivered IV throughout the entire procedure. Anesthesia was maintained with isoflurane in oxygen (2.5%-3.5%). Intraoperative monitoring consisted of lead II electrocardiogram and heart rate (MDE Escort Model E 100, Arleta, CA, USA), systolic blood pressure with a Doppler probe placed on a medial metatarsal artery and a size 1 cuff place around the tarsus/metatarsus, respiratory rate and end-tidal carbon dioxide measured with a sidestream monitor attached to a port on the endotracheal tube adaptor (Criticare Systems, Inc., Waukesha, WI, USA). Cloacal temperature was maintained between 36.6-38.1 degrees Celsius by means of warmed forced air (Bair-Hugger 505, Augustine Medical, Inc. Eden Praire, MN, USA), intraoperative plastic drapes and an infrared heating lamp.

Under general anesthesia, the feathers were manually plucked from the keel and the remaining affected thoracic limb. Margins of the feather removal extended anteriorly to the keel, caudally to the last rib, posteriorly to the spine, and cranially to the thoracic inlet.

The patient was positioned in lateral recumbency and supported with the aid of foam positioning wedges. The wing was suspended using the "hanging leg drape" technique. The distal aspect of the wing was grasped using a small Backhaus towel clamp and suspended above the patient using adhesive tape attached to a standing IV pole. The patient's exposed skin was then scrubbed with 2% chlorhexidine solution and aseptically prepared for surgery. The sterile field was established using sterile quadrant drapes to cover all non-sterile surfaces and secured with small Backhaus towel clamps. The distal aspect of the limb was grasped and wrapped using sterile adhesive wraps (Vet Wrap, 3M Animal Care Products, St. Paul, MN, USA). A clear plastic fenestrated drape (Veterinary Transparent Surgical Drapes, Veterinary Specialty Products, Boca Rotan, FL, USA) was placed over the limb to add an additional barrier over the sterile field.

The skin was incised elliptically approximately 5 mm from the gleno-humeral articulation (Figure 4). Hemostasis was maintained using bipolar radio-cautery forceps (Ellman Int. Inc, Hewlett, NY, USA). Using blunt dissection, the skin was carefully dissected and reflected circumferentially from the underlying musculature to aid in the exposure of the tri-osseum muscle [*canalis triosseus*] origin.

All musculature was dissected using bipolar radiocautery forceps (Ellman Int. Inc, Hewlett, NY, USA). The humerus was approached ventrally with the superficial and deep pectoral muscles being removed at the proximal attachments on the humerus (Figure 5). The propatagialis muscle complex was identified and the tendons of the complex were transected just distal to the muscle to preserve tissue for coverage during closure. The propatagialis complex was partially transected proximally from its clavicular origin (Figure 6). The *biceps brachii m.* was transected distal to its proximal humeral origin. The brachial and sub-scapular arteries were identified and ligated using an absorbable monofilament polydioxanone suture (4-0 polydioxanone (PDS), Ethicon Inc. Sommerville, NJ, USA) and then transected.

The *supracoracoideus m.* and the *coracobrachialis cranialis m.* were transected at their insertions on the dorsal humeral tubercle and the ventral humerus, respectively. The *deltoideus* major and minor were transected at their humeral insertions (Figure 7). Using a tuberculin syringe fitted with a 30-gauge needle, a 0.02 ml volume of a 0.125% lidocaine (Hospira, Lake Forest IL, USA) and 0.125% bupivicaine (US Pharmacopeia, Rockville MD, USA) mixture was infused into the perineural sheaths of the cranio-pectoral, axillary, radial nerves prior to being sharply transected (Figure 7). The nerves were placed against a flat surface during scalpel transection to reduce residual nerve trauma and neuroma formation (12-16). The *humerotriceps m.* and *scapulotriceps* m. were then isolated and transected distally (Figure 8). The humerus was disarticulated from the clavicle, coracoid and scapula using bipolar cautery. The exposed tissue was then irrigated with saline and 0.02 mls of the lidocaine and bupivicaine mixture was distilled onto the muscle bellies.

The scapula, coracoid and exposed clavicular air sac were covered and protected using *pectorals and deltoideus m.* apposed superficial *rhomboideus m.* and *serratus ventralis m.*

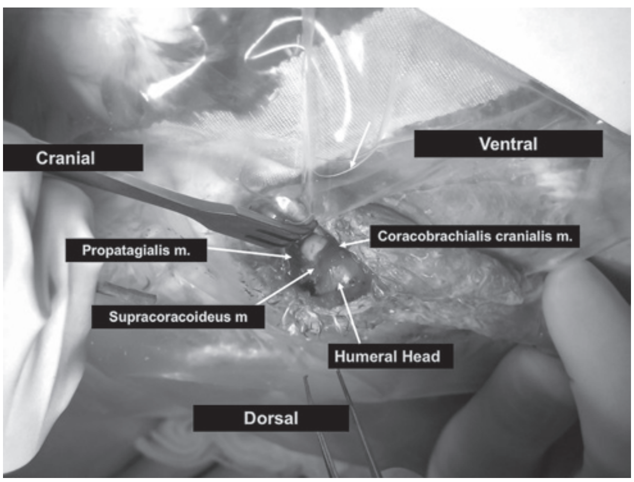

Figure 4: Dissection of Superficial and caudodorsal muscles humerus. (a) An elliptical Incision is made around the scapulohumeral joint to get exposure to humeral head. (b) The *rhomboideus superficialis* m., the cranial head of the *lattismus dorsi*, and serratus ventralis m. are transected for the caudodorsal portion of the elliptical approach.

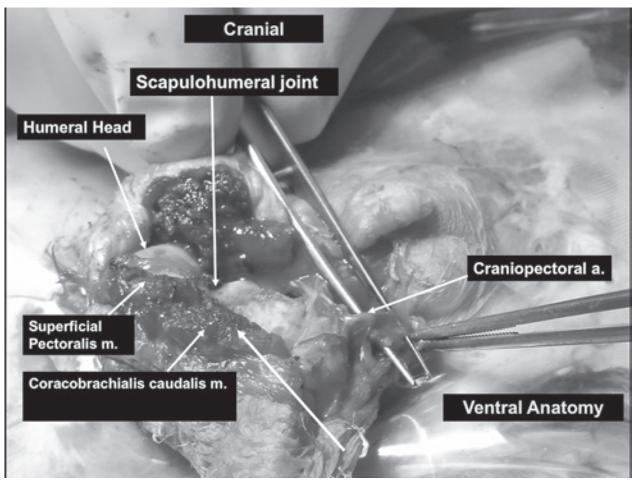

Figure 5: Dissection of the Ventral attachments. (a) The superficial and deep pectoral muscles are removed from their proximal humeral attachments. (b) Once the wing is retracted laterally, this provides exposure to the scapulohumeral joint.

using 3-0 PDS (Figure 9). The subcuticular tissue was then apposed in a continuous pattern using absorbable monofilament polydioxanone 4-0 PDS. The skin was then closed using 3-0 Nylon using a Ford interlocking pattern.

DISCUSSION

This case series presents a dual orthopedic and anesthetic approach to scapulohumeral disarticulation of the wing. Species-specific avian thoracic girdle and brachial plexus anatomy were carefully examined to develop a surgical approach that would maximize post-operative pain management for different avian species that have undergone complete limb amputation. The use of lidocaine and bupivicaine for an intra-operative brachial plexus block is the first to be reported in psittacine and raptor clinical cases.

Avian orthopedic anatomy and surgical procedures have been well described (17-32). As wing salvage is paramount for optimal quality of life, indications for complete wing amputation are limited and case reports are scarce. Indications for full wing amputations include severe proximal humeral and/or humeral air sac infectious or neoplastic disease (31,33-34) invasive neoplastic disease at the elbow joint (32) severe radial nerve paralysis (35), and chronic proximal humeral malunion fractures.

Surgical exposure of the scapulohumeral joint disrupts the anatomical components necessary for flight. It requires the excision of complex muscle bellies (superficial and deep pectoral muscles, disruption of the protagium musculature) and can involve risk to the axillary vessels, axillary nerves, and intramedullary air sacs. The classic approach to the proximal humerus involves making a linear incision along the lateral aspect of the humerus (19) but does not provide ideal exposure for scapulohumeral disarticulations. The ventral approach to the clavicle and coracoid has also been described (19). Claviculohumeral articulation seen in this approach does provide some exposure of the shoulder joint. Unfortunately, the ventral approach involves significant pectoral muscle excision and provides limited exposure of the entire scapulohumeral joint. These orthopedic approaches are thought to commonly result in painful recoveries experienced by human amputees secondary to articular, nervous and periosteal pain (15,16).

Successful thoracic girdle surgeries in raptors and psittacines have been reported (28-33). However, several scapulohumeral case reports, which employed the ventral or dorsal surgical approaches either lack detailed surgical descriptions, note air sac rupture, or exclude the use of nerve blocks (30-34). To the best knowledge of the authors there are no reports that describe a scapulohumeral disarticulation method which minimizes disruption of the coracoid and clavicular articulations of the thoracic girdle, minimizes transection of the pectoral musculature, and describes minimized risk of breech into the thoracic cavity.

The novel approach developed in this case series provided

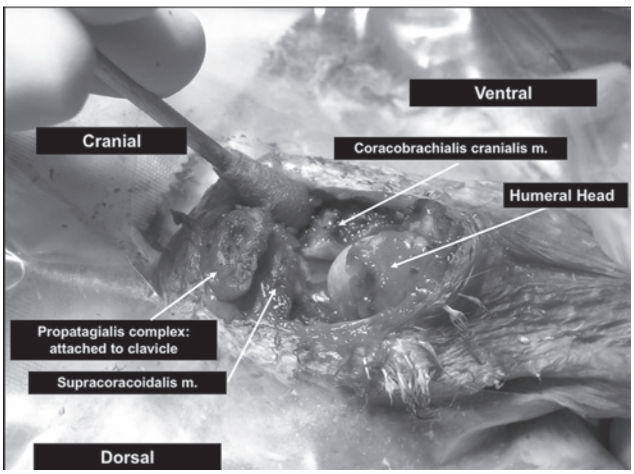

Figure 6: Exposure of the Joint. (a) The *propatagalis* complex can be partially resected from its insertion on the humeral head. (b) The *supracoracoidalis* m. is removed from his proximal insertion on humeral head. (c) The *coracobrachialis cranialis m.* is removed from its caudal insertion on the humeral head.

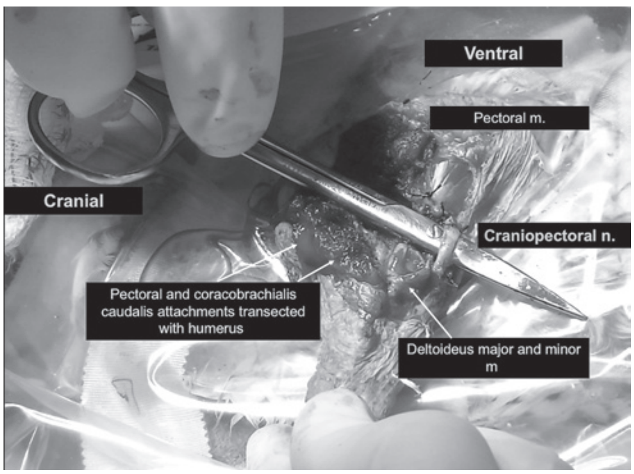

Figure 7: Exposure of the Plexus. The wing is retracted laterally now that the pectoral attachments have been released. (a) The *deltoideus major* and *minor mm*. are transected from their insertions on the humerus. (b) The plexus is exposed for ligation and transection.

ideal surgical exposure of the scapulohumeral joint. The benefits of employing this featured approach include: (1) an elliptical approach that isolates shoulder joint specifically; (2) minimal major muscle belly resection prior to intra-operative axillary nerve block; (3) a neurectomy technique employed to reduce nerve injury and neuroma formation (11-14); and (4) use of a *minute* capsular disarticulation with the use of bipolar cautery that serves to limit clavicular air sac damage. Intra-operative causes for secondary air sacculitis can develop from hemorrhagic leakage into the air sac, bacterial contamination of the air sac, and/or the seeding of neoplastic cells into the air sac.

Successful surgical outcomes were determined based on post-operative follow-up for each patient spanning 3 years, with no evidence of immediate or chronic post-operative complications confirmed by imaging, absence of recurrent disease, return to normal function and behavior, and absence of pain on palpation of the surgical site and pectoral musculature.

There are many challenges with managing pain in avian patients, due to several reports that highlight species-specific variation in response to different classes of analgesics, particularly opioids (36, 37). In addition, recognition of pain in the avian patient is dependent upon the knowledge and detection of changes in species-specific behavior repertoires. Clinicians are left to manage pain with extrapolated drug dosages for several avian species from the few empirical pharmacokinetic, and pharmacodynamic studies on select analgesics that are available (36, 37). During the timeline of presentation for these cases (2008-2013), literature on opioid use and non-steroidal anti-inflammatory (NSAID) drug use in raptors and psittacines was largely developing, and when available, was used to guide dose selection in all three cases to provide pre-emptive and post-operative analgesia. In retrospect, the pre-operative use of buprenorphine, meloxicam, and tramadol cannot be excluded as contributors to optimize pain control. However, given the analgesic response variability reported in the literature for different classes of analgesics in birds, the importance of mitigating pain intra-operatively and post-operatively with the use of local analgesics became paramount.

Literature documenting the use of local and regional anesthesia for orthopedic pain management in avian medicine is limited (33). Meta-analyses studies of pain management in human shoulder surgery has linked the use of local anesthetics with the reduction of immediate post-operative pain, reduced incidence of phantom limb pain (16,38), a reduction of central neuroplasticity and pathological pain (16) and shorter post-operative recovery times (15,39). The use of 0.125% to 0.25% bupivicaine is not only used intra-operatively in human orthopedic surgeries, it is also commonly used in combination with opioid therapy for intravenous

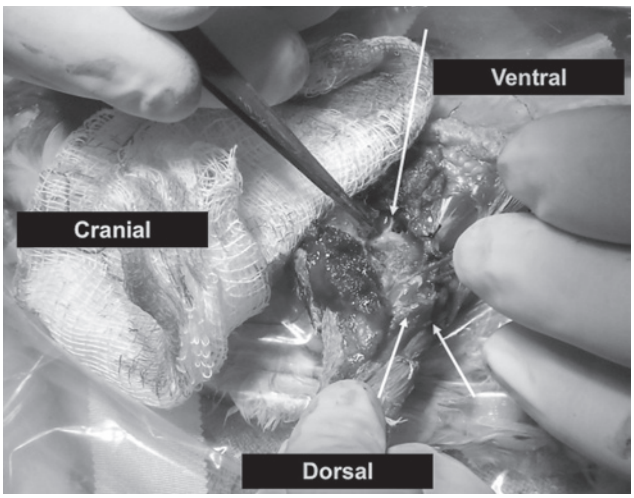

Figure 8: Disarticulation of the joint. The wing is retracted dorsally. (a) The remaining craniodorsal attachments of the *scapulotriceps m.* and *humerotriceps m.* are transected distally. The humerus is disarticulated from the clavicle, coracoid and scapula. (b) Note the air sac at site of scapulohumeral disarticulation.

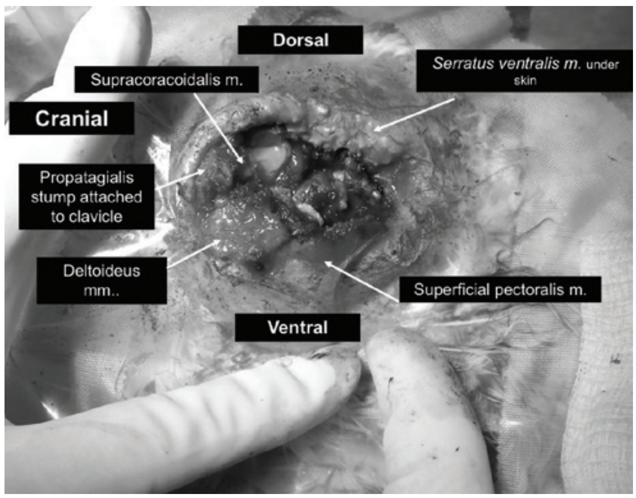

Figure 9: Closure of the Surgical Site. (a) The *deltoideus major and minor mm*, *superficial* and *deep pectoral mm*, *rhomboideus* m. and *serratus ventralis m* are apposed over the axillary defect. (b) The skin is closed in a Ford Interlocking or simple continuous pattern.

patient controlled analgesia in humans (15, 40-42). The use of bupivicaine, its isomer levobupivicaine, and ropivicaine have all been studied in humans for efficacy and potency in nerve blockade and analgesia for out-patient orthopedic and arthroscopic procedures (40-43). Studies analyzing the potency of these agents in rats (45-46), dogs (47, 48, 49), domestic fowl (50-54), and psittacine (55), indicate some degree of comparable analgesic potencies to those seen in human medicine. Preliminary work in avian pain management that has investigated the efficacy of specific local anesthetics has been in beak amputations (50), articular pain models (52), and brachial plexus nerve blockade (54-58). The results of these avian studies, reviewed in conjunction with our current understanding of avian pain physiology (36, 37), fosters the justification for the use of local anesthetics in avian patients as standard of care when there are indications for surgical orthopedic procedures.

Brachial plexus blocks and continuous regional anesthesia and analgesia provide a multimodal approach to reduce pain in small animal anesthesia. The incorporated use of indwelling catheters for regional anesthesia in small animals mirrors the success noted in human pediatric medicine (44) regarding pain management, ease of catheter placement, and minimal post-operative complications (47-49).

There are new investigations that explore the use of different brachial plexus block techniques in birds, however inconsistent results have been reported (54-58). For avian species, local analgesia concentrations, site of injection, instillation volumes and contact times at the site of brachial plexus remain unknown for several species. This is compounded by the nature of brachial plexus anatomical variations across species, whereby access to the plexus is more challenging in parrots due to highly developed pectoral musculature, which can make visualization more difficult (57). In one study, the exact causes for the reported high failure rates (67% success) for peripheral blockade are unknown, however the authors speculate that this may be due to reduced stationary contact time of the analgesic in the plexus, needle position relative to the position of the central or perpendicular axis of the plexus (58), and/or avian specific perineural sheath diameters that require different dosage, volume, and contact times as compared to mammals (58).

In this case series, the choice to carefully employ the use of an intra-operative block was elected due to the lack of consistent evidence of peripheral brachial plexus nerve block efficacy in avian species (54-58). To optimize local analgesic nerve contact, perineural sheath blocks were carefully performed, with low volumes of lidocaine and bupivicaine to prevent injury to the nerve. Accidental nerve injection has been reported in the human literature as a primary cause of potential neuronal injury, which can cause axonal injury in the absence of clinical signs (59). However, the report of residual clinical neuronal pain, secondary to accidental epineural injection, appears to be variable and as evidence of the true incidence of morbidity grows, the use of intentional intraneural injections to optimize block efficacy, remains a controversial safety issue in human medicine (60, 61). In this case series, the authors elected to carefully employ the use of a low pressure, perineural (outer epineurium) sheath injection method. It is believed that an injection into the connective tissue surrounding the nerve bundle provides an intimate exposure of nerve fascicles to high concentrations and doses of local anesthetics, without needle penetration into the nerve fascicles, and this can result in prolonged blockades without sustained neuronal injury (62). High pressure intraneural injections and intrafascicular injections have been shown to cause neurologic defects coinciding with neuronal injury due to axonolysis and cellular infiltration (62, 63).

Effective dose and local anesthetic toxicity reports in avian species are scarce. Ropivicaine, a less cardiotoxic and less CNS toxic local anesthetic agent that bupivicaine, has been studied in chickens (54). Utilizing a transpectoral injection (90-degree angle to the wing and neck) approach to block the brachial plexus, instillation of one milliliter of 0.75% of ropivicaine (7.5 mg/kg) resulted in a sensory and motor blockage in 5 of 6 chickens with no appreciable signs of toxicity, however mean arterial pressure (MAP) and heart rates (HR) were not reported. Intravenous lidocaine has been administered to anesthetized chickens and no clinically significant decrease (>30%) in MAP or HR was observed at 6 mg/kg, offering that this anesthetic may have a reduced toxicity profile than previously assumed (64). The cardiovascular tolerance of intravenous bupivicaine has also been evaluated in chickens, and one such study has established an effective dose limit for clinically significant changes in MAP and HR (65). This study revealed a 1% likelihood of a clinically significant decrease (>30%) in MAP or HR at 1.33 mg/kg delivered IV in 50% of a population, and a 50% likelihood for the same decreases in MAP and HR at 1.96 mg/kg (65).

The doses of lidocaine and bupivicaine (0.5mg/kg) administered as perineural injections in this case series, were chosen prior to the publication of the aforementioned toxicity studies. Effective blockades were suspected based on a hastened post-operative recovery, absence of pain on palpation of the surgical site, immediate return to function (ability to perch and ambulate) after surgery, and the clinical absence of neuropathic pain defined as pain on palpation, and self-mutilation of the surgical site.

CONCLUSION

The surgical approach to avian scapulohumeral surgery should entail a detailed anatomical knowledge of the thoracic girdle and use of local analgesic pain management. This case series reveals a detailed, illustrated surgical approach that can be employed to reduce surgical complications, by limiting air sac disruption and excessive hemorrhage, and limiting post-operative neurologic pain due to nerve injury. The incorporation of intra-operatively nerve blocks should be employed in efforts to decrease post-operative pain, reduce recovery time, and reduce neuropathic pain in avian patients, especially if pre-operative brachial plexus blockades fail. The use of a combination of bupivicaine and lidocaine is the first published in avian scapulohumeral disarticulation cases. Further investigations are warranted for the use of local anesthetics regarding dose efficacy and potency, species-specific variations, duration of action, infusion techniques, and the safety of less toxic local anesthetics.

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