Veterinarski Glasnik 2025, 79(2), 181-189
UDC: 598.252.3:591.471.37
https://doi.org/10.2298/VETGL250225018K

Case Report

ANESTHESIA AND SURGICAL MANAGEMENT OF HUMERAL FRACTURE IN THE WILD SWAN

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Received 25 February 2025; Accepted 09 September 2025
Published online: 07 November 2025

How to cite: Petar Krivokuća, Milan Hadži-Milić, Maja Vasiljević, Dragan Ristanović, Risto Dučić, Stefan Veličković, Bogomir-Bolka Prokić. Anesthesia and surgical management of humeral fracture in the wild swan. Veterinarski Glasnik, 2025. 79(2): 181-189. https://doi.org/10.2298/VETGL250225018K

Abstract

A wild, unmarked swan with a trauma of the left wing was found in the Belgrade metropolitan area. After a physical and radiographic examination, it was determined that the swan had a fracture of the left humerus. After a one-day stabilization, the swan underwent intervention, stabilization of the left humerus with an intramedullary pin, a plate (LC DCP 2.7 mm) and 8 × cortical rods (2.7 mm). The patient was under complete monitoring during the surgical intervention under general inhalation anesthesia (sevoflurane). According to our knowledge is the first described case of surgical repair of a fractured humerus in a wild swan in Serbia. After the surgical procedure was performed, the wild swan was under constant veterinary supervision. After full recovery, the swan was released at the location where it was found. This case presents the importance of quick and adequate patient evaluation, selection of a proper anesthetic protocol, and importance of postoperative care in avian orthopedic patients.

Key Words: humerus, monitoring, orthopedic intervention, wild swan

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CASE PRESENTATION

The mute swan (*Cygnus olor*, Gmelin, 1789), a large water avian species with well-developed wings, began to inhabit the northern parts of Serbia in the eighties of the last century (Hulo, 1997). This aim of this paper is to present a case of a wild swan with an orthopedic wing trauma and the method of postsurgical rehabilitation that was used. According to our knowledge, this is the first described case of surgical care and anesthesiology protocol for osteosynthesis of a humerus fracture in a wild swan in our country. All procedures were conducted in accordance with the Directive 2010/63/EU in Europe and the Law for animal welfare protection, Republic of Serbia.

The injured wild swan was found in the Belgrade metropolitan area. It was brought to the Clinic of Surgery, Orthopedics and Ophthalmology of the Faculty of Veterinary Medicine in Belgrade with trauma of the left wing due to collision with a light pole. Eyewitnesses confirmed that after collision, the bird fell onto the grass from a height of approximately 10 m, and it was unable to fly. The swan was male, approximately one-year-old, in good health condition and 8.6 kg body weight. Upon physical examination, it was revealed that the swan suffered a closed fracture of the humerus with hematoma along the injured area. Radiographic examination confirmed the multifracture injury (Figure 1). After detailed analysis, it was decided to insert an intramedullary pin and a plate to stabilize all humeral fragments. The swan was stabilized with therapy (analgesics, antibiotics, and fluid therapy), and its wing was immobilized with an elastic bandage to return it to its anatomical position and secure it to the swan's body. After 24 h of continuous observation in the Intensive Care unit, surgery was performed.

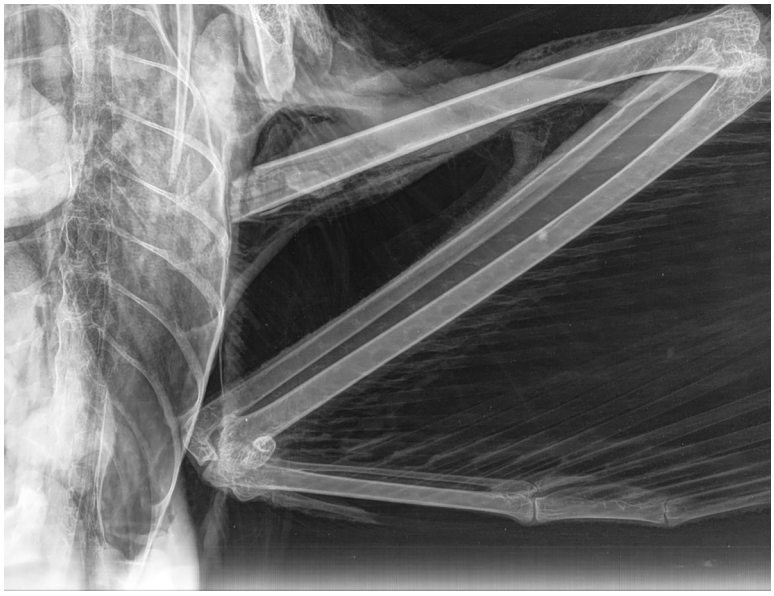

Figure 1. X-ray of the fractured humerus of the left wing

Prior to general anesthesia and surgery, the bird underwent thorough clinical examination in a quiet environment. The American Society of Anesthesiologists (ASA) grade was used to evaluate the bird's status (it was ASA II), in order to prevent any anesthesia risk. The body temperature was 39.4°C, and the bird was 5% dehydrated, estimated measuring skinfold elasticity, corneal moisture and prominent degree of eyes. Sedation was by an intramuscular injection (IM) of medetomidine 100 μg/kg b.w. mixed with ketamine 5 mg/kg b.w. in the same syringe. The mixture of medications was applied into the pectoral muscles to reduce stress levels. Pain was reduced with meloxicam at a dose of 1 mg/kg b.w. IM. Intravenous (IV) catheter (22G intravenous catheter) for injections and fluid therapy was introduced into the medial metatarsal vein of the right leg (Figure 2). Warmed lactated Ringer's solution, 50 ml/kg/ b.w./day IV, was given slowly twice a day in the medial plantar metatarsal vein during patient stabilization and continued for two days after the surgical procedure. To prevent postsurgical site infection, enrofloxacin at a dose of 15 mg/kg b.w. was given IM twice a day. After premedication, propofol (2 mg/kg b.w., IV) was administered to effect.

Figure 2. Position of the intravenous catheter

Thereafter, we proceeded with the endotracheal intubation. Selection of an appropriate endotracheal tube was very important due to the anatomy of the bird's tracheal rings, possible subsequent trauma and postoperative complications. We used endotracheal tube size 4 without the cuff inflated (Figures 3a and 3b). The swan was positioned in sternal recumbency, and the injured wing was exposed with constant heating with heating pads. Non-rebreathing circuits were used. The inhalant anesthetic sevoflurane was used, at a dose of MAC 5 at the beginning of surgery, and after five minutes it was

reduced to MAC 3. The eyes were lubricated during the induction with artificial tears. Electrocardiogram, pulse oximeter, temperature monitoring and capnograph were used during the surgical procedure, with constant evaluation of corneal reflex, cloacal reflex, pedal reflex, and muscle tone in order to evaluate the stage of anesthesia.

Figure 3a. Endotracheal intubation

Figure 3b. Endotracheal intubation – mouth view

The surgical field was prepared after the bird was sedated, the feathers were plucked. The skin was treated with chlorhexidine-based soap and then 70% ethanol. After applying a sterile self-adhesive compress, a 15 cm linear incision was made on the skin of the left wing in the area of the humerus. The subcutaneous tissue and muscle were cut so that we could visualize all the fragments of the broken humerus. We decided on a lateral approach to the wing, due to easier visualization and preservation of the radial nerve. The wound was washed with a sterile solution of 0.9% NaCl, which was preheated, and the blood clots were removed from the wound. Lidocaine (1.5 mL of 2% solution) was applied locally on the tissue near the *nervus radialis* of the left wing. Bone fragments were stabilized with plate (LC DCP 2.7 mm), rods (cortical 2.7 mm, 8 pieces) (Figures 4 and 5) and with an intramedullary pin. Absorbable monofilament size 3-0 (USP) was used for suturing the muscle and subcutaneous tissue with running sutures. Non-absorbable monofilament size 3-0 (USP) was used for suturing the skin with simple interrupted sutures. The operation took 40 minutes together with the pre-operative preparation.

Figure 4. Stabilized bone fragments with LC DCP plate being positioned and connected on the fracture site

Figure 5. Stabilized bone fragments and LC DCP plate in final position on the fracture site

Postoperative radiograph showed bone alignment and adequate implant positioning (Figure 6). The bird with immobilized wing was placed in a therapy cage during the next ten days under constant monitoring, to administer the antibiotic and analgesic

therapy. The stiches were taken out 12 days after the surgery. The space where the wild swan stayed was of limited size, 5 m^2 with an absorbent mat (diapers), room temperature of 20°C and a daily light regime of 12 hours. Antibiotic therapy for 10 days postoperatively was enrofloxacin and 5 days of meloxicam. Dressing the wound and then immobilization were done every day until the sutures were removed. Postoperative wound care was performed daily with povidone-iodine solution. After removing the threads, the wing was immobilized with an elastic bandage and the swan was released, with the recommendation to keep it in a limited space without obstacles.

Figure 6. X-ray of the stabilized left wing humerus

DISCUSSION

The most common etiologies of fractures in birds are accidental injuries and inadequate care (Calvo Carrasco, 2019). Traumas are the most common injuries in wild birds, and humerus fractures account for 36% of all fractures. Fractures in the distal third of the humerus were found to be more complex than other bone fracture sites (Coutant et al., 2022). Male birds suffer humerus fractures more frequently, which can be explained by the fact that females spend more time in the nest. The reason for the higher number of complex fractures in the distal and middle third of the humerus can be explained by the lower coverage of the humerus in these regions with the soft tissues. The success rate of complex humerus fracture treatment is 33.8%. Faster recovery and fewer complications are associated with greater preservation of soft tissues, shorter surgical intervention and good postoperative treatment of the patient (Reding and Ponder, 2016). Several surgical methods of humerus fracture repair in

birds have been described, using intramedullary pins, cerclage wires, plates and external fixators (Bennett and Kuzma, 1992).The use of surgical plates provides good stability against displacement and rotation in contrast to intramedullary pins, but there are also limiting factors, such as localization of the fracture on the bone, bone size, the thinner cortex of bird bone compared to mammalian bone, plate size and cost. Nonetheless, this method with plates has proven successful in fractures of the middle part of the humerus in large birds (Guzman et al., 2007). In simple humerus fractures, healing can take up to three weeks (Ponder and Reding, 2016). Presenting cases like our wild swan and the dissemination of the surgical and care teams' knowledge can help further research and the success of osteosynthesis in birds.

Birds with trauma are usually in a state of shock and require immediate stabilization (replenishment of fluids, oxygenation, analgesia) and prevention of further damage to the traumatized tissue. Ideally, the patient should be examined in detail, and the entire skeletal system should be palpated before X-ray imaging. If the patient is not cooperative, but is sufficiently stable, anesthesia can be used but with great caution (Coutant et al., 2022). In this case, an eyewitness to the accident (and the subsequent rescuer of the bird) brought the bird to a veterinarian a few hours after the trauma. After the bird was examined in detail, it was immediately decided to take an X-ray, which confirmed the presumed fracture of the humerus. In this case, based on the veterinarian's assessment and adequate fixation methods, the wild swan was examined without sedation in the supine position with the left wing extended. Due to the state of shock, as stated by Coutant et al., (2022), the bird was then first stabilized and left in the veterinary hospital for 24 h under constant supervision. Surgical interventions of this type require a well-organized staff and several team members. A large bird, such as a wild swan, should be carefully manipulated and at the same time further injuries have to be prevented.

The authors of this work decided on the method explained above, because of the large number of fragments and the extremely thin cortex of the humerus. The main goal was to preserve the function of the wing. One limitation in this case was the challenge posed by the extremely thin cortex of the humerus, which increases the risk of screw loosening or secondary fractures during manipulation. Alternative techniques such as external fixation or intramedullary pinning were considered, but were excluded due to concerns regarding rotational stability and fragment alignment. These considerations reflect the need for individualized treatment planning based on anatomical, mechanical, and patient-specific factors. The complete monitoring of the patient during the surgical intervention, which was possible due to the size of the bird, is a great advantage, since it enables the surgical team to obtain the parameters of the patient's condition at any moment. Application of lidocaine near the *nervus radialis* of the left wing before the intervention itself reduced the amount of general inhalation anesthetic. Endotracheal intubation enabled a constant and precise flow of inhalation anesthetic, the bird was stable during the entire intervention and no correction of any of the parameters was necessary. The central venous route is not always possible

in birds, due to their size. However, in large birds, when possible, the central venous route is recommended for fluid therapy, induction into general anesthesia and the application of certain medications in case of complications.

Post-surgery, keeping the bird in a confined space under the daily supervision of a veterinarian is our recommendation to prevent possible complications and speed up the healing process. Although the outcome was positive, this is a single-case report and does not allow generalization of the results. Factors such as the bird's age, nutritional status, and stress level could also influence healing, yet were not fully assessed in this case. Additionally, long-term follow-up data regarding wing function and flight ability are lacking and would be valuable in future case reports. Despite these limitations, this case provides valuable insight into the surgical management of complex fractures in wild avian species. This case presents the importance of quick and adequate patient evaluation, of selecting proper anesthetic protocol, and of expert postoperative care in avian orthopedic patients. Future studies should aim to compare outcomes between different fixation methods in birds of similar size and fracture complexity, as well as to evaluate the long-term functionality and survival rates post-rehabilitation.

Acknowledgements

The study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract number 451-03-136/2025-03/200143).

Authors' contributions

All authors contributed equally to the preparation of this manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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ANESTEZIJA I HIRURŠKO ZBRINJAVANJE PRELOMA HUMERUSA KOD DIVLJEG LABUDA

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Kratak sadržaj

Na teritoriji grada Beograda pronađen je neobeležen divlji labud sa povredom levog krila. Kliničkim pregledom i rendgenskim snimanjem dijagnostikovan je složen prelom levog humerusa. Nakon jednodnevne stabilizacije pacijenta, sprovedena je hirurška intervencija – stabilizaciju levog humerusa intramedularnom pinom i pločicom (LC DCP 2,7 mm). Tokom hirurške intervencije u opštoj inhalacionoj anesteziji (Sevofluran) pacijent je imao potpuni monitoring. Nakon završenog hirurškog zahvata, labud je bio pod stalnim veterinarskim nadzorom i u ograničenom prostoru. Posle potpunog oporavka, labud je vraćen osobi koja ga je prethodno pronašla, nakon čega biva pušten na teritoriju mesta pronalaska. Ovaj prikaz slučaja ističe važnost brze i adekvatne procene pacijenta, odabira odgovarajućeg anesteziološkog i hirurškog protokola, kao i važnost postoperativne nege kod ptica sa ortopedskim povredama. Prema našim saznanjima ovo je prvi opisani slučaj hirurške sanacije preloma humerusa divljeg labuda u Republici Srbiji.

Ključne reči: divlji labud, hirurška intervencija, humerus, monitoring