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CASE REPORT

Wildlife

Surgical management of post-traumatic abdominal hernias in three rehabilitated microchiropteran (Vespertilionid) bats (*Nyctalus noctula* and *Eptesicus serotinus*)

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Abstract

Abdominal hernias in bats are rarely reported in the literature, with most reports evaluating postmortem findings. The present study documents successful surgical management of post-traumatic abdominal hernias in three vespertilionid bats. Three injured bats (two *Nyctalus noctula* and one *Eptesicus serotinus*) were admitted for veterinary care after sustaining presumed trauma. Clinical examinations and radiography confirmed abdominal wall herniation with intestinal prolapse in all three cases. Surgical intervention was performed under isoflurane anaesthesia, and postoperative management involved analgesic and antibiotic therapy, with gradual feeding reintroduction and symptomatic gastrointestinal medication. All surgeries resulted in successful reduction of the hernias, with postoperative complications (abdominal distension and suture dehiscence). Post-rehabilitation, all bats were placed into artificial hibernation for eventual release. This study focuses on a small number of cases, limiting generalisability. This report highlights the feasibility of surgical intervention for abdominal hernias in bats, contributing to the veterinary care of these protected species.

BACKGROUND

Vespertilionid bats are small mammals, typically weighing between 8 and 30 g, that rarely become subjects of surgical veterinary intervention.[1] However, as urban environments expand, displacement of bat roosts due to human expansion and conflict (e.g., building development, destruction and renovation) increasingly results in traumatic injuries to these animals.[2–4]

In most Northern Hemisphere countries, bats have legal protections against killing, harming or sometimes relocating bats due to their vital roles in the ecosystem. Thus veterinary care for these animals is essential to rehabilitate injured individuals and facilitate their return to the wild.

Abdominal hernias, involving the protrusion of abdominal organs or tissues through ruptured musculature, are rarely documented in bats.[1,5] For example, an external abdominal hernia in a parti-coloured bat (*Vespertilio murinus*) was described in the Czech Republic.[1] Postmortem analyses of free-ranging Vespertilionid bats in Germany revealed abdominal or diaphragmatic herniation in 7% of the bats with identified trauma.[5] Notably, these cases were identified either during clinical observation or after death, with no reported surgical intervention or rehabilitation attempts. Successful

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surgical procedures on bats are unique practices that require high precision, specialised knowledge and experience and have to be documented.

This case series describes three post-traumatic abdominal hernias in mid-sized vespertilionid (Chiroptera, Vespertilionidae) bats (*Nyctalus noctula* and *Eptesicus serotinus*) and documents successful surgical repair and following rehabilitation. It highlights the challenges of surgical intervention in such delicate species and contributes valuable insights into bat veterinary care.

CASE PRESENTATION

Between 18 December and 31 December 2021, three injured bats were admitted to the Bat Rehabilitation Center of Feldman Ecopark (currently the Ukrainian Bat Rehabilitation Center), Kharkiv, Ukraine, for treatment: two adult *N. noctula*, one female (ID1; bat banding number DT24621) and one male (ID2; not marked) as well as an adult male *E. serotinus* (ID3; bat banding number DT24638). Both *N. noctula* originated from the same winter aggregation located on the second floor of a building. The colony was forcibly displaced from their roost during repair works. Torpid animals sustained a fall from the second floor onto the pavement where they were finally found on 18 December 2021. One *E. serotinus* was removed from its roost under similar circumstances and was found on a pavement on 25 December 2021.

All three bats were taken to a bat rehab centre for rehabilitation. Within 4 days of their detection, all animals developed similar clinical signs of lethargy, poor appetite and, as a result, a decrease in the volume of faeces and a decrease in the frequency of defecation and exhaustion. In addition, ID1 had a large open skin wound at the right shoulder, about 1.5 cm in diameter, containing large amounts of necrotic tissue.

Haematuria was observed only a single time in ID1 a day after admission to the clinic. A comparative summary of the three cases is provided in Table 1.

INVESTIGATIONS

Upon clinical examination, a soft subcutaneous fluctuating mass was palpable at the abdominal wall in each animal (Figure 1a,b). In ID1, it was located laterally in the right upper abdomen. In ID2, a similar mass was found on the right lower abdomen. In contrast, in ID3, such mass was detected on the left mid-abdomen. After feeding, the size and firmness of these masses noticeably increased, and the general condition of the animals worsened. Lethargy increased to apathy. Subsequently, x-ray images were taken from all bats (Figure 2a–c). Only the presented projections are available, with no orthogonal views accessible from the clinical records. Each image demonstrated a herniation of the abdominal wall with suspected prolapse of either a part of the small intestine (ID1), a part of the colon (ID2) or of both, small and large intestine (ID3). Due to the small size of the animals, as well as the limit of the resolution of the x-ray images, no absolute criteria that would allow differentiation between the small and large intestines with radiography were found. This assumption was based primarily on understanding the normal anatomy of animals. However, the diagnostic assumption was confirmed in all cases during surgical intervention.

These findings led to the diagnosis of transverse–lateral hernia of the abdominal wall with subcutaneous dislocation of the intestine.

LEARNING POINTS/TAKE HOME MESSAGES

- Abdominal hernias in vespertilionid bats are rare and usually detected only postmortem. Successful surgical management remains exceptional.
- Key factors for repair include careful anaesthetic planning, gentle tissue handling and appropriate suture selection. Postoperative care should be tailored to species-specific feeding, housing and wound management.
- When these measures are applied, complete recovery and release to the wild are possible, showing that advanced clinical intervention can support conservation goals.
- Veterinarians managing wildlife trauma should consider small bats viable candidates for surgery if expertise, facilities and post-release monitoring are available.

TABLE 1 Comparative summary of three bats with traumatic abdominal herniation.

Individual ID	Species	Sex	Hernia location	Suspected prolapsed organ/s	Surgical complications	Postoperative complications	Outcome
ID1; DT24621	*Nyctalus noctula*	Female	Right upper abdomen	Part of the small intestine	Oedematous and inflamed intestinal loops; intraoperative respiratory arrest	Single episode of severe abdominal distension; partial suture dehiscence with local inflammation and purulent exudate	Released to nature
ID2; not marked	*N. noctula*	Male	Right lower abdomen	Part of the colon	No complications	No complications	Released to nature
ID3; DT24638	*Eptesicus serotinus*	Male	Left mid-abdomen	Both, small and large intestines	No complications	Mild abdominal swelling after feeding; partial suture dehiscence with local inflammation	Released to nature

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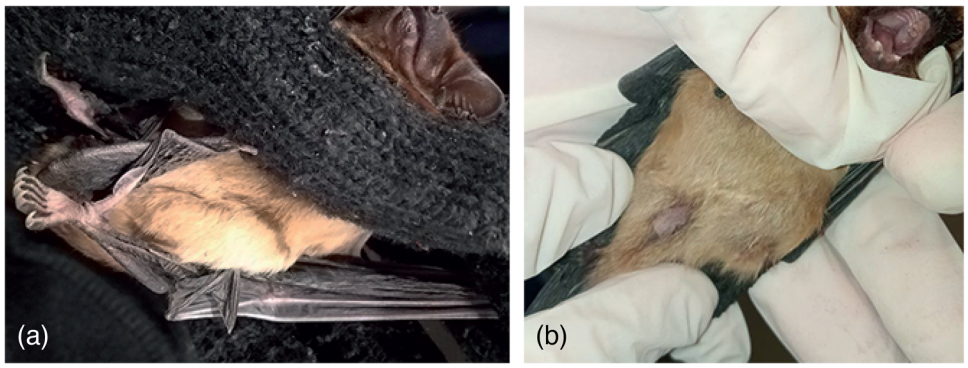


FIGURE 1 Examples of the external appearance of abdominal hernias in (a) *Nyctalus noctula* and (b) *Eptesicus serotinus*.

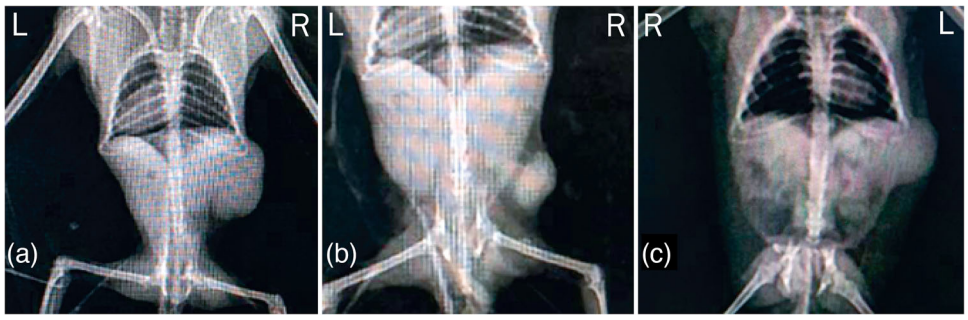


FIGURE 2 Ventrodorsal and dorsoventral radiographs of injured bats prior to surgery. (a) ID1—adult female *Nyctalus noctula* with abdominal wall rupture and prolapsed small intestine. (b) ID2—adult male *N. noctula* with abdominal wall defect and colonic prolapse. (c) ID3—adult male *Eptesicus serotinus* with extensive rupture and displacement of both small and large intestines.

DIFFERENTIAL DIAGNOSIS

Potential differential diagnoses for the observed subcutaneous swelling included subcutaneous emphysema, abscess formation, cystic lesions and abdominal wall hernia. In our cases, the swellings were characterised as soft, subcutaneous and fluctuating masses, and all animals demonstrated concurrent digestive disturbances, which made herniation the most likely diagnosis. Diagnostic puncture was avoided due to the small body size of the bats and the associated risk of organ injury. Therefore, radiography was performed to clarify the diagnosis and confirm the presence of abdominal wall herniation.

TREATMENT

Within 1 day after the herniation was diagnosed, the animals were prepared for surgical intervention to close the ruptured abdominal wall. A fasting period of 8 hours was endured. As premedication, meloxicam (Ukrzoovetprompostach; 5 mg/kg, orally) and butorphanol (Brovafarma; 2 mg/kg, subcutaneously in the interscapular region) were used. Anaesthesia was induced by isoflurane (Laboratorios Karizoo S.A.) via box induction at 4% and maintained with a facemask at 2% and an oxygen flow rate of 2 L/min.[6,7] Induction occurred for 2–3 minutes.

A cutting needle and absorbable polyglycolic acid suture (size 1.5; equivalent to USP 4-0; Mefil, Biopolymer) were used. The abdominal cavity was gently lavaged with warm sterile sodium chloride solution. The herniated intestinal loops were carefully repositioned using anatomical forceps, applied with the closed rounded tip to avoid grasping or traumatising the bowel. All loops were visually examined for signs of inflammation or necrosis prior to reduction. Closure of the abdominal wall was performed with a continuous suture pattern, while the skin was closed with interrupted simple knots.

In the case of ID1, the following difficulties occurred during surgery: due to an extensive abdominal wall defect located almost in the region of the right cranial abdomen, the surgical access was complicated by a risk of liver injury during the reduction process. To avoid trauma, the liver was carefully displaced with closed atraumatic forceps without grasping the tissue, ensuring that the needle was guided against the instrument tips rather than the hepatic parenchyma. Moreover, due to strong compression the prolapsed intestinal loops were oedematous and inflamed. During surgery, the animal experienced respiratory arrest and was resuscitated with pure oxygen and chest compressions, successfully restoring respiratory function. After the surgery, a large postoperative skin suture remained.

In the case of ID2, the same surgical technique as for ID1 was used. The smaller abdominal wall defect (approximately half the length of ID1) and its lower location facilitated surgical access. The intestinal loops were less compressed and only mildly oedematous, which allowed for easier repositioning. The surgery proceeded without complications, and the postoperative suture line was of moderate length.

In case of ID3, the rupture of the abdominal wall was extensive, spanning from slightly below the left cranial abdomen towards the left thigh, allowing a rather large volume of intestinal loops to dislocate subcutaneously. Still, the surgery

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was performed without complications, but resulted in a long T-shaped suture line.

Postoperative care included a 10-day course of antibiotic therapy with enrofloxacin (KRKA d.d., Slovenia; 0.45 mg/g, orally, twice daily), analgesia with butorphanol (1 mg/kg, subcutaneously in the interscapular region, three times daily for 2 days), and administration of a non-steroidal anti-inflammatory drug, meloxicam (5 mg/kg, orally, once daily for 5 days). In addition, the suture line was disinfected with 0.05% chlorhexidine solution (Biolik; twice daily for 10 days).

Feeding was performed in several small portions. During the first 2 days, fragments of a single mashed *Zophobas* larva were fed every 6 hours, followed by 2 days with feeding portions of two mashed *Zophobas* larvae every 8 hours increasing to two to four mashed *Zophobas* larvae for the next 3–5 days every 12 hours. Ten days after the operation, all animals received whole mealworm larvae of different sizes depending on their appetite, but not more than five larvae at a time. After 14 days, the bats were fed ad libitum once per day.

OUTCOME AND FOLLOW-UP

During rehabilitation, ID1 experienced a single episode of severe abdominal distension on the second postoperative day, approximately 1 hour after feeding, which lasted for 8 hours. Because of this, every 8 hours, 15 minutes before feeding, orally administered simethicone (KUSUM PHARM; 70 mg/kg) was added to the therapy for 5 subsequent days. Within 3 days, the abdominal distension disappeared. Still, this individual had a long-term (8 days) lack of appetite, slow weight gain, and was in an apathetic state. For 7 days, the animal did not consume more than two larvae or pomace per feeding. On day 10 after surgery, several sections of the suture line dehisced, and the surrounding tissue appeared hyperemic. Infection was indicated by the presence of purulent exudate. The loose sutures at the dehiscence sites were removed and chlorhexidine solution and decasan solution (Yuria-Pharm) were used twice daily until the suture was completely healed on day 17 after the operation. The same disinfectant treatment was used for another 14 days to support the healing of the skin wound at the shoulder area.

ID2 did not experience any complications during the rehabilitation period, and after 5 days, it independently consumed whole *Zophobas* larvae. This individual showed stable weight gain, physical activity, good appetite and normal suture healing.

ID3 revealed a slight abdominal swelling after feeding during the first 3 postoperative days. As in ID1, simethicone was added to the treatment regimen for 5 days. Partial suture dehiscence associated with local inflammation occurred 6 days after surgery. The condition was managed in the same manner as in ID1, with removal of loose suture threads and twice-daily application of chlorhexidine and decasan solutions until complete recovery. Otherwise, the rehabilitation process was uneventful: the animal remained active, showed a good appetite, consumed whole larvae by the fifth postoperative day, and gained weight rapidly.

After completing their recovery, all three bats were placed into artificial hibernation under carefully controlled conditions designed to mimic their natural wintering environment.[8] These bats successfully survived the artificial hibernation and were released to nature in the Kharkiv city area into April 2022.

DISCUSSION

Abdominal hernias in vespertilionid bats are rarely reported, and most accounts describe postmortem findings rather than successful surgical intervention.[1,5,9] These three cases demonstrate that, with tailored anaesthesia, careful surgical technique, and intensive postoperative care, even severe traumatic injuries in small insectivorous bats can be successfully treated, leading to full recovery and release.

Previous studies have focused on larger fruit bats (*Rousettus aegyptiacus*, *Artibeus jamaicensis* and *Rousettus lanosus*), providing guidance on anaesthetic monitoring, wound closure and perioperative analgesia.[10,11,12] Reports in vespertilionids remain scarce due to their small size and anaesthetic risk.[13,14] In our cases, inhalational isoflurane with preemptive analgesia (butorphanol) was well tolerated, with respiratory arrest as the main intraoperative risk. Careful tissue handling and appropriate suture selection ensured secure closure.

Postoperative care included analgesia, wound management with chlorhexidine and decasan solution, along with controlled housing and feeding to support recovery. Wound healing was rapid and effective, consistent with previous observations in bat tissue.[11,13–16]

Although most surgical reports concern megachiropterans, these cases show that microchiropterans can also undergo advanced interventions and return successfully to the wild. Limitations include the small sample size, challenges in long-term post-release monitoring, and the lack of evidence-based guidelines, highlighting the need for further clinical reporting.

AUTHOR CONTRIBUTIONS

Treatment and data collection: Anastasia Domanska, Valeriia Bohodist and Kateryna Zemliana. *Analysis and conceptualisation*: Ihor Tovstukha and Anton Vlaschenko. *Visualisation*: Kateryna Zemliana. *Writing the first draft, review and editing*: Anton Vlaschenko, Anastasia Domanska, Ihor Tovstukha, Valeriia Bohodist and Kateryna Zemliana. All the authors read and agreed with the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, financial or personal, that could have influenced the work reported in this manuscript.

ETHICS STATEMENT

All procedures were conducted in compliance with ethical guidelines for wildlife rehabilitation and were approved by the Ukrainian Bat Rehabilitation Center Animal Welfare Committee. The UBRC works under the general permission of the Kharkiv Oblast Authority for Ecology and Natural Resources.

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IMAGE QUIZ

Examine the x-ray image. What anatomical abnormality can be observed in the bat's abdominal area?

Hint: The image reveals organ displacement.

MULTIPLE CHOICE QUESTION

Which diagnosis best explains the radiographic findings in these bats?

POSSIBLE ANSWERS TO MULTIPLE CHOICE QUESTION

Neoplastic mass in the abdominal cavity
Abdominal wall rupture with intestinal herniation
Pulmonary barotrauma
Gastric volvulus

CORRECT ANSWER

(B) Abdominal wall rupture with intestinal herniation

Explanation: Radiographic assessment revealed a breach in the integrity of the abdominal musculature, with prolapse of the intestines beyond the normal anatomical boundaries. This is consistent with a traumatic abdominal hernia, a condition requiring surgical intervention to restore normal anatomical positioning and prevent further complications.

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