

## CASE REPORT

## Isoflurane-associated penile erection in two bats: a Savi's pipistrelle (*Hypsugo savii*) and a Kuhl's pipistrelle (*Pipistrellus kuhlii*)

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### Abstract

This report describes two cases of persistent penile erection in vespertilionid bats (*Hypsugo savii* and *Pipistrellus kuhlii*) during anaesthesia with isoflurane. The bats, presenting with wing fractures, were anaesthetised setting the vapouriser at 5% isoflurane for induction and 2% for maintenance. Both subjects developed penile erection upon induction of anaesthesia, which persisted for the duration of the procedures, lasting approximately 20 minutes. The condition resolved spontaneously after isoflurane discontinuation in both cases. No complications were observed and recovery was uneventful. This phenomenon has been reported in other species and in human medicine, often linked to the use of drugs exhibiting vasodilating properties. However, the exact underlying mechanisms remain unclear. Isoflurane is widely used in bats since it has several advantages, including rapid induction of and recovery from anaesthesia. Sevoflurane, which shares similar benefits but has a less pungent odour, could be an alternative choice, and investigating a potential dose-dependent effect of this agent might provide valuable insights. This is particularly relevant given the possible role of the anaesthetic's smell as a psychogenic trigger for penile erection.

**Keywords** adverse effects, bat anaesthesia, isoflurane, microchiroptera, penile erection, priapism.

### Introduction

In human medicine, a persistent penile erection lasting longer than 4 hours without sexual arousal is defined as priapism (Rochat 2001; Rezende et al. 2013). In veterinary medicine, however, this time frame is applied more flexibly, particularly when the condition arises during anaesthesia. In such cases, interventions to address the issue are typically implemented before the 4 hours have elapsed, as prolonged penile erection

can lead to complications such as oedema, increased risk of abrasions, tissue dehydration and necrosis of the penis (Rochat 2001; Rezende et al. 2013). This report describes an instance of penile erection in two vespertilionid bats during anaesthesia with isoflurane, which resolved spontaneously after the anaesthetic was discontinued.

### Case description

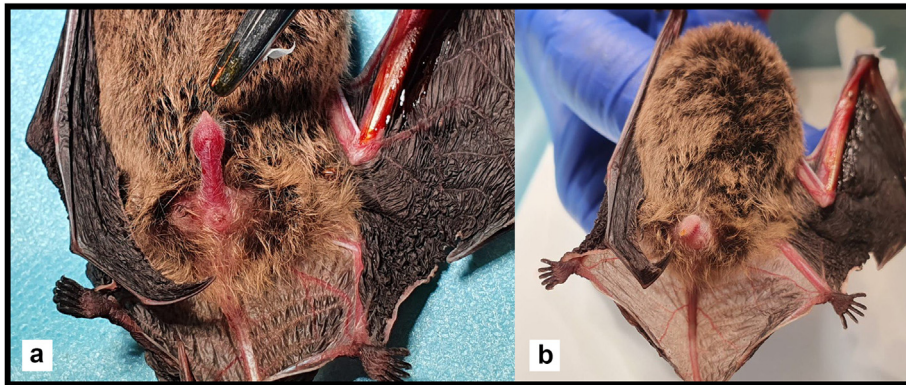
At different times, two adult male wild bats – a Savi's pipistrelle (*Hypsugo savii*) weighing 5 g and a Kuhl's pipistrelle (*P. kuhlii*) weighing 6 g – were presented with flight impairment due to fractures of their left wings. In the first case, the fracture affected the first phalanx of the fifth digit, while in the second it involved the distal radius.

To conduct a thorough clinical examination while avoiding the stress of handling the animals while conscious, the bats were placed in an induction chamber made using a transparent plastic container, and anaesthesia was induced with 5% isoflurane (IsoFlo 100%, Zoetis, Italy) in 100% oxygen at 2 L minute<sup>-1</sup>, using a non-rebreathing circuit (Bain Coaxial Breathing System, Intersurgical, UK). Subsequently, the bats were removed from the chamber and anaesthesia was maintained via a face mask with 2% isoflurane in 100% oxygen at 1 L minute<sup>-1</sup>. Both bats were positioned on a heating pad (Buster ICU Heat Mat, Kruuse, Denmark). Monitoring included electrocardiography and pulse oximetry; however, the variables could not be detected, likely due to the small size of the animals and their elevated heart and pulse rates, which exceeded the limits of the monitoring system (Infinity M540, Dräger Italia S.p.A., Italy). Consequently, this monitoring was discontinued in both cases, and the respiratory rate (ranging from 32 to 40 breaths minute<sup>-1</sup>) was assessed by observing chest movements every 5 minutes.

Upon induction of anaesthesia, both bats developed penile erection (Figs. 1a and 2a), which persisted throughout the examination and the procedures to stabilise the fractures, lasting approximately 20 minutes. Fluids, comprising 30 mL



**Figure 1** Penile erection in a Savi's pipistrelle (*Hypsugo savii*) (a) undergoing clinical examination, anaesthetized with the use of isoflurane. View of the penis in its normal flaccid state, upon recovery (b).



**Figure 2** Penile erection in a Kuhl's pipistrelle (*Pipistrellus kuhlii*) (a) undergoing clinical examination, anaesthetized with the use of isoflurane. View of the penis in its normal flaccid state, upon recovery (b).

$\text{kg}^{-1}$  of a 1:1 mixture of Ringer's lactate and 5% glucose (Baxter S.p.A., Italy) were administered subcutaneously, along with meloxicam  $1 \text{ mg kg}^{-1}$  (Meloxidyl  $5 \text{ mg mL}^{-1}$ , Ceva Salute Animale S.p.A., Italy).

Once the procedures were completed, isoflurane administration was discontinued, and the bats fully recovered within 2 minutes (righting reflex resumed, ambulating) without any complications. In both cases, upon recovery the penis was no longer erect and had returned to its normal flaccid state (Figs. 1b and 2b). The bats were hospitalised, and no further episodes of penile erection were observed in the following days.

## Discussion and conclusions

Penile erection during anaesthesia has been documented across various species, including horses, dogs and cats (Rochat 2001). Most reports concern equine practice, where prolonged erection is often linked to the administration of acepromazine. In this species, the reported methods for treating this condition

are varied, including the use of massage, cold compresses, intravenous benzotropine administration and intracavernosal phenylephrine (Driessen et al. 2011; Rezende et al. 2013). Penile erection and priapism have also been observed in humans during anaesthetic procedures, with some reports linking the condition to the use of propofol (Staerman et al. 1995; Savoie et al. 2019), although the underlying mechanisms remain unclear. Propofol can induce transient hypotension, presumably due to vasodilation, thereby increasing blood flow to the penis and contributing to the onset of erection (Staerman et al. 1995). Additionally, psychogenic stimuli may arise during anaesthesia from heightened auditory sensations, or from the taste and smell of anaesthetic agents, or dreams (Staerman et al. 1995; Rezende et al. 2013). This could also potentially explain the role of isoflurane in our cases, as its smell could have contributed to the onset of the erection.

In the report by Savoie et al. (2019), the condition was observed after the administration of propofol and resolved shortly after its discontinuation. In our cases, the temporal

relationship of the symptom, the lack of other drugs administered at the time of the event and the complete resolution of the condition after discontinuation of the anaesthetic lead us to infer that the bat's penile erection was caused by isoflurane exposure.

Inhalation anaesthetic agents are often utilised in bats, particularly for the suborder Microchiroptera, due to several advantages, including rapid induction of and recovery from anaesthesia, and ease in modulation of anaesthetic depth, regardless of the animals' body weights. Moreover, the use of inhaled anaesthetic agents prevents dose errors associated with the small size of the subjects, or iatrogenic damage resulting from the parenteral administration of injectable anaesthetic drugs (Jonsson et al. 2004; Heard 2014). Isoflurane can also cause vasodilation, which could provoke effects comparable with those described above regarding propofol. However, even in this instance, any hypothesis regarding the aetiology of isoflurane-associated penile erection can only remain speculative. A decrease in penile tone, accompanied by penile extraction from the prepuce, has been observed during anaesthetic procedures in Egyptian fruit bats (*Rousettus aegyptiacus*). This phenomenon has been correlated with anaesthetic depth and muscle relaxation (Tuval et al. 2018, 2021). By contrast, the two chiropterans described in the present report exhibited an increase in penile tone, resulting in a marked erection. Therefore, the underlying mechanisms are probably different from those reported by Tuval et al. (2018, 2021). However, it is possible that the onset of erection in these cases may also be related to the depth of anaesthesia, given the resolution of the condition at the end of the procedure.

Although the onset of a persistent penile erection can have serious consequences, particularly in veterinary medicine due to the potential for self-mutilation, in this situation it resolved spontaneously. Therefore, the possible occurrence of this condition should not deter the use of isoflurane in bats but underscores the importance of careful monitoring and readiness to cease anaesthesia if deemed necessary. Further evaluations concerning the onset of this adverse effect with different

concentrations of isoflurane, compared with those used in these cases both for induction and for maintenance of anaesthesia, would be beneficial. Investigating a potential dose-dependent effect or using a volatile agent with a less pungent odour, such as sevoflurane, could provide valuable insights, particularly considering the potential influence of this factor (Staerman et al. 1995).

As this condition has not been previously reported in other microchiropterans, it remains uncertain whether an extended duration of anaesthesia, and consequent prolonged penile erection, could result in harmful effects for these animals. Notably, no such complications were observed during the procedures lasting ~20 minutes. Given the spontaneous resolution observed, a conservative approach may be adequate in similar scenarios, aiming to minimise the duration of anaesthesia. This approach allows the avoidance of unnecessary interventions while maintaining effective anaesthetic management in bats.

### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### **Authors' contributions**

MS: case management, collection of information, manuscript preparation and revision. IP and MMvD: case management, collection of information, critical review of the manuscript. CO and GB: case management. GQ: critical review of the manuscript.

**Multiple choice questions**

What is one of the primary advantages of using inhalational anaesthetic agents in chiropterans?

- A. Analgesic properties.**
- B. Unexpensive equipment required.**
- C. Rapid induction of and recovery from anaesthesia.**
- D. Increased risk of dosing errors.**

Reference

Heard D (2014) Chiropterans (bats). In: Zoo Animal and Wildlife Immobilization and Anesthesia (2nd edn). West G, Heard D, Caulkett N (eds). John Wiley & Sons, USA. pp. 543–550.

What is the effect of hibernation or torpor on bats' anaesthetic requirements?

- A. No change in anaesthetic requirements.**
- B. Reduction in anaesthetic requirements due to lowered body temperature and metabolic rate.**
- C. Increased need for inhalation anaesthetics.**
- D. Anaesthesia is ineffective during hibernation.**

Reference

Heard D (2014) Chiropterans (bats). In: Zoo Animal and Wildlife Immobilization and Anesthesia (2nd edn). West G, Heard D, Caulkett N (eds). John Wiley & Sons, USA. pp. 543–550.

Which of the following is a potential consequence of persistent penile erection?

- A. Increased fertility.**
- B. Oedema and necrosis.**
- C. Damage to the gonads.**
- D. Reduced stress.**

Reference

Rochat MC (2001) Priapism: a review. *Theriogenology* 56, 713–722.

**References**

- Driessen B, Zarucco L, Kalir B et al. (2011) Contemporary use of acepromazine in the anaesthetic management of male horses and ponies: a retrospective study and opinion poll. *Equine Vet J* 43, 88–98.
- Heard D (2014) Chiropterans (bats). In: Zoo Animal and Wildlife Immobilization and Anesthesia (2nd edn). West G, Heard D, Caulkett N (eds). John Wiley & Sons, USA. pp. 543–550.
- Jonsson NN, Johnston SD, Field H et al. (2004) Field anaesthesia of three Australian species of flying fox. *Vet Rec* 154, 664.
- Rezende ML, Ferris RA, Leise BS et al. (2013) Treatment of intraoperative persistent penile erection in a stallion. *J Equine Vet Sci* 34, 431–435.
- Rochat MC (2001) Priapism: a review. *Theriogenology* 56, 713–722.
- Savoie C, Rajanna V, Khandhar P (2019) Propofol-associated priapism in a prepubescent pediatric patient. *Glob Pediatr Health* 6, 2333794X1985973.
- Staerman F, Nouri M, Coeurdacier P et al. (1995) Treatment of the intraoperative penile erection with intracavernous phenylephrine. *J Urol* 153, 1478–1481.
- Tuval A, Las L, Shilo-Benjamini Y (2018) Evaluation of injectable anaesthesia with five medetomidine-midazolam based combinations in Egyptian fruit bats (*Rousettus aegyptiacus*). *Lab Anim* 52, 515–525.
- Tuval A, Dror-Maman I, Las L et al. (2021) Evaluation of alfaxalone and midazolam with or without flumazenil reversal in Egyptian fruit bats (*Rousettus aegyptiacus*). *Vet Anaesth Analg* 48, 239–246.

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