

## REVIEW ARTICLE

# ONCOLOGY OF THE SUGAR GLIDER (*PETAURUS BREVICEPS*): A COMPREHENSIVE REVIEW

**Jelle Stans**<sup>1\*</sup>

<sup>1</sup>Institute for Globally Distributed Open Research and Education, Heverlee-Leuven, Belgium

**\*Corresponding author:**  
Jelle Stans

**Address:**  
Institute for Globally Distributed Open Research and Education  
Heverlee-Leuven, Belgium  
**ORCID:** 0000-0002-4804-9466  
**E-mail:** jelle.stans@igdore.org

**Original Submission:**

01 December 2022

**Revised Submission:**

09 May 2023

**Accepted:**

22 May 2023

**How to cite this article:** Stans J. 2023. Oncology of the sugar glider (*Petaurus breviceps*): A comprehensive review. *Veterinaria* 72(2), 135-141.

**ABSTRACT**

Sugar gliders (*Petaurus breviceps*) are increasingly being kept as pets. Despite their popularity, relatively little is known about the oncology of this species. To summarize the current body of knowledge, a literature search was performed to identify published cases. Only a small number of cases was identified that described cancer in sugar gliders. The identified case reports described several tumour types, ranging from mammary (adeno) carcinoma to haemangiosarcoma. In the majority of cases, no metastases were reported. In several cases, the primary tumour was removed using a surgical approach. Pain management also was a cornerstone of the treatment. The prognosis was often poor, with only two animals out of eight being alive at the time of publication. It is clear that further research is required to get more insight into the epidemiology and characteristics of cancer in this species.

**Keywords:** Cancer, cases, epidemiology, sugar glider, treatment

**INTRODUCTION**

The sugar glider (*Petaurus breviceps*) is a small, nocturnal marsupial originally from New Guinea and Australia (Campbell et al., 2019; Varriale et al., 2019). These animals are kept as an exotic pet in several countries such as Italy (Varriale et al., 2019) and the United States (Campbell et al., 2019). Therefore, several studies have investigated important aspects of husbandry such as nutrition (Dierenfeld, 2009) and behavioural aspects (Mallick et al., 1994). Work has also been published on medical aspects such as common emergencies (Lennox, 2007; McLaughlin and Strunk, 2016), common procedures (Johnson-Delaney, 2006), surgical procedures (Morges et al., 2009; Miwa and Sladky, 2016) and diagnostic approaches (Evans and Souza, 2010). Cusack and colleagues (2016) published a case of bilateral hydronephrosis, while Johnson-Delaney and Lennox (2017) investigated reproductive disorders. Other conditions, where case reports or series were published, include pulmonary hyalinosis (Sokol

et al., 2017), zoonoses (Pignon and Mayer, 2011), toxoplasmosis (Barrows, 2006) and cancer (Gentz et al., 2003; Sokol et al., 2017; Son et al., 2021). Several cases of neoplasia in sugar gliders have been described. Gentz and colleagues (2003) described 33 cases of neoplastic lesions of different histological types. In a more recent retrospective study, three cases of cancer in gliders were identified (Sokol et al., 2017). These studies did, however, not describe the case characteristics, such as symptoms and treatment in detail. Relevant details have been described in single case reports (Churgin et al., 2015; Chen et al., 2018). To this date, no review has been published. Therefore, this paper aims to provide a comprehensive review of the current knowledge of cancer in the sugar glider.

## SEARCH STRATEGY AND LITERATURE INCLUSION

The Medline database (through PubMed) was searched using the keywords “Sugar glider\*” (103 results) and “Petaurus” (85 results). Additionally, Google Scholar was searched using “Sugar glider tumor” (724 results), “Sugar glider cancer” (1970 results), “Petaurus tumor” (520 results) and “Petaurus cancer” (453 results). The titles of the publications in the search results were screened for potential eligibility for inclusion. The abstracts of these selected papers were read and the papers were included if they (1) described cancer in at least one sugar glider, (2) they mentioned at least basic information about the animal, (3) mentioned at least basic information about the disease and (4) mentioned at least basic information about the treatment and outcome. Relevant information was then extracted from the publication.

## IDENTIFIED LITERATURE

Eight single case reports were identified that met the inclusion criteria (Hough et al., 1992; Marrow et al., 2010; Keller et al., 2014; Rivas et al., 2014; Churgin et al., 2015; Lindemann et al., 2016; Chen et al., 2018; Son et al., 2021). The extracted data is shown in Table 1.

Two case series (Gentz et al., 2003; Sokol et al., 2017) described several cases retrospectively, but did not meet the inclusion criteria because they did not report any information on the treatment pursued. No other case series were identified. Additionally, no studies investigating any risk factors for neoplastic disease in sugar gliders were identified. Finally, no prospective trials were identified that assessed potential treatment strategies.

## CASE CHARACTERISTICS AND TREATMENT

The ages of the animals at presentation ranged from 4 (Hough et al., 1992) to 15 years (Lindemann et al., 2016), while the average age was 8.5 years. Three out of the eight animals were male. Little additional consistent information about the animals was mentioned.

Two cases of mammary (adeno)carcinoma were reported (Keller et al., 2014; Churgin et al., 2015). Other types of cancer ranged from lymphosarcoma (Hough et al., 1992) to hemangiosarcoma (Rivas et al., 2014). In the majority of cases, no metastases were reported. Symptoms were very variable and depended on the type and location of a tumour. Likewise, the treatment also varied significantly according to the specific case. However, surgical removal of the primary tumour was performed in several cases (Keller et al., 2014; Rivas et al., 2014; Chen et al., 2018). In several cases, antibiotic treatments were also initiated. It is also clear that pain management is very important.

Unfortunately, in five cases (Hough et al., 1992; Marrow et al., 2010; Keller et al., 2014; Churgin et al., 2015; Lindemann et al., 2016), the animal was eventually euthanized at the time the case was published. In one further case, the animal died (Son et al., 2021). In only two cases, the glider was alive without signs of cancer (Rivas et al., 2014; Chen et al., 2018).

**Table 1** Extracted data from the included case reports

Ref.	Age	Sex	Cancer type	Metastasis	Symptoms	Treatment	Outcome
Hough et al., 1992	4 yrs.	M	Cutaneous lymphosarcoma	Lymph nodes Sinusoids of the spleen	Initial Suppurating ulcer right hind leg Small vesicles around pinnae Swollen digits  Day 7 Reduced swelling digits Areas with vesicles increased in size  Day 18 Extended limb ulceration Most digits swollen Nodules on trunk skin	Initial (for diagnosis of dermatitis / infection) Lincomycin (30 mg / day) Metacresolsulphonic acid (topical)  Day 7 (for diagnosis of dermatitis / infection) Debridement of ulcer Amoxycillin (30 mg / day) Topical gentamicin Power containing zinc bacitracin (250 U/g) Neomycin sulphate 5 mg/g Plymixin B sulphate 5000 U/g  Day 18 (for diagnosis of dermatitis / infection) Metronidazol (80 mg/kg oral / day)	Euthanized 5 days after day 18 treatment
Marrow et al., 2010	10 yrs.	M	Paracloacal transitional cell carcinoma with squamous differentiation	None identified	Initial No clinical signs Pericloacal mass  5 months Self-mutilation cloacal skin Tenesmus Reduced food intake Large, firm mass Abdominal distention	Initial Enrofloxacin (5 mg/kg orally every 12 hours for 10 days)	Euthanized 5 months after initial presentation
Keller et al., 2014	9 yrs.	F	Mammary carcinoma	None identified	Initial Subcutaneous mass right caudal abdomen  Days after surgery at day 5 Self-mutilation of tail	Initial Meloxicam (0.5mg/kg oral, once a day)  Day 5 Surgical excision 150 Gy of strontium-90 radiation therapy	Euthanized within 14 days after the surgery

Ref.	Age	Sex	Cancer type	Metastasis	Symptoms	Treatment	Outcome
Rivas et al., 2014	11 yrs.	F	Dermal hemangiosarcoma	None identified	Initial No overt clinical signs Lesion on right patagonium  Day 9 Increased size of lesion	Initial (for diagnosis of infected wound) Meloxicam (0.2 mg/kg, orally, every 24 hours, for 10 days) Trimethoprim-sulfamethoxazole (15 mg/kg, orally, every 12 hours)  Day 9 Surgical excision  Post-operative care Enrofloxacin (10 mg/kg, orally, every 24 hours for 7 days) until day 28 after presentation Meloxicam (0.2 mg/kg, orally, every 24 hours for 4 days) until day 28 after presentation	No local or systemic sign of disease after 1 year
Churgin et al., 2015	9 yrs.	F	Mammary adenocarcinoma	Sublumbar Pouch lymph node Axillary lymph nodes Lung	Initial Lethargy Partial anorexia Mass within the pouch  6 months Weight loss Growth of pouch mass  7 months Inability to bear weight on right rear leg Growth of pouch mass	No specific treatment	Euthanized 7 months after initial presentation
Lindemann et al., 2016	15 yrs.	F	Adrenocortical carcinoma Hepatocellular carcinoma	None identified	Initial Diarrhea Weight loss Mass in midabdomen Circling to the right Impaired vision  72 hours Lethargy Circling to the right Impaired vision	Fluid therapy 40 mL/kg subcutaneously  2.5% dextrose  Vitamin B complex 0.05 mL subcutaneously  Amoxicillin-clavulanic acid 12.5 mg/kg orally, every 12 hours for 10 days  Prednisolone 0.2 mg/kg, orally every 12 hours	Euthanized 72 hours after presentation

Ref.	Age	Sex	Cancer type	Metastasis	Symptoms	Treatment	Outcome
Chen et al., 2018	4 yrs.	M	Paraocloacal gland carcinoma	None identified	<p>Initial</p> <p>Self-mutilation cloacal region</p> <p>Vocalisation &amp; straining during elimination</p> <p>Hyperemic &amp; swellign pericloacal region</p> <p>Day 178</p> <p>Swelling</p> <p>Vocalisation during elimination</p> <p>Cloacal bleeding</p> <p>Reduced activity</p> <p>Reduced appetite</p> <p>Day 217</p> <p>Right side cloaca larger than left</p> <p>Mass below skin</p> <p>Day 229</p> <p>Swelling right side cloaca</p> <p>Intensified straining during elimination with blood</p> <p>Four weeks after day 229</p> <p>Vocalisation during elimination</p>	<p>Initial</p> <p>Correction of husbandry</p> <p>Enrofloxacin 5mg/kg orally, twice a day</p> <p>Metronidazole 25mg/kg orally, twice a day</p> <p>Meloxicam 0.2mg/kg orally, once a day (42 days)</p> <p>Nystatin 2000 IU/kg orally, twice a day for 10 days</p> <p>E-collar (one month)</p> <p>Day 178</p> <p>E-collar</p> <p>Tramadol 2mg/kg orally, twice a day (5 weeks)</p> <p>Meloxicam 0.2mg/kg orally, once a day (5 weeks)</p> <p>Sulfamethoxazole/trimethoprim 15mg/kg orally, twice a day (5 weeks)</p> <p>Metronidazole 25mg/kg orally, twice a day (5 weeks)</p> <p>Metoclopramide 0.1mg/kg orally, twice a day (5 weeks)</p> <p>Sucralfate 10mg/kg orally, twice a day (5 weeks)</p> <p>Day 217</p> <p>Chloramphenicol 25mg/kg orally, twice a day (1 week)</p> <p>Day 229</p> <p>Surgical removal of glands</p> <p>Ciprofloxacin 10mg/kg orally, twice a day</p> <p>Meloxicam 0.2mg/kg orally, once a day</p> <p>Metronidazole 25mg/kg orally, twice a day</p> <p>Tramadol 2mg/kg orally, twice a day</p> <p>Lactulose 0.5mg/kg orally, twice a day (7 days)</p> <p>E-collar</p>	Alive 515 days following surgery
Nguyen et al., 2021	6 yrs.	F	Disseminated histiocytic sarcoma	<p>Urinary bladder</p> <p>Medial iliac lymph nodes</p> <p>Pericloacal mass</p> <p>Liver</p> <p>Spleen</p> <p>Small intestine</p> <p>Uterus</p> <p>Left ovary</p>	<p>Initial</p> <p>Swelling at pouch</p>	None mentioned	Died 8 days after initial presentation

## DISCUSSION AND CONCLUSION

A relatively small number of case reports was identified about cancer in sugar gliders. This means that there is a clear lack of external and internal validity in the current body of literature.

There was a wide range of ages at presentation. However, with an average of 8.5 years, it could be stated that it seems that age is a potential risk factor for cancer in gliders. There was a relative equal distribution between males and females. However, based on these limited cases, it is very difficult to make sound conclusions about potential risk factors and epidemiology of the condition.

There were several different histological types of cancer described in the case reports. Previous case series have reported more cases and could provide a better overview of the most common types of cancer that occur in sugar gliders (Gentz et al., 2003; Sokol et al., 2017). In most cases, there were no metastases reported. However, it is not clear which mechanisms play a role in metastasizing in this species and which types may be predisposed to metastasize.

Several treatment strategies were utilized depending, amongst others, on the type and location of the primary tumour. Based on the current results, it does not seem feasible yet to develop standardized, evidence-based treatment guidelines for specific cancer types. It is, however, clear that surgical excision is an important component of several treatment

schedules. Unfortunately, most of the animals were euthanized or died, while only two animals were alive at the time of publication of their case. This confirms that further research is required to assess and establish therapeutic strategies.

Further research could start with a better reporting of cases. An important role could be played by communities of owners. These communities are very active in discussing health problems with their pets. They could be approached to assist in the recording of cases. Additionally, retrospective studies could be conducted of cases already seen in veterinary practices. Finally, prospective clinical trials should be conducted to establish effective and save therapeutic strategies.

Relatively few case reports were identified regarding cancer in sugar gliders. There was a large variation in the age at which the animals were diagnosed and in the tumour types that were described. In several of the published cases, surgical removal of the primary tumour was performed. This was often complemented with pain management. Unfortunately, prognosis was very poor, since only two out of eight animals were alive at the time of publication. Further research is required to get more insight into the epidemiology and characteristics of cancer in this species.

## CONFLICT OF INTEREST

The author declared that there is no conflict of interest.

## REFERENCES

- Barrows M. 2006. Toxoplasmosis in a colony of sugar gliders (*Petaurus breviceps*). *Vet Clin North Am Exot Anim Pract*, 9(3), 617-623. <https://doi.org/10.1016/j.cvex.2006.05.006>
- Campbell CD, Pecon-Slattey J, Pollak R, Joseph L, Holleley CE. 2019. The origin of exotic pet sugar gliders (*Petaurus breviceps*) kept in the United States of America. *Peer J*, 7. <https://doi.org/10.7717/peerj.6180>
- Chen J, Yu P, Liu C, Chi C. 2018. Paracloacal gland carcinoma in a sugar glider (*Petaurus breviceps*). *J Exot Pet Med*, 27, 36-40.
- Churgin SM, Deering KM, Wallace R, Clyde VL. 2015. Metastatic Mammary Adenocarcinoma in a Sugar Glider (*Petaurus breviceps*), *J Exot Pet Med*, 24(4), 441-5. <https://doi.org/10.1053/j.jepm.2015.08.011>.
- Cusack L, Schnellbacher R, Howerth EW, Jiménez DA, Mayer J, Divers S. 2016. Bilaterally hydronephrosis in a sugar glider (*Petaurus breviceps*). *J. of Zoo and Wildlife Medicine*, 47(3), 886-9. <https://doi.org/10.1638/2016-0007.1>
- Dierenfeld ES. 2009. Feeding behavior and nutrition of the sugar glider (*Petaurus breviceps*). *Vet Clin North Am Exot Anim Pract*, 12(2), 209-viii. <https://doi.org/10.1016/j.cvex.2009.01.014>
- Evans EE, Souza MJ. 2010. Advanced diagnostic approaches and current management of internal disorders of select species (rodents, sugar gliders, hedgehogs). *Vet Clin North Am Exot Anim Pract*, 13(3), 453-69. <https://doi.org/10.1016/j.cvex.2010.05.003>
- Gentz EJ, Richard MJ, Crawshaw G, Willette M, Rose K, Canfield, PJ. 2003. Neoplasia in sugar gliders (*Petaurus breviceps*): thirty-three cases. In *Joint Conference American Association Of Zoo Veterinarians*, 132-4.
- Hough I, Reuter RE, Rahaley RS, Belford C, Miller R, Mitchell G. 1992. Cutaneous lymphosarcoma in a sugar glider. *Aust*

- Vet. J, 69(4), 93–4. <https://doi.org/10.1111/j.1751-0813.1992.tb15562.x>
- Johnson-Delaney CA. 2000. Therapeutics of companion exotic marsupials. *Vet Clin North Am Exot Anim Pract*, 3(1), 173–vii. [https://doi.org/10.1016/s1094-9194\(17\)30100-7](https://doi.org/10.1016/s1094-9194(17)30100-7)
- Keller KA, Nevarez JG, Rodriguez D, Gieger T, Gumber S. 2014. Diagnosis and treatment of anaplastic mammary carcinoma in a sugar glider (*Petaurus breviceps*). *J Exot Pet Med*, 23(3), 277–82. <https://doi.org/10.1053/j.jepm.2014.06.008>
- Lennox AM. 2007. Emergency and critical care procedures in sugar gliders (*Petaurus breviceps*), African hedgehogs (*Atelerix albiventris*), and prairie dogs (*Cynomys spp*). *Vet Clin North Am Exot Anim Pract*, 10(2), 533–55. <https://doi.org/10.1016/j.cvex.2007.01.001>
- Lindemann D, Carpenter J, DeBey B, Ryseff J. 2016. Concurrent Adrenocortical Carcinoma and Hepatocellular Carcinoma with Hemosiderosis in a Sugar Glider (*Petaurus breviceps*). *J Exot Pet Med*, 25. <https://doi.org/10.1053/j.jepm.2016.03.013>
- Mallick J, Stoddart DM, Jones I, Bradley AJ. 1994. Behavioral and endocrinological correlates of social status in the male sugar glider (*Petaurus breviceps* Marsupialia: Petauridae). *Physiol. Behav*, 55(6), 1131–4. [https://doi.org/10.1016/0031-9384\(94\)90398-0](https://doi.org/10.1016/0031-9384(94)90398-0)
- Marrow J, Carpenter J, Lloyd A, Bhupinder B. 2010. A Transitional Cell Carcinoma with Squamous Differentiation in a Pericloacal Mass in a Sugar Glider (*Petaurus breviceps*). *J Exot Pet Med*, 19, 92–5. <https://doi.org/10.1053/j.jepm.2010.01.008>
- McLaughlin A, Strunk A. 2016. Common Emergencies in Small Rodents, Hedgehogs, and Sugar Gliders. *Vet Clin North Am Exot Anim Pract*, 19(2), 465–99. <https://doi.org/10.1016/j.cvex.2016.01.008>
- Miwa Y, Sladky KK. 2016. Small Mammals: Common Surgical Procedures of Rodents, Ferrets, Hedgehogs, and Sugar Gliders. *Vet Clin North Am Exot Anim Pract*, 19(1), 205–44. <https://doi.org/10.1016/j.cvex.2015.09.001>
- Morges MA, Grant KR, MacPhail CM, Johnston MS. 2009. A novel technique for orchietomy and scrotal ablation in the sugar glider (*Petaurus breviceps*). *J. of Zoo and Wildlife Medicine*, 40(1), 204–6. <https://doi.org/10.1638/2007-0169.1>
- Pignon C, Mayer J. 2011. Zoonoses of ferrets, hedgehogs, and sugar gliders. *Vet Clin North Am Exot Anim Pract*, 14(3), 533–vii. <https://doi.org/10.1016/j.cvex.2011.05.004>
- Rivas A, Pye G, Papendick R. 2014. Dermal Hemangiosarcoma in a Sugar Glider (*Petaurus breviceps*). *J Exot Pet Med*, 23. <https://doi.org/10.1053/j.jepm.2014.07.001>
- Sokol SA, Agnew DW, Lewis AD, Southard TL, Miller AD. 2017. Pulmonary hyalinosis in captive sugar gliders (*Petaurus breviceps*). *J Vet Diagn Invest*, 29(5), 691–5. <https://doi.org/10.1177/1040638717703683>
- Son NV, Chambers JK, Nam NH, Nakata M, Giang NTH, Shiga T, et al. 2021. Pathological and Immunohistochemical Findings of Disseminated Histiocytic Sarcoma in a Sugar Glider (*Petaurus breviceps*). *J Comp, Pathol*, 187, 83–8. <https://doi.org/10.1016/j.jcpa.2021.07.005>
- Varriale L, Russo TP, Pace A, Mediatore S, Borrelli L, Santaniello A, et al. 2019. Microbiological survey of sugar gliders (*Petaurus breviceps*) kept as pets in Italy. *Lett Appl, Microbiol*, 69(6), 399–402. <https://doi.org/10.1111/lam.13233>

## ONKOLOGIJA MALOG ZLATNOG LETAŠA (*PETAURUS BREVICEPS*): SVEOBUH VATNI PREGLED

### SAŽETAK

Mali zlatni letaši (*Petaurus breviceps*) se sve češće drže kao kućni ljubimci. Uprkos njihovoj popularnosti, malo je poznato o onkologiji ove vrste. Kako bi se napravio presjek postojećih saznanja na ovu temu, izvršen je pregled literature sa ciljem identifikacije objavljenih slučajeva, a koji su kod malih zlatnih letaša pronađeni u malom broju. Identificirani prikazi slučajeva su opisali nekoliko tipova tumora, od mamarnog (adeno) karcinoma do hemangiosarkoma. U većini slučajeva nisu opisane metastaze. U nekim slučajevima, primarni tumor je otklonjen operativnim putem. Terapija bola je predstavljala osnovu terapije. Prognoza je često bila loša, pri čemu su u doba publikacije samo dvije životinje od njih osam bile žive. Jasno je da su potrebna daljnja istraživanja kako bi se stekao bolji uvid u epidemiologiju i karakteristike karcinoma ove vrste.

**Ključne riječi:** Karcinom, slučajevi, epidemiologija, mali zlatni letaš, terapija