Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
DOI: 10.29261/pakvetj/2025.139

CASE REPORT

Retrospective study of Spontaneous Tumors in 32 Pet African Pygmy Hedgehogs, with a Focus on 3 Histiocytic Neoplasms

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ARTICLE HISTORY (24-849)

Received: December 27, 2024
Revised: February 15, 2025
Accepted: February 24, 2025
Published online: March 28, 2025

Key words:
African pygmy hedgehog
Hedgehog tumors
Histiocytic neoplasm
Privately owned hedgehog
Tumor incidence

A B S T R A C T

The number of hedgehogs kept as pets has been increasing worldwide. Tumor occurrence can vary depending on age, living environment, era, and diet. Particularly, pet hedgehogs have distinctly different living conditions and dietary patterns compared to hedgehogs in zoos or wildlife. Previous retrospective studies and reviews on hedgehog tumors have not systematically differentiated their environmental origins. This study examines 34 tumors in 32 privately owned African Pygmy hedgehogs, providing a comprehensive analysis of tumor incidence based on sex, age, malignancy, organ, and location. The research offers valuable insights for veterinary practitioners. Notably, the study focuses on three specific histiocytic neoplasms: histiocytoma, malignant histiocytoma, and malignant fibrous histiocytoma. By presenting an updated report on tumor incidence in privately owned hedgehogs, this research aims to guide diagnosis and treatment strategies for pathologists and small exotic animal veterinary practitioners.

To Cite This Article: Eun-Joo Lee, 2025. Retrospective study of Spontaneous Tumors in 32 Pet African Pygmy Hedgehogs, with a Focus on 3 Histiocytic Neoplasms. Pak Vet J, 45(1): 450-453. http://dx.doi.org/10.29261/pakvetj/2025.139

INTRODUCTION

The popularity of exotic pets, including hedgehogs, has been steadily increasing. According to the American Veterinary Medical Association, approximately 11.9 million U.S. household own pets other than dogs and cats, encompassing birds, reptiles, amphibians, small mammals, and fish. While precise statistics for hedgehog ownership are not available, an estimated 1.3 million households own small exotic mammals, including hedgehog, as of 2024.

Understanding neoplasia in exotic pets is crucial, as early detection and accurate diagnosis can significantly improve treatment outcomes. Neoplasia is a significant health concern in hedgehog, accounting for 24-53% of documented diseases (Raymond and Garner, 2001; Gardhouse and Eshar, 2015; Sila *et al*., 2022). However, the last comprehensive study on hedgehog tumors was conducted over two decades ago, leaving a critical knowledge gap in veterinary oncology (Raymond and Garner, 2001). In addition, the previous retrospective studies have shown that the types and frequencies of tumors can vary considerably by region and time period (Raymond and Garner, 2001; Heatley *et al.,* 2005; Gardhouse and Eshar, 2015; Okada *et al.,* 2018). These variations in tumor prevalence may be attributed to differences in raising environments, such as zoos, wildlife habitats, or private homes, diet, geographic location, and temporal factors.

This study analyzes tumors from 32 privately owned hedgehogs, aiming to answer: How have the patterns of tumor incidence in hedgehogs evolved since the last comprehensive retrospective study in 2001? By providing an information on incidence of tumors in privately owned hedgehogs and detailed examination of tumors, with a specific focus on histiocytic neoplasms, we seek to offer valuable insights for pathologists and clinicians in diagnosis and treating hedgehog neoplasms.

MATERIALS AND METHODS

Thirty-four tumors from 32 hedgehogs were submitted to the Department of Veterinary Pathology, College of Veterinary Medicine, Kyungpook National University. The tumors were received without clinical histories. The information of each case is listed in Table 1. One sample collected from the abdominal cavity of a 5-year-old male hedgehog was excluded from this study because the mass was not properly fixed, resulting in poor sample quality that precluded a definitive diagnosis. No

additional samples were subjected to selection or exclusion criteria in this study. The tumors were fixed in 10% normal formalin and routinely processed. The processed tissues were embedded in paraffin and cut into 4 um thickness. The slides were stained with Hematoxylin & Eosin. To facilitate the differential diagnosis of spindle cell tumors including fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, and myxosarcoma, we performed immunohistochemistry using antibodies from Santa Cruz Biotechnology. The antibody panel included Vimentin (1:200), alpha smooth muscle actin (1:200), MyoD (1:200), CD34 (1:100), and S100 (1:100). The method of histopathology and diagnosis criteria were followed by the established protocol (Meuten, 2020). The differences between sex were analyzed by Binomial test.

RESULTS

Tumor incidence by sex: Similar to previous reports, tumors are more frequent in female hedgehogs than in males (P=0.0002). In this study, 81.25% of tumors occurred in females, a higher incidence than previously reported (Fig. 1A). One study found that 40% of patients with tumors were female, 31.4% were male, and 28.6% had unknown sex (Raymond and Garner, 2001).

Age distribution: The median age of tumor occurrence in hedgehog in this study is 3.09 years, ranging from 8 months to 6 years. This range is broader than the previously reported median of 3.5 years (range: 2–5.5 years) (Table 2). The tumor occurrence by age is as follows: <1 years old (3.1%), 1~2 years old (12.5%), 2~3 years old (28.1%), 3~4 years old (21.9%), 4~5 years old (15.6%), 5~6 years old (15.6%), and >6 years old (3.1%) (Fig. 1B).

Tumors in hedgehogs younger than 3 years old account for 43.8% of cases, indicating a high incidence in younger individuals given the lifespan of pet hedgehogs, which is up to 10 years (Gardhouse and Eshar, 2015). The youngest case, an 8-month-old hedgehog, was diagnosed with a plasma cell tumor, which is notable as these tumors typically occur in middle-aged to older animals. In young hedgehogs (<3 years), epulis is the most common tumor (28.57%, 4/14), including three acanthomatous ameloblastomas and one peripheral odontogenic fibroma. The average age of epulis onset is 1.6 years (range: 1–2.25 years). In hedgehogs aged 3 years or older, liposarcoma (15%, 3/20) is the most common tumors, followed by fibrosarcoma (10%, 2/20) and papilloma (10%, 2/20).

Malignancy trends: Hedgehogs tend to develop more malignant tumors than benign ones. In this study, 58.8% of tumors were malignant, while 41.2% were benign (Fig. 1C). Among 32 hedgehogs with tumors, two had multiple primary tumors. A five-year-old male hedgehog presented with a histiocytoma on a forelimb toe and a pleomorphic liposarcoma on a hindlimb toe. A five-year-old female hedgehog had an adenosarcoma in the uterus and a malignant granulosa cell tumor in the ovary.

Most common tumors: The most common tumor in this study was liposarcoma (14.7%, 5/34), followed by epulis (11.8%, 4/34) and fibrosarcoma (8.8%, 3/34). Interestingly, this study found no cases of mammary gland adenocarcinoma or oral squamous cell carcinoma,

Table 1: Diagnosis of the 34 tumors in 32 hedgehogs of this study

No.	Sex	Age	Location	Diagnosis	Origin	Malignancy
1	M	2y	Oral cavity	Hemangiosarcoma	Mesenchymal	M
2	F	1y 4m	Skin	Myxoid liposarcoma	Mesenchymal	M
3	M	2y 2m	Skin	Mast cell tumor	Hematopoietic	M
4	F	6y	Gingiva	Fibrosarcoma	Mesenchymal	M
5	M	2y 3m	Gingiva	Acanthomatous ameloblastoma	Epithelial	B
6	F	1y 8m	Skin	Malignant histiocytoma	Hematopoietic	M
7	F	5y	Skin	Liposarcoma	Mesenchymal	M
8	F	2y 1m	Skin	Hemangioma	Mesenchymal	B
9	F	3y	Uterine	Adenosarcoma	Epithelial	M
10	F	2y	Skin	Histiocytoma	Hematopoietic	B
11	F	3y 1m	Skin	Fibrosarcoma	Mesenchymal	M
12	F	5y	Uterine & Ovary	Adenosarcoma & Malignant granulosa cell tumor	Epithelial & Mesenchymal	M
13	M	2y	Oral cavity	Mixed form of rhabdomyosarcoma and Schwannoma	Mesenchymal	M
14	F	3y 3m	Uterine	Endometrial adenocarcinoma	Epithelial	M
15	F	1y	Gingiva	Acanthomatous ameloblastoma	Epithelial	B
16	F	2y 6m	Uterine	Leiomyosarcoma	Mesenchymal	M
17	F	1y	Gingiva	Peripheral odontogenic fibroma	Mesenchymal	B
18	F	4y	Skin	Basal cell carcinoma	Epithelial	M
19	F	4y	vagina	Hemangioendothelioma	Mesenchymal	B
20	F	1y 10m	Oral cavity	Myxosarcoma	Mesenchymal	M
21	F	5y	Oral cavity	Viral fibro papilloma	Epithelial	B
22	F	3y 7m	Skin	Liposarcoma	Mesenchymal	M
23	F	4y	Skin	Lipoma	Mesenchymal	B
24	F	3y	Skin	Malignant fibrous histiocytoma	Mesenchymal	M
25	M	2y 2m	Gingiva	Acanthomatous ameloblastoma	Epithelial	B
26	F	5y	Oral cavity	Papilloma	Epithelial	B
27	M	5y	Skin	Histiocytoma & Pleomorphic liposarcoma	Mesenchymal	B
28	F	4y 3m	Skin	Liposarcoma	Mesenchymal	M
29	F	3y	Skin	Granular cell tumor	Mesenchymal	B
30	F	2y 1m	Uterine	Fibrosarcoma	Mesenchymal	M
31	F	3y	Uterine	Leiomyoma	Mesenchymal	B
32	F	8m	Skin	Plasma cell tumor	Hematopoietic	B

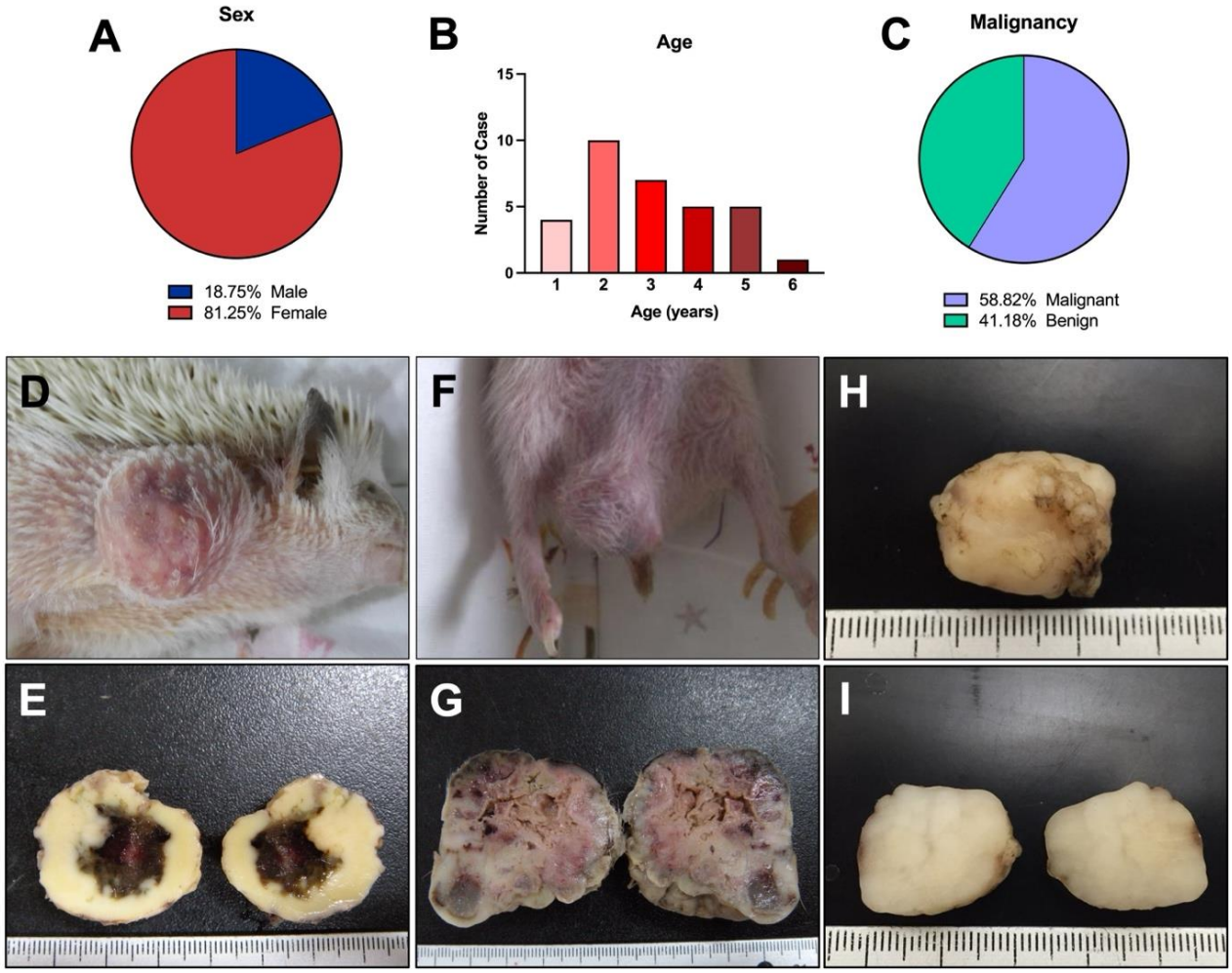

Fig. 1: The frequency and classification of 34 tumors of this study according to Sex (A), Age (B), and Malignancy (C). The gross observation of cutaneous histiocytoma (D, E), histiocytic sarcoma (F, G), and undifferentiated pleomorphic sarcoma (H, I).

Table 2: Summary of the present study, comparing with a previous study

	Present study	Raymond *et al.* (2001)
Total number	34 tumors in 32 hedgehogs	40 tumors in 35 hedgehogs
Owner		
Privately owned	100% (32)	40% (14)
Owned by zoo	0	60% (21)
Age		
Median age	3.08 years	3.5 years
Range of age	8 months - 6 years	2 - 5.5 years
Sex		
Female	82.15% (26)	40% (14)
Male	18.75% (6)	31.4% (11)
Unknown	-	28.6% (10)
Malignancy		
Malignant	58.8% (20)	85% (34)
Benign	41.2% (14)	15% (6)
Origin		
Mesenchymal	61.8% (21)	20% (8)
Epithelial	26.5% (9)	50% (20)
Round cell	11.8% (4)	30% (12)
Most common		
1st	Liposarcoma (5)	Mammary gland adenocarcinoma (8)
2nd	Epulis (4)	Lymphosarcoma (6)
3rd	Fibrosarcoma (3)	Oral squamous cell carcinoma (5)
Multiple : single		
	2 : 30	3 : 32

which were the most common tumors in earlier reports (Raymond and Garner, 2001; Gardhouse and Eshar, 2015). In this study, 61.8% of tumors originated from mesenchymal cells, while 26.5 and 11.8% originated from epithelial and round cells, respectively. (Raymond and Garner, 2001).

Histiocytic neoplasms: Histiocytic neoplasms include histiocytoma, histiocytic sarcoma, and undifferentiated

pleomorphic sarcoma, formerly termed malignant fibrous histiocytoma.

Cutaneous histiocytoma: A 2-year-old female hedgehog presented with a histiocytoma on the right shoulder. The 3 × 2.7 × 2.9 cm^3 tumor was poorly circumscribed and highly cellular. Neoplastic cells, with bean-shaped nuclei and eosinophilic cytoplasm, formed cords or sheets, and frequent mitotic figures were observed (Fig. 1 D, E).

Histiocytic sarcoma: A 1-year, 8-month-old female hedgehog developed a histiocytic sarcoma in the rectum. The tumor rapidly grew to 5 × 4.7 × 4.8 cm^3 over two months, causing anorexia, decreased activity, and dyschezia. Neoplastic cells, with ovoid to spindle-shaped nuclei, proliferated in a solid pattern with severe central necrosis and a high mitotic index (6–10 figures per high-power field). Multinucleated giant cells were prominent (Fig. 1 F, G).

Undifferentiated pleomorphic sarcoma: A 3-year-old female hedgehog exhibited a mass under the left jaw. The 2.1x1.7x1.3 cm^3 tumor infiltrated subcutaneous adipose tissue. Neoplastic cells showed pleomorphism, proliferating in a storiform pattern, with frequent mitotic figures and prominent nucleoli (Fig.1 H, I).

DISCUSSION

Tumor incidence by sex: The higher tumor incidence in females can be attributed to tumors frequently occurring in the female reproductive system. A retrospective study of 100 African pygmy hedgehogs found that 31.4% of submitted specimens were from the female reproductive system (Okada *et al*., 2018). In contrast, tumors in the male reproductive system are rare, suggesting a lower susceptibility in males.

Age distribution: While the lifespan of wild hedgehogs is typically 1–4 years, pet hedgehogs in this study developed tumors up to 6 years of age, suggesting that captive conditions may extend their longevity. This observation aligns with reported lifespans from different captive settings: African hedgehogs in Taipei Zoo live 3.4±1.1 years (Pei-Chi, *et al.*, 2015). The age of tumor incidence in zoo-housed hedgehogs (5.1 years) corresponds with the upper range of their captive lifespan (Pei-Chi, *et al.*, 2015). In contrast, wild European hedgehogs in Denmark have a mean lifespan of only 1.8 years (Rasmussen *et al*., 2023), indicating that controlled environments and veterinary care may significantly extend hedgehog longevity. The extended lifespan of pet hedgehogs highlights the importance of studying neoplasms in this species.

Malignancy: The malignancy rate of this study (58.8%) was lower than the previous report (85%) by Raymond *et al.* (2001) (Table 2). Unlike previous studies, all tumors in this study were from privately owned hedgehogs, potentially facilitating the detection of benign tumors despite their slower growth and smaller size. Clinicians should note that malignant tumors may be less common in pet hedgehogs compared to existing reports. Additionally, two cases (6.25%) highlight the occurrence of multiple primary tumors in hedgehogs and underscore the need for thorough diagnostic evaluations.

Most common tumors: The differences of incidence of tumors may be attributed to environmental and lifestyle factors. Unlike previous studies, which included 40% of cases from zoos or wildlife, all cases in this study were from privately owned hedgehogs. These different living environments could significantly influence tumor incidence patterns through variations in diet and care. Wild hedgehogs naturally consume a diverse diet, while zoo-housed hedgehogs receive carefully formulated diets developed by veterinary nutritionists. In contrast, privately owned hedgehogs are typically fed commercially available pet food or owner-selected diets including mealworm, which can vary considerably in their nutrient composition. Since diet is one of the most crucial factors influencing tumor development, these dietary differences across housing environments could distinctly affect tumor incidence patterns.

Histiocytic neoplasms: Histiocytic neoplasms are rare in hedgehogs. Only three prior cases have been reported: one malignant fibrous histiocytoma and two disseminated histiocytic sarcomas (Ogihara *et al.*, 2016; Sirivisoot *et al.*, 2021). This study adds new cases of cutaneous histiocytoma, histiocytic sarcoma, and undifferentiated pleomorphic sarcoma.

Conclusions: This retrospective study examines 34 tumors in 32 privately owned hedgehogs, highlighting distinct patterns of tumor occurrence, in terms of sex, age, malignancy and most common tumors, compared to previous reports involving zoo and wild hedgehogs. These findings offer valuable updated insights for small animal practitioners.

Authors contribution: EL made diagnosis, analyzed the data, wrote and edited the manuscript.

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