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MICROCHIP-ASSOCIATED LEIOMYOSARCOMA IN AN EGYPTIAN FRUIT BAT (*ROUSETTUS AEGYPTIACUS*)

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Abstract: Microchips are commonly used in companion, research, and zoo animal medicine for easy, reliable, and cost-effective identification with relatively low risk of side effects. This report describes development of a metastatic leiomyosarcoma associated with a microchip in an Egyptian fruit bat (*Rousettus aegyptiacus*).
Key words: α-Smooth muscle actin, Egyptian fruit bat, leiomyosarcoma, microchip, neoplasia, *Rousettus aegyptiacus*.

BRIEF COMMUNICATION

A 7-yr-old, 150-g male Egyptian fruit bat (*Rousettus aegyptiacus*) was housed with eight conspecifics in a 1.8- × 3.7- × 2.1-m indoor medical holding exhibit at the Lubee Bat Conservancy (Lubee Bat Conservancy, Gainesville, Florida 32609, USA). The daily diet for an individual bat was seasonal fruits and vegetables and a complete, commercial supplement (Lubee Fruit Bat Supplement, Ohio Pet Foods Inc., Lisbon, Ohio 44432, USA).

This bat had been diagnosed approximately 3 yr earlier with hemochromatosis by hepatic biopsy. At presentation for this report, it was evaluated for an annual physical examination while anesthetized with isoflurane (Isoflo, Abbott Laboratories, North Chicago, Illinois 60064, USA) in oxygen administered by facemask. Physical examination revealed a firm, multilobulated, light tan subcutaneous mass (1.6 × 1.5 × 1 cm) between the scapulae. The mass was surgically excised and gross inspection of cut-section revealed a Trovan microchip (Trovan, Ltd., Electronic Identification Systems, Ltd., Santa Barbara, California 93140, USA) (Fig. 1).

The mass was placed in 10% buffered formalin and submitted for routine histopathologic examination. Additionally, immunohistochemical staining was performed with mouse monoclonal anti-human α-smooth muscle actin (clone 1A4), anti-bovine vimentin (clone 3B4), and rabbit polyclonals anti-desmin and anti-cow cytokeratin antibodies at 1:100, 1:100, 1:200, and 1:100 dilutions, respectively, by using the standard protocol (Dako North America, Inc., Carpinteria, California 93013, USA). Positive controls included equine heart (α-smooth muscle actin and desmin) and canine skin (vimentin and cytokeratin).

Microscopic examination revealed an invasive neoplasm consisting of mesenchymal cells arranged haphazardly in interlacing fascicles and bundles with multifocal areas of coagulative necrosis. The neoplastic cells exhibited moderate pleomorphism and anisocytosis, varying from elongate and spindloid to polyhedral and round. Both cell types had wispy eosinophilic cytoplasm and indistinct borders. Less commonly, groups of cells had markedly vacuolated cytoplasm. Nuclei featured marked anisokaryosis with chromatin patterns that were moderately stippled. Nucleoli varied widely in size and number with giant nucleoli ranging up to 3 μm in diameter. Although some large nuclei had as many as six nucleoli, the majority of neoplastic cells had one to two nuclei. Although in most areas mitotic figures averaged 0–2 per high-power field (×400), some foci contained as many as five mitotic figures per high-power field (Fig. 2A). Most neoplastic cells had strong cytoplasmic immunoreactivity for α-smooth muscle actin (Fig. 2B) and weak reactivity for desmin. Myocytes of small arteries had strong sarcoplasmic reactivity to α-smooth muscle actin as a positive internal control. Nonspecific staining was observed for cytokeratin. Vimentin clone 3B4 was strongly reactive in neoplastic cells and normal mesenchymal cells, which served as an internal positive control. Leiomyosarcoma was diagnosed based on cellular morphology and smooth muscle actin immunoreactivity.

Approximately 5 wk after initial evaluation, the bat died and was submitted for necropsy. Marked subcutaneous edema was noted in the lateral walls and ventrum of the thorax and abdomen. An 8-mm-diameter tan nodule was present on the dorsal as-

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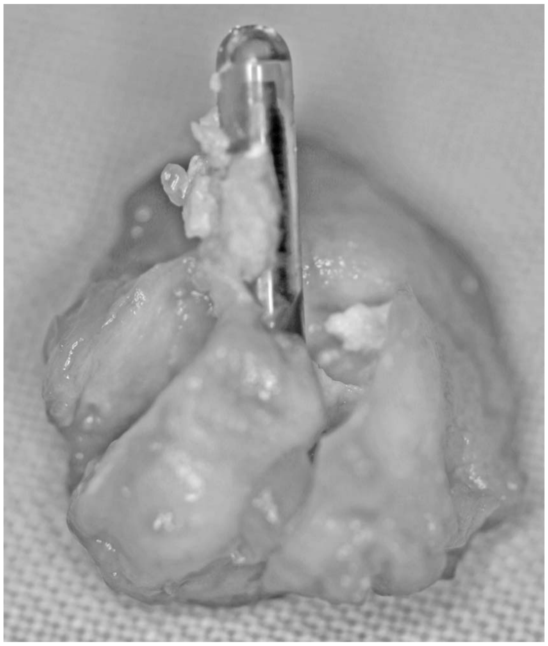

Figure 1. Photograph of mass surgically removed from interscapular subcuticular region of an Egyptian fruit bat. Note the presence of the microchip embedded within the tumor.

pect of the peritoneal surface of the diaphragm. Many smaller nodules were present adjacent and ventral to the larger nodule. Numerous tan 1–2 mm nodules also were present at the gastrosplenic and hepatoduodenal ligaments, in connective tissue surrounding the adrenal glands, and throughout the liver parenchyma. Fewer but larger tan nodules (3–9 mm) were observed on the capsular surface of the right kidney, with numerous smaller nodules scattered in surrounding connective tissue. Gross distribution of nodules was consistent with invasive spread from the subcutaneous mass through the musculature of the dorsal body wall into the diaphragm and liver with subsequent seeding of the peritoneal cavity.

Microchip-associated tumors have been reported in rats (*Rattus norvegicus*), mice (*Mus musculus*), a degu (*Octogon degus*), a feathertail glider (*Acrobates pygmaeus*), and a dog (*Canis familiaris*).[5,14,17] In two chronic toxicity/oncogenicity studies (520 rats/study), 0.5–1% of rats chronically implanted with microchips developed a neoplasm surrounding the microchip implant. All neoplasia were mesenchymal in origin, including malignant schwannoma, fibrosarcoma, anaplastic sarcoma, and histiocytic sarcoma, but not leiomyosarcoma as in this report; they were rapidly growing, and metastases were detected in some rats at postmortem examination.[5] In mice, 0.8% developed microchip-associated tumors, including fibrosarcoma and malignant fibrous histiocytoma.[16] Although these findings are consistent with previous reports of foreign body-induced neoplasms in other animals and people,[1] earlier investigations of microchip-associated tumorigenesis failed to reveal any tumor development in mice necropsied 2 yr after device implantation.[15] Similarly, microchips implanted into guinea pigs (*Cavia porcellus*), rabbits (*Oryctolagus cuniculus*), woodchucks (*Marmota monax*), and amphibians did not result in detectable tumor growth associated with the microchip at the time of necropsy examination.[13]

Leiomyosarcomas of the skin and subcutis are rare compared with leiomyomas,[4] although they have been reported in dogs and cats (*Felis silvestris catus*),[4,11] humans (*Homo sapiens*),[7] ferrets (*Mustela putorius furo*),[12] a cow (*Bos taurus*),[9] and a squirrel monkey (*Saimiri sciureus*).[2] A leiomyosarcoma reported in a wild long-eared bat (*Plecotus townsendii virginianus*) was located subcutaneous and dorsal near the shoulder blades as in this case.[3] Subcutaneous leiomyosarcomas arise from arrector pili muscles and from smooth muscle in the dermal vasculature.[11] Distant metastasis is usually not characteristic of leiomyosarcomas in dogs, cats, and ferrets. However, individual reports of widespread metastasis in dogs, humans, a cow, and a horse (*Equus caballus*) have been reported.[4,7] To our knowledge, leiomyosarcoma has not been reported in association with a microchip in any species.

Foreign body-induced sarcomas are rapidly and locally invasive with mortality usually occurring within weeks of diagnosis.[1] Tumor development is thought to occur in a two-part process, induced by the body's response to the chronic presence of any foreign object.[1,5] Factors of foreign bodies that have been associated with tumorigenesis include surface texture, surface continuity, size or surface area, and shape.[1,5,17] Relatively large, smoothly surfaced implants are more commonly associated with tumor development than small implants with rough surfaces. Surgical resection of subcutaneous leiomyosarcomas is usually curative in the dog and ferret.[11,12] Staging of the mass and treatment options were not pursued in this case.

It is possible the underlying hemochromatosis previously diagnosed and associated immunosuppression in this animal may have predisposed it to developing a leiomyosarcoma.[6] Iron plays a role in modulating immune function, including cytokine activity, nitric oxide formation, and immune cell proliferation, and iron overload may interfere with

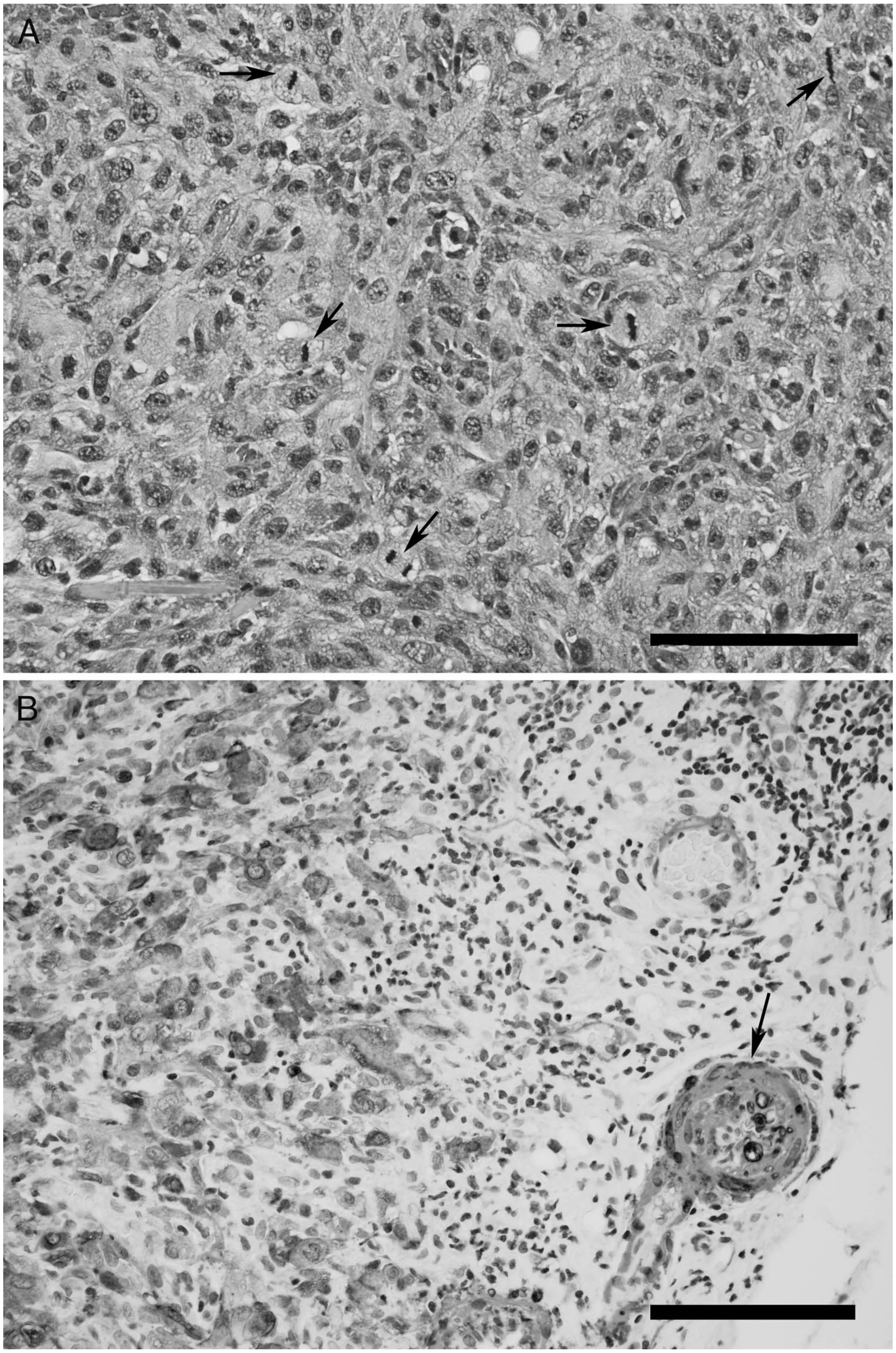

Figure 2. Leiomyosarcoma of the dorsal subcutis in an Egyptian fruit bat. **A.** Photomicrograph of section of tumor depicting a solid sheet of neoplastic cells demonstrating arrangement of interlacing fascicles and bundles. The individual cell morphology varies from elongate and spindloid to polyhedral and round with wispy eosinophilic cytoplasm, variably sized intracytoplasmic vacuoles, and indistinct cytoplasmic borders. In this area, mitotic figures range up to five per high-power field (arrows). H&E. Bar = 100 μm. **B.** Photomicrograph of immunohistochemistry staining of tumor with anti-α-smooth muscle actin (clone 1A4). Strong cytoplasmic immunoreactivity in neoplastic cells and adjacent vascular smooth muscle (arrow) is demonstrated. Bar = 100 μm.

Table 1. Neoplasms reported in retrospective survey of necropsies and surgical biopsies from captive bats at the Lubee Bat Conservancy. Neoplasms are listed according to species of bat and age at tumor diagnosis.

Species	Age (yr) at diagnosis	Neoplasm
Variable flying fox (*Pteropus hypomelanus*)	8	Cutaneous fibrosarcoma
Egyptian fruit bat	9	Cholangiocarcinoma
	7	Hepatocellular carcinoma
Dog-faced fruit bat (*Cynopterus brachyotis*)	7	Cutaneous squamous carcinoma
Short-tailed leaf nosed bat (*Carollia perspicillata*)	9	Uterine leiomyosarcoma
Common fruit bat (*Artibeus jamaicensis*)	15	Malignant fibrous histiocytoma
Little golden mantle bat (*Pteropus pumulis*)	11	Cutaneous hemangiosarcoma

these processes. Consequently, hemochromatosis may interfere with immune function and consequently endogenous responses to neoplastic cells.[10]

Microchips are used in research, zoo, aquatic, companion, production, and wild animals for rapid, reliable, cost-effective, and consistent means of animal identification.[5,13,15,16] Disadvantages associated with microchip use include migration from the original implantation site, loss, functional failure, infection, swelling, foreign-body-induced tumorigenesis, and incompatibility between different manufacturers' readers.[5,16,17] At the Lubee Bat Conservancy, 421 bats (representing 15 species of Megachiroptera) over the past 14 yr have been implanted with Trovan microchips. Only three bats have experienced an adverse reaction; two individual cases of abscessation at the implant site related to poor sterilization of the implantation needle, and the current case of neoplasia. A 13-yr retrospective search of records from adult bats at the Lubee Bat Conservancy submitted to the Veterinary Anatomic Pathology Service, University of Florida, identified 169 necropsies and 90 surgical biopsy cases submitted for assessment of gross lesions or death. Neoplasia was identified in seven of the cases as outlined in Table 1.

Although the rate of tumor occurrence due to microchip implantation is considered low, when such tumors do occur they may compromise the overall health of the animal due to large tumor size in relation to body size, as well as the potential for metastases.[5,15,16] Clinicians are advised to monitor for adverse side effects after microchip placement at regular intervals. Identification and palpation of the microchip and any associated masses is recommended during all physical examinations.

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