Canine Malignant Melanotic Schwannomas: A Light and Electron Microscopic Study of Two Cases

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Abstract. Malignant, melanotic schwannoma of the spinal cord was diagnosed in two two-year-old dogs. The neoplastic spindle cells were arranged in a herringbone or storiform pattern; the intracytoplasmic melanin varied in amount in different areas of the two neoplasms. Ultrastructural features including cytoplasmic lamellar premelanosomes and melanosomes, rudimentary cell junctions, scattered pinocytotic vesicles, and remnants of external lamina supported the diagnosis of melanotic schwannoma.

Included among primary neoplasms of the spinal cord reported in the dog are astrocytoma, ependymoma, meningioma, neurofibroma, neurofibrosarcoma, and malignant schwannoma. Schwan- and malignant schwannomas and neurofibrosarcomas have been reported most commonly. None of these neoplasms, including schwannoma, has been described as pigmented or melanotic. The central nervous system and spine are occasionally sites of metastasis in dogs with malignant melanoma, especially of the oral cavity; however, primary melanoma of the central nervous system has not been described in the dog.

In man, several histologic types of pigmented neoplasms of neural crest origin have been reported in the spinal cord. The most common type is melanotic meningioma, and the second most common type is melanotic schwannoma (pigmented nerve sheath tumor). Both benign and malignant melanotic schwannomas have been described. We describe the clinical and light and electron microscopic features of two malignant melanotic schwannomas in the dog.

Case Histories

Dog 1: A two-year-old male, mixed-breed dog was examined because of progressive incoordination of 15 days duration. The dog had become nonambulatory two days prior to examination. Physical examination revealed posterior paresis.

Dog 2: A two-year-old female Doberman pinscher was examined because of weakness of the right rear leg of two weeks duration. Physical examination revealed pain in the sacral region, patellar hyperpathia, and a lower motor neuron syndrome affecting the hind limbs, rectum, and bladder. A lesion affecting the cauda equina was diagnosed. The dog was killed and a complete necropsy was done.

Results

In dog 1, a 35-mm segment of the spinal cord in the T11-T12 region contained a 30 mm x 10 mm x 10 mm neoplasm which infiltrated the cord and nerve roots on the left side. Segments of the spinal cord adjoining the neoplasm were replaced with neoplastic tissue. Tissue bordering the tumor was hemorrhagic and normal architecture was lost. The surface of the neoplasm was dark and gray, with minute cyst-like structures. Cross sections of the spinal cord at the site of the neoplasm were firm and mostly black with pale, gray areas. No other significant gross lesions were seen.

In dog 2, a 50-mm segment of the spinal cord involving the cauda equina area and nerve roots was dark, thickened, and less pliable than normal. Cross section of the spinal cord revealed replacement of the cord and subdural space by firm, dark neoplastic tissue. No other significant gross lesions were seen.

Tissue sections from both neoplasms were fixed in 10% buffered formalin, processed routinely, and stained with hematoxylin and eosin, periodic acid-
Schiff, Perl's, and Fontana-Masson stains. Tissues for transmission electron microscopy were fixed in Karnovsky's fixative (paraformaldehyde and glutaraldehyde) buffered with s-collidine, postfixed in osmium tetroxide, and embedded in maraglas epoxy resin.

Light microscopy revealed that the two neoplasms had similar histologic characteristics, and thus they will be described as one. Examination of tissue sections taken from the central area of the neoplasm revealed complete replacement of the normal spinal cord with tumor—which also surrounded or replaced the peripheral nerve roots. The dura mater was intact, but there was no capsule surrounding the neoplasm. Examination of sections taken from the peripheral areas of the neoplasm revealed compressed and degenerated neural tissue with perivascular infiltration of neoplastic cells. Diffuse edema, necrosis, and hyalinization were seen in sections of uninvolved spinal cord adjoining the neoplasm.

The neoplastic tissue was cellular with foci of both compact and loosely arranged cells. The medium-sized spindle or oval cells primarily were arranged in interlacing bundles with areas of whorling or storiform patterns (figs. 1, 2). In dog 1, the nuclei were hyperchromatic with scattered chromatin and small nucleoli. In dog 2, the nuclei were more pleomorphic than in dog 1, were vesiculated, and had one or two nucleoli. Mitotic cells were seen frequently. Occasional large cells were noted in both tumors. The cytoplasm of the neoplastic cells that did not contain pigment was eosinophilic with indistinct cytoplasmic boundaries.

The concentration of cells containing dark brown, intracytoplasmic pigment varied from one area to another, and the pigment content varied from one cell to another (figs. 1, 2). In some of the neoplastic cells, the pigment obscured the cellular details; in others it formed fine, intracytoplasmic granules, and in many cells there was no pigment. The pigment did not stain for iron or with the periodic acid-Schiff, but there was a positive reaction with Fontana-Masson stain.

Electron microscopic examination revealed ovoid and spindle-shaped cells joined by scattered, rudimentary cell junctions in a dense collagenous stroma (figs. 3–5). Scattered throughout the lesion were morphologically similar cells that contained numerous electron-dense, cytoplasmic melanosomes (figs. 3, 4). Rare pigmented and unpigmented cells possessed remnants of investing external lamina (figs. 4, 5). At higher magni-

![Fig. 1: Spindle-shaped cells arranged in whorled pattern with peripheral melanin-containing cells.](image1)

![Fig. 2: Interlacing bundles of spindle-shaped cells; many contain melanin.](image2)
Fig. 3: Low magnification electron micrograph; ovoid and spindle-shaped cells joined by scattered rudimentary cell junctions. Numerous melanosomes in cytoplasm of one cell.

Discussion

Many types of benign and malignant schwannoma, meningioma, neurofibroma, and neurofibrosarcoma have been described in the spinal cord of dogs and are potentially melanotic, but none has been diagnosed as such. Thus, melanotic schwannoma in the dog is probably rare. Various types of melanotic neoplasms affecting the spinal cord have been reported in man.

The diagnosis of malignant melanotic schwannoma in the two dogs of this report was based on the gross association of the neoplasm with nerve roots, the storiform pattern formed by spindle cells, the lack of a capsule and frequent mitosis, and the presence of melanin pigment. Ultrastructurally, the presence of isolated, cytoplasmic, lamellar premelanosomes and melanosomes, rudimentary cell junctions, remnants of external lamina, and scattered pinocytic vesicles confirmed the diagnosis. These latter features are similar to those reported in human patients with nerve sheath tumors. The lack of a complete external lamina seen in the cases of this report is compatible with greater malignancy of the neoplasms.

Various hypotheses have been proposed regarding the origin of melanin in melanotic schwannomas, including active phagocytosis of melanin by the neoplastic cells, transfer of melanin from melanocytes to Schwann cells by "cytocrine injection," transformation of melanoblasts to Schwann cells by means of the neoplastic process and neoplastic proliferation of two independent cell lines. The most acceptable theory, however, is that of ectopic production of melanin by neoplastic Schwann cells. This theory has been upheld by results of electron microscopy of pigmented schwannomas and is consistent with the common embryonic neural crest origin of both melanocytes and Schwann cells. Similar ultrastructural characteristics of both of these cell types have been seen in cellular and malignant blue nevi, malignant melanotic tumor of sympathetic ganglia, melanotic neurofibroma, and spinal melanotic clear-cell sarcoma—an indication of the pluripotentiality of cells derived from the neural crest. In addition, melanogenesis has been demonstrated recently in the Schwann cells of the normal dermis in man.

Malignant melanoma in the dog, specifically from the oral cavity, is highly anaplastic and produces diffuse metastasis, including that to the central nervous sys-
tem. Thus, it is essential that oral and cutaneous melanomas be carefully eliminated before making a diagnosis of primary melanotic tumor at any unusual site. In both of our dogs, no tumors or any pathologic changes other than those associated with the primary neoplasm were found at necropsy. The reported age range of dogs with malignant melanoma is seven to 14 years, and multiple metastasis involving the regional lymph node, lungs, and other tissues is common. The dogs of this study were only two years old, and the lesions were solitary and affected only the spinal cord and adjoining nerve roots. Light and electron microscopic features differed from those of melanoma in man and the dog.

Leptomeningeal melanoma was included in the differential diagnosis. This neoplasm has not been described in the dog, but has been reported in a horse and piglet. The histologic findings are similar to those of melanoma.

In man, malignant melanotic schwannomas are relatively benign compared to primary melanomas of the central nervous system and melanomas at other sites. Peripheral nerve sheath tumors in the dog are prone to regrowth and usually do not metastasize, even though they are histologically malignant. We believe that melanotic schwannomas may behave the same way, and thus surgical removal is the treatment of choice.
Fig. 6: High magnification electron micrograph of cytoplasm of pigmented cell; fully pigmented melanosomes and ellipsoidal premelanosomes with striated core.

References

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