AN OSTEOGENIC SARCOMA OF A DOG: PATHOLOGIC AND ROENTGENOLOGIC OBSERVATIONS

WILLIAM H. FELDMAN, D.V.M., M.S.
Division of Experimental Pathology and Surgery, The Mayo Foundation,

AND

FRANCES A. FORD, M.B., M.D., M.S.
Section on Therapeutic Radiology, The Mayo Clinic, Rochester, Minnesota

Osteogenic sarcoma is not common among lower animals, and opportunity seldom occurs to study the lesion and its response to roentgen-ray treatment. In the last year it has been our privilege to observe an animal with osteogenic sarcoma, and this brief report is offered for the information of others who may have opportunity to study this malignant condition.

Case Report

History of Case: A male English setter, aged two years, became lame in the left front leg. An enlargement about 1 cm. in diameter finally appeared near the distal end of the radius. This was thought to have resulted from an injury, and the involved area was treated for a time with liniments and tincture of iodine. Study of roentgenograms and of histologic sections prepared from biopsy material resulted in a diagnosis of osteogenic sarcoma. The animal lost a good deal of weight in the first four months following the appearance of the lesion and seemed to be in continuous distress. The veterinarian in charge informed the owner of the seriousness of the condition, and the dog was sent to our laboratories in the hope that we might recommend therapeutic procedures which would be of benefit.

Roentgenograms of the thorax failed to disclose metastasis, and a course of exposures to roentgen rays was instituted. The disease continued to progress, however, and the affected leg was finally amputated at the proximal third of the humerus, about six months after the growth was first noted.

Recovery after the amputation was uneventful. An attractive diet was provided and the animal soon gained weight; marked improvement in his general physical condition continued for a period of approximately six weeks, when gastro-intestinal disturbance developed. Symptoms of circulatory impairment became evident, and the feet and legs became swollen and edematous. The animal's condition was considered hopeless and at the owner's request he was permitted to die under an anesthetic.

Necropsy revealed metastatic formations around the heart and numerous nodules of variable sizes throughout both lungs. The thoracic wall was also slightly involved. The other tissues and organs were ap-
parently free of the disease. The amputation wound had healed completely and the stump was without gross evidence of tumor.

**Gross Appearance of the Neoplasm:** Roentgenogram of the affected leg revealed a neoplastic process, involving the distal portions of the radius and ulna (Fig. 1). The tumor appeared to have originated from the periosteum, and only a minimal amount of ossification had occurred. Although there was some ulceration of the superficial portion of the skin overlying the affected parts, the neoplastic tissues were not exposed (Fig. 2).

![Fig. 1. Osteogenic Sarcoma of the Left Ulna of a Dog](image)
The extent of involvement and osteoplastic character of the growth are shown.

The metastatic tumors of the lung were more or less circumscribed, and their grayish-white color contrasted sharply with the surrounding tissues in which they were embedded. The majority of the metastatic nodules were devoid of gross evidence of calcification or bone, but a few growths contained considerable mineral substance; this imparted to the tumor a hardness comparable to bone. In some of the growths there was extravasation of blood, but necrosis or ulceration was not discernible even in the larger masses.

**Histopathology of the Tumor:** Tissues prepared for histologic study included the biopsy material obtained before application of roentgen rays, the tumor removed with the amputated leg after exposure to roentgen rays, and metastatic nodules from the lung.

The tissues secured at biopsy revealed a highly cellular neoplasm with every characteristic of immaturity. The growth was composed of slightly elongated, rather plump cells containing prominent, hyperchromatic nuclei. Intercellular substance was scanty, and definite stroma was not discernible. Blood channels and blood spaces of primitive design were
numerous and an abundance of mitotic figures were to be seen. Scattered promiscuously throughout the tissue were large numbers of protoplasmic masses commonly referred to as foreign-body giant cells (Fig. 3). Osseomucin or other evidence of cellular differentiation was not observed in the biopsy material. In fact, the cellular constituent of the tumor closely resembled that of fibrosarcoma.

The tissue obtained from the depths of the tumor after the affected leg had been amputated revealed an even more immature type of cell than that making up the tissue secured at biopsy. The cellular units were

![Image](image_url)

**Fig. 2. Osteogenic Sarcoma**

The tumor is of a diffuse character with some ulceration of the superficial tissues. The photograph was taken just prior to amputation.

definitely spindle-shaped, and the nuclei were large, hypochromatic, and often polymorphic. Mitotic division was a common phenomenon. Giant cells, such as were found in the biopsy material, were not observed. As a whole the tissue exhibited all the characteristics of a vigorously growing malignant lesion without evidence of diminution of its growing propensities, regardless of the fact that the tumor had received intensive roentgen-ray treatment.

A study of the sections prepared from the lung disclosed all transitions in the differentiation of the osteogenic cell making up the neoplasm. Nodules were examined which consisted entirely of immature cells of an elongated or spindle-shaped contour comparable in every respect to those
found in tissue obtained at biopsy and to those observed in the primary tumor following the application of roentgen rays (Fig. 4). Many of the nodules in the lung, however, showed the type cell in various stages of differentiation. There were many areas in which deposits of osseomucin were just beginning and it was possible to trace the development of the osteogenic process from the earliest appearance of an osseomucinous matrix to the formation of bone spicules with calcification (Figs. 5 and 6). In fact it was necessary to decalcify some of the material before histologic sections could be prepared. Although the nodules in the lungs were circumscribed, encapsulation had not occurred and much of the adjacent lung tissue was in a state of atelectasis.

Fig. 3. Osteogenic Sarcoma: Photomicrograph Prepared from Material Removed at Biopsy from Primary Lesion. × 300

Giant cells such as occurred in the biopsy material were not seen in any of the numerous sections prepared from the different nodules in the lungs.

The tumor was considered osteogenic sarcoma for the following reasons: (1) the relation of the tumor to the periosteum and its gross appearance as shown in the roentgenogram; (2) the osteoblastic potency of the type cell as revealed by the production of osseomucin and the formation of bone; (3) the progressive nature of the neoplasm, its tendency to infiltrate and destroy the surrounding tissues, and eventually to establish distant metastasis.

Dosage of Roentgen Rays: A Kelley-Koett mechanically rectified apparatus with a maximal capacity of 165 kilovolts and a universal Coolidge broad focus tube were used for the irradiation. The technical factors employed were: 135 kilovolts peak as measured by a standard sphere-
Fig. 4. Osteogenic Sarcoma: Lung Metastasis Showing the Immature, Undifferentiated Appearance of the Neoplastic Cells. × 225

Fig. 5. Osteogenic Sarcoma: Lung Metastasis

The deposition of osseomucin is apparent and the neoplastic process has a more adult appearance than is depicted in Fig. 4. × 120
gap; 5 milliamperes current; 4 mm. aluminum filter, and 16 inch skin-target distance. With this setting the output of rays in r units measured in air by a Victoreen dosimeter was 17.5 for each minute or (with the 40 per cent addition for scattering) 24.5 r units at the surface of the part irradiated. The initial treatment covered three fields, two on the dorsal aspect which were approximately 6 by 10 cm., dividing the tumor laterally at the median line and extending several centimeters beyond any apparent swelling, and one ventral field measuring approximately 5 by 12 cm. The beam of rays from each field converged toward the center of the tumor. A forty minute exposure was given to each area. In three later treatments given at intervals of five to seven days twenty minutes of irradiation was applied to one dorsal area and to one ventral area. This gave a total of 5,880 r in a period of twenty-two days. We recognize that the dog's skin tolerates about two and a half times the intensity of irradiation which human skin can tolerate, but we have no information in regard to the proportion of the rays which are filtered out or absorbed by the skin itself. However, in this case the incisions for biopsy, the ulceration caused by the tumor, and the secondary infection, had partly denuded the dorsal aspect of the area.

**Fig. 6. Osteogenic Sarcoma: Lung Metastasis**

A decalcified lesion showing the bone-like character of the tumor in an area in which the neoplastic cells have become fully differentiated. × 120
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COMMENT

The majority of osteoblastic tumors of dogs that have been described have been malignant, and in most instances the process has affected the bones of the extremities. Petit saw an osteoblastic sarcoma of the lower part of the diaphysis of the femur of a dog. The tumor had its origin from the periosteum and, while there was a marked tendency for the growth to become ossified, the bone of the leg remained recognizable within the tumor. An enormous osteogenic tumor of the left femur of a six-year-old Newfoundland dog was reported by Hogard. The growth weighed 5,800 gm. within a period of six months. Apparently it arose from the periosteum and involved the lower portion of the epiphysis and the adjoining half of the diaphysis. Spontaneous fracture of the diseased part eventually occurred. Osteosarcoma, situated at the distal end of the forearm of a two-year-old dog was observed by Joest. The tumor, which was described as being of the size of a child’s head, had developed within two to three months. Ossification was extensive.

McWhorter and Whipple described in detail “a giant-cell sarcoma of the periosteal type” which occurred in a seven-year-old male St. Bernard dog. The animal became lame before the appearance of the tumor, although there was no history of trauma. The neoplasm was situated immediately above the carpus of the right foreleg and extended into the diaphysis of the radius, but the ulna was not affected. Metastasis was not discernible, the tumor being limited by the epiphyseal line. The tumor grew rapidly but it was considered of relatively low-grade malignancy. Attempts to transplant it were futile.

A highly osteoplastic, osteogenic sarcoma of the distal fourth of the right radius of a six-year-old great Dane was described by Stewart. The tumor apparently had its inception in the periosteum and had been present for about five months. Two osteogenic tumors were listed by Crocker among a total of 1,548 dogs examined at necropsy. One was considered a giant-cell sarcoma of the left scapula and the other an osteosarcoma of the left femur.

Ratcliffe reported an osteogenic sarcoma of a Chacma baboon which he designated giant-cell tumor. The growth originated near the distal epiphysis of the ulna, progressed rapidly, and metastasized to the lungs, heart, and gluteus muscles. Attempts to transplant the tumor to Macacus rhesus monkeys failed.
It is evident from the few cases of osteogenic blastoma of the extremities of dogs that have been reported that such tumors usually arise from the periosteum and that without question the majority of them are malignant.

The possible part of trauma in the inception of osteogenic sarcoma is not established so far as the dog is concerned. Although injury was thought to antedate the neoplasm in some instances, there are not sufficient data to consider such occurrences as other than coincidental. It is recognized, however, that the recorded observations are too few to justify definite conclusions concerning the pathologic changes in this disease. Whether trauma is of etiologic significance is therefore problematic.

The histologic study of the material on which this report is based illustrates rather well the wide variations in the morphologic structure of osteogenic sarcoma. In the immature or embryonic state the type cell is usually devoid of features by which it can be identified. It resembles in every way a primitive connective-tissue cell, which in truth it is. The potency of the type cell may not be revealed in wide expanses of the tumor, and it is only by a study of the roentgenogram that evidences of differentiation are revealed in the gross specimen. The inherent possibilities of the osteoblastic cell were clearly apparent in the lesions of the lung. All transitions from the most immature, undifferentiated form of the osteoblast to the formation of true bone, which is the end product, could be seen often in a single field.

Although metastasis was limited to the lungs, it is probable that if the disease had been permitted to run its course, metastatic foci would have become established in many of the other organs.

In the treatment of osteogenic sarcoma of human beings, great variability of response to irradiation is encountered, due to the diversity of possible cellular constituents. Although the more active types of malignant tissue, exhibiting rapid cell division and little cellular differentiation are biologically more sensitive to the rays, this factor may be offset by the particular tissue from which the growth originates and by the relative amount of calcareous, cartilaginous, or other anaplastic deposits. The endothelial myelomas of Ewing, for example, are far more radiosensitive than are osteogenic sarcomas of the periosteum, or fibrosarcomas. In the case described the massive irradiation had no apparent effect in checking the growth or in altering its cytology.
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Summary

Osteogenic sarcoma of the periosteum which involved the distal portion of the radius and ulna of a two-year-old English setter is described. The tumor progressed rapidly, and the application of roentgen rays, and amputation, were not successful in preventing metastasis.

Bibliography