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Radiation Therapy

Helma Weeks
University of Pennsylvania

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Veterinarians utilize many therapeutic measures employed by physicians, and radiation therapy, long used in human medicine to treat cancer, is finding its place in veterinary medicine.

"For many decades physicians have applied radiation therapy to reduce or eliminate tumors," said Dr. Sydney Evans of the School of Veterinary Medicine, University of Pennsylvania. "In veterinary medicine, radiation therapy has been available for about 20 years, but its use is not widespread. There are only about 25 institutions in the nation where animals can receive such therapy; Penn is one of them."

In veterinary hospitals radiation therapy most frequently consists of X-rays, termed "orthovoltage radiation." The ionizing radiation is generated by equipment that is similar to a conventional X-ray machine. This type of radiation therapy is rarely used in human medicine, which now relies on higher energy radiation emitted from a cobalt-60 source or linear accelerators.

Orthovoltage radiation does not penetrate tissue as deeply as the higher energy radiation. Also, bone absorbs orthovoltage radiation at a greater rate than the surrounding tissue, increasing the danger of bone necrosis. These factors limit the application of orthovoltage therapy, confining it to tumors located relatively close to the surface.

Gamma rays interact with tissues differently than orthovoltage X-rays. Due to this different type of interaction, there is no difference in the absorption rate between bone and soft tissue. The maximum dose for this type of radiation is located 5 mm below the skin surface, reducing the skin changes seen with orthovoltage X-rays. Radiation generated by linear accelerators has even higher energy and can penetrate more deeply. It is used to treat large tissue volume in people. This type of radiation therapy is generally not available to treat animal cancers.

Cancer in animals is common. It is estimated that 381 new cases occur per 100,000 dogs per year and 156 new cases per 100,000 cats per year. Owners have come to expect sophisticated veterinary care for their companion animals, and they do not hesitate to ask for radiation therapy in order to prolong a pet's life.

"The animals we see here often are older and have become an integral part of the family," said Dr. Evans. "Radiation therapy is considered when it is felt that the animal's life can be prolonged and when the animal can lead a normal, comfortable life during and after therapy."

Dogs and cats present a special set of problems to the therapist. In human medicine, radiation treatments are given over a period of four to six weeks, usually five days a week. This is not possible for animals as each treatment requires sedation to keep the dog or cat still. "We treat the animals three times a week for 21 to 30 days. The logistics of extending the treatments over a longer time become untenable.

Dr. Evans explained that in most cases radiation therapy is not the sole treatment. Often surgery has been performed to reduce or remove a tumor. "When a tumor is removed surgically, microscopic traces of the growth remain behind and radiation helps to destroy these. In other cases the entire tumor cannot be removed because of its location. Radiation is then employed to destroy the remaining cancerous tissue." Chemotherapy is also used to reduce the tumor burden prior to radiation therapy. Chemotherapy may also be employed following therapy to decrease the chance of tumor metastasis. Radiation dosages have to be carefully calculated to minimize damage to healthy tissue. To arrive at the proper individual dosage, the radiologist calculates the total dose of radiation needed and then divides it by the number of treatments. In general, the aim is to give the maximum dose to the tumor without causing irreparable damage to normal tissues.

"Ionizing radiation penetrates the tissues and deposits energy within the cells," Dr. Evans said. "It affects not only the tumor cells but also the healthy tissue, thus one has to be careful." It is thought that radiation damages the DNA of the cells, causing them to die. The effect of radiation is seen quickly on cells which regenerate rapidly, such as skin cells. Damage to nonproliferating tissues such as muscles, nerve, or bone only becomes evident after a period of time. The cells most affected by radiation are those with a high oxygen content. Tumor cells of this type are close to the surface of the tumor where the tumor blood supply is best developed. The more central cells, far away from the blood supply, may be less well oxygenated. As a result the central tumor cells are hypoxic, low in oxygen, and they do not respond well to radiation therapy. However, as oxygenated tumor cells are killed by the therapy, the blood supply to remaining cells enhances somewhat, increasing the chances of destroying these cells during the next treatment. But is often impossible to destroy all the hypoxic tumor cells, and sometimes a pool of cells remains to begin tumor growth anew. Dr. Evans' research centers on studying means to enhance the oxygen content of hypoxic cells to make them more susceptible to radiation therapy.

Recent review studies have shown that radiation therapy does increase the survival rate. "We have studied the records of a number of patients here. We compared cases where animals received surgery alone and cases where radiation therapy was given in addition to surgery." It was found that in some tumors, when patients received the combined therapy, they had a longer survival rate. "Nasal tumors are among the more common ones we see here," said Dr. Evans. "Previous studies have shown that dogs untreated or treated with surgery alone lived less than six months. We studied 70 cases treated with surgery and radiation therapy between 1973 and 1985. Of these, 29 died because of the tumor, 14 died from other causes, and 18 are alive; 9 were lost to the study. These animals received a bilateral rhinotomy, and three weeks after

surgery ten radiation treatments were administered over a period of 22 days. The age range of the animals was two to 15 years; the mean age was 8.9 years. The median survival rate was 34.7 months; the survival range was 0.5 to 61.7 months. If the animal survived for one year, its chance of survival for a longer period of time was good.

Another tumor treated with radiation therapy is hemangiopericytoma. In a retrospective study of surgery plus radiation therapy, it was found that animals with this type of tumor on the hindleg had a better survival rate than those with the tumor on the front leg. Tumor-free intervals after therapy ranged from 1.5 to 55 months; the overall recurrence rate of the tumor was 36.9 percent.

Canine oral nontonsillar carcinomas are another category of tumors treated with radiation therapy. Many of these tumors also involve the bone. However, the response to treatment is good, particularly if the animal is a younger one and bears a relatively small tumor.

There are many different tumor types, and the response to radiation therapy is known for some of them. Transmissible venereal tumors and acanthomatous epulis of periodontal origin respond well to radiation therapy. The chances of treating oral squamous cell carcinomas are fair to good. If a tumor has metastasized, radiation therapy is not appropriate.

Animals do not suffer the severe side effects from radiation treatment experienced by people. They do not have general hair loss or the weakness after treatment. "There is hair loss at the site of the radiation treatment," said Dr. Evans. "But sometimes the hair will grow back, though frequently it will be patchy and white."

Dr. Evans treats about 100 patients a year. "I wish we could handle more," she said. "But we just don't have the personnel." She explained that the School had been given a cobalt unit. "This would greatly enhance our capabilities. We currently have a suitable space at VHUP to put this unit in, but it would require major expenses to build a room to contain the rays and quite a bit of money to refurbish the unit." Currently the radiation therapy unit is housed in the old building. The room is shielded and equipped with monitoring television cameras for Dr. Evans to observe the animals during the 5 to 10 minute treatments.

Radiation therapy for animals is an exciting field, but one where much research is needed; often the data from work on companion animals can benefit people as well. "It is attracting people, and slowly the number of clinicians who can administer these treatments is increasing," she said. "But at this time, radiation therapy of animals is not the norm, and to utilize it fully we need much more data."

Dr. Evans is assistant professor of radiology at Penn's School of Veterinary Medicine. She received her VMD in 1977 and studied radiation therapy at the Medical School of the University of Pennsylvania.

—H.W.