Principles and Applications of Radiation Therapy in Exotic Animals

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KEYWORDS

• Radiation therapy • Radiotherapy • Avian • Rabbit • Reptile • Oncology
• Small mammal

KEY POINTS

- Radiation therapy is increasingly available and being used to treat cancer in exotic animals using both external beam radiotherapy and strontium-90.
- Conventional dosing and fractionation schemes used to treat birds based on mammalian data may be insufficient to get treatment responses.
- Thymoma in the rabbit is very responsive to radiation therapy as a sole therapy with rapid clinical response, robust tumor responses, and long reported survival times.

INTRODUCTION

Radiation therapy is an increasingly used tool in managing the veterinary patients with cancer.[1] Knowledge of outcomes and side effects in dogs and cats treated with radiation therapy has grown substantially over the past decades, but there is still very little published on the use of radiation as a treatment modality in exotic animals. What is not known about the use of radiation to treat cancer across this large range of species is more than is known. There are also particular challenges that clinicians face when treating exotic animals, including the need for repeated anesthetic episodes; accurately and precisely positioning the animals at each treatment; and treating what are often very small patients and using small field sizes, which can make dose calculation difficult and in some cases limits the ability to treat an individual animal.

Radiation can be used as a definitive therapy if the goal is to cure the patient, or can be used in a palliative setting if the goal is decrease clinical signs by shrinking a tumor or by directly controlling pain. When talking with owners it is important to make sure

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that they understand what is being attempted. The goal of therapy affects the dosing and number of treatments (fractions) used in prescribing a dose (**Box 1**).

Radiation therapy works by damaging the DNA, causing cells to die when they try to divide or in some cases through apoptosis. This process means that gross tumors may not decrease in size right away and that even acute side effects can occur after finishing a course of radiotherapy.

Radiation is most commonly used as a localized therapy, although wide field irradiation has been used in multiple species for hematopoietic tumors. It is also a therapy that works best in the setting of microscopic disease, meaning that it is often used as an adjuvant therapy to surgery when there is an incomplete surgical margin. In cases in which a tumor is not resectable or when using it to treat very radioresponsive tumors that are small, it is sometimes used as a sole modality. Radiation is also used as a palliative treatment in the gross disease setting when a tumor has already metastasized, when a tumor is not resectable, when surgery is not practical or feasible, or if the owner declines surgery. Radiation therapy can also be used along with chemotherapy. Chemotherapy can either be given systemically or by intralesional injection. The goals of combining radiation with chemotherapy are to increase chances of local control and also to treat known or suspected metastasis.

Radiation dose is quantified as units of energy delivered per mass of tissue. The SI unit for radiation dose is the Gray (Gy), which is equal to 1 J/kg. An older term for dose is the rad, which is equal to 1 cGy. Radiation doses are often, except for plesiotherapy, fractionated, meaning that the dose is broken up into multiple sessions. Total dose and fractionation schedules depend on the goals of therapy, the tolerance of the normal tissues that are also irradiated, and to some degree the radiotherapy technique used.

This dose can be delivered in a single or multiple fractions, depending on the type of radiation being used and the goals of therapy. For linear accelerator–based radiotherapy, curative intent radiotherapy is usually fractionated into 12 to 20 fractions of 2.5 to 4 Gy/fraction in veterinary medicine. By using a lower dose per fraction a higher total dose can be delivered while decreasing the risk of late side effects. The exception to this is stereotactic radiosurgery, in which, in veterinary medicine, patients are often treated in 1 to 5 fractions of 8 to 15 Gy/fraction. Palliative protocols vary widely in total dose and fractionation scheme and the ideal fractionation is not known. Usually a smaller number of fractions, between 4 and 6, are given using higher doses of radiation (6–9 Gy/fraction) in each treatment. This approach increases the risk of late side effects, but, in patients unlikely to live more than 6 months because of their tumor or concurrent disease, it can be a very good option.

Before calculating a dose of radiation the clinician must decide on the volume of tissue to irradiate. In radiation therapy, several volumes have been defined. The gross

Box 1
Components of a radiation prescription

- Type/source of radiation
- Total dose
- Dose per fraction (treatment)
- Frequency of fractions (eg, daily, Monday-Wednesday-Friday, weekly)
- Volume of tissue to be irradiated