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Stereotactic body radiation therapy for heart-base tumors in six dogs

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Abstract *Introduction:* Heart-base tumors are increasingly treated with radiotherapy, yet safety and efficacy are incompletely understood. This case series describes outcomes after stereotactic body radiation therapy (SBRT) for presumed chemodectoma.
Animals: Six pet dogs.
Methods: A retrospective study was performed, including dogs with a clinical diagnosis of chemodectoma and treatment with three-fraction SBRT (30 Gy total).
Results: Heart-base tumors, presumed or confirmed to be chemodectomas, were diagnosed via histopathology or imaging. Treatment was delivered with intensity modulation and cone-beam computed tomography–based image guidance, using a linear accelerator and robotic couchtop. Intrafraction respiratory motion was managed with either neuromuscular blockade and breath-holding (n = 3) or high-frequency jet ventilation (n = 3); mean total anesthesia times for each technique were 165 and 91 min per fraction, respectively. Four tumors were assessed after SBRT; tumor volume decreased by 30–76%. Possible treatment-related complications included cough, tachyarrhythmias, and congestive heart failure. Two dogs experienced sudden death 150 and 294 days after SBRT. Three dogs are alive 408–751 days after SBRT, and one dog died of unrelated disease 1,228 days after SBRT.
Conclusions: This SBRT protocol resulted in rapid tumor volume reduction, and jet ventilation effectively reduced treatment delivery times. However, cardiac arrhythmias (presumably tumor or treatment associated) and sudden death were

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common after SBRT. Therefore, SBRT is a potentially useful treatment but may not be appropriate for dogs with incidentally diagnosed, slowly growing tumors, which are not causing cardiovascular disturbances. Longer follow-up and larger case numbers are needed to more completely define safety and impact of treatment on long-term survivability.

Abbreviations

CT	computed tomography
GTV	gross tumor volume
Gy	Gray
OAR	organs at risk
PTV	planning target volume
SBRT	stereotactic body radiation therapy

Introduction

Up to 1.5% of dogs may be afflicted by heart-base tumors (i.e. aortic body chemodectomas), and certain breeds (Boxers and Boston Terriers) are at increased risk [1—4]. Although regional (lymph node and myocardium) and distant (lung, liver, adrenal glands, and brain) metastases have been reported in up to 22% of cases, this is typically considered a slowly progressive disease for which dogs rarely succumb to their metastatic disease burden [2,5]. Diagnosis may be prompted by evaluation of clinical signs arising from tumor-associated ailments (e.g. congestive heart failure, pericardial tamponade) [4,6,7]. However, the diagnosis may be incidental in many dogs that have clinically silent tumors [1].

Pericardiectomy has been associated with prolonged survival in dogs with aortic body tumors, but this approach does not slow tumor growth or improve cardiovascular function in dogs with compressive tumors [7,8]. Tumor-directed therapy may include surgical resection or systemic drug therapy (e.g. toceranib phosphate), but neither approach has been extensively studied [8,9]. External beam radiotherapy is another potential treatment option. A recent case report provides evidence for chemodectoma being a relatively radioresponsive tumor type [10].

Largely driven by improved convenience, stereotactic body radiotherapy (SBRT) has become an attractive alternative to conventional full-course radiation therapy [11]. Despite increasing clinical implementation of SBRT for this disease, many questions remain with regard to both safety and efficacy, optimization of the treatment protocol, and case selection. Therefore, the goal of this retrospective case series is to report the feasibility of, and clinical outcomes associated with, a three-fraction linear accelerator-based SBRT protocol. The secondary aim is to describe strategies for the management of respiratory motion in these dogs.

Animals, materials and methods

A retrospective study of dogs treated with SBRT for heart-base tumors, confirmed or presumed to be chemodectomas, at the North Carolina State University Veterinary Hospital from 2013 to 2016 was performed. Dogs were included if they had a histopathologically confirmed or presumptive (based on echocardiographic appearance as determined by an American College of Veterinary Internal Medicine board—certified cardiologist and/or tomographic appearance as determined by an American College of Veterinary Radiology board—certified radiologist) diagnosis of chemodectoma and were treated with three-fraction SBRT. At this institution, clients are offered SBRT for chemodectoma unless their dog has large and/or fluctuating volumes of fluid in the chest; in those cases, full-course conformal radiotherapy is recommended instead of SBRT. That is because interfraction and intrafraction tumor location is impossible to control with large volumes of fluid and because rapidly fluctuating volumes of pleural or pericardial effusion can have significant impacts on radiation dosimetry. Both scenarios create uncertainties that are difficult and/or impossible to manage with regard to safe and accurate delivery of extremely conformal, large fractional doses of radiation.

A medical record review was performed. Information including age, sex, breed, presenting clinical signs (if present), results of systemic staging tests, the method of respiratory motion management used for treatment simulation and delivery, documentation of presumed or confirmed acute

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