Computed Tomography of the Musculoskeletal System

Elizabeth A. Ballegeer, BS, DVM

KEYWORDS

• Computed tomography • Appendicular • Musculoskeletal • Shoulder • Hip • Elbow • Foot

KEY POINTS

- Musculoskeletal computed tomography (CT) is mostly useful for diagnosing bony abnormalities, although with added contrast it may be sensitive for some soft tissue lesions.
- Musculoskeletal CT is much more sensitive than radiography for detecting abnormalities to areas superimposed on planar images.
- The ability of CT to obtain images and 3-dimensional (3D) reconstruction of the imaged part leads to a better understanding of the complexity and precise configuration of abnormalities.
- The scientific literature is focused primarily on the canine species and joint abnormalities. Brief synopses of what is available are presented.
- Imaging should always be interpreted with the patient's clinical presentation in mind; the contralateral limb often provides a good comparison for interpretation.

INTRODUCTION

Computed tomography (also known as CT or CaT scanning) is an imaging modality that is of increasing availability, usefulness, and ease of use for the modern-day veterinarian. What was once only available in veterinary referral institutions of higher learning is more commonplace. Briefly, CT uses the differential absorption of x-rays by tissues to mathematically create a 2-dimensional matrix with pixels of differing greys dependent upon that absorption, to give cross-sectional information about

The author has nothing to disclose.
Diagnostic Imaging, Department of Small Animal Clinical Sciences, College of Veterinary Medicine, Michigan State University, 736 Wilson Road, D211 Sm An Clin Sci, East Lansing, MI 48824, USA
E-mail address: ballegee@cvm.msu.edu

Vet Clin Small Anim 46 (2016) 373–420
http://dx.doi.org/10.1016/j.cvsm.2015.12.005 vetsmall.theclinics.com
0195-5616/16/$ – see front matter

the third dimension of an object. Radiographs did and do project the information of all of the structures in an object, superimposed into a single planar image, and, therefore, decrease the conspicuity of each individual structure. By slicing through an object, this superimposition is removed, and the third dimension of data reconstructs a much more conspicuous image. This imaging has progressed from its first medical application in 1971 with long acquisition times and largely pixelated images,[1] to extraordinarily detailed small-pixeled matrices acquired in fractions of seconds.

Among the most impactful developments in CT were the invention of slip-ring technology, which allowed helical and not single-slice/axial (much slower) data acquisition, and multislice scanners, which allow acquisition of multiple rows of data simultaneously. The most recent developments involve software that facilitates further computational manipulations to the raw data, which allows reconstruction into 3-dimensional (3D) models capable of showing specific internal or surface structures, is able to be rotated or sliced as the operator desires, and can be modified experimentally to mimic traumatic and physiologic events, or operative procedures.[2,3]

The usefulness of CT for large body cavities and the axial skeleton is indisputable. Its rapid acquisition of images allows the ability to breath-hold or hyperventilate and respiratory pause for intrathoracic structures or cranial abdominal structures affected by the motion of respiration, the ability to obtain images from suboptimally positioned, perhaps unanesthetized or critically ill patients,[4,5] or those animals that will be subsequently continuing to very long surgical procedures under the same anesthetic event, and need the shortest time allocated to their imaging as possible. The radiation dose received by the patient is substantially greater with CT than radiography[6]; thus, in humans with greater life-time cumulative DNA damage from this ionizing radiation, the benefit must be weighed against the risk of possible carcinogenesis. The short life span and relative lack of procedures performed on veterinary patients makes this less of a concern, but should be taken into account if a patient is receiving repeated CT scans. Whole-body scanning protocols exist for small animal patients,[7] but as a screening tool are usually discouraged in humans.

For veterinary applications, the use of CT for the appendicular skeleton is still developing. The relative paucity of veterinary patients compared with human subjects indicates that caution must be used in interpreting the validity of fledgling techniques in studies, or may be loosely adapted from techniques in use for humans, requiring perhaps reduced skepticism. The published data presented in compiled form here are presented with these caveats in mind.

For ease of referencing, the appendicular skeleton will be divided into its component joints, first in an anatomic manner, then in terms of what has been done and what can be interpreted about that particular joint. The bulk of the literature presented regards canine patients, although a specific section is included regarding oncologic changes specifically, and both feline patients and applications not confined to a joint will occupy their own section.

General guidelines for performing musculoskeletal CT

- In general, CT requires minimal movement to avoid streaking artifact (**Fig. 1**). This blurs the margins of the image, reduces symmetry useful for interpretation, and is scanner/technique dependent. In other words, the patient only needs to be still for the amount of time it takes that body part to pass through the gantry. This may be achieved through general anesthesia, particularly if very unnatural positions or manipulations are needed to the body part, or may be achieved with a heavy sedative protocol that produces sufficient stillness, such as alpha-2 adrenergic agonists. This is, of course, dependent on the physiologic status of the