Indications for and Basic Principles of MRI Imaging

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Survey radiographs

Survey radiographs provide the basis of our imaging of emergency patients. Within the thorax they allow us to measure heart size and analyze the lungs for infiltrative disease. The basis for evaluation of radiographic manifestation of pneumonia, edema, bronchial and interstitial disease are well known and taught throughout veterinary curricula. Radiographs are often a quick, low morbidity procedure rarely requiring sedation or general anesthesia providing a large amount of information about large portions of the patient. In the case of cats, whole body ("cat-o-gram") radiographs provide imaging of the entire body, with the possible exception of skull and distal rear limbs.

Survey radiographs of the abdomen give a vast amount of information regarding the gastrointestinal tract; overall dimensions, content and evidence of regional disease. Survey radiographs of the musculoskeletal, especially the boney components surrounding the nervous system are the mainstay for initial imaging in emergency patients.

Why not survey radiographs?

Often survey radiographs are confusing. Trauma may produce many lesions, especially in the thorax, which are superimposed upon each other. Radiographs are relatively insensitive for small lesions. Nodules less than 3-5 mm are occult radiographically. Even large lesions can hide in the thorax. Survey radiographs cannot image the vascular structures in any body part. Thromboembolic and neoplastic infiltration of vessels is occult on all but the most sophisticated contrast radiographic series. Skull radiographs are very insensitive for fractures or brain tumors. Even with multiple oblique projection, we may only get a hint regarding traumatic skull changes. Spine lesions may be very subtle or occult on survey radiographs. There is a minor, but often consequential, morbidity associated with restraint for radiography. As will be discussed in the forthcoming lecture, cats are especially fragile.

MRI

Magnetic resonance imaging (MRI) is cross sectional imaging with the patient in a strong magnetic field with recurrent resonant radiofrequency pulses applied. By manipulations of the variables surrounding the radiofrequency pulses, MRI provides very high level soft tissue contrast. MRI has the greatest soft tissue characterization of all cross-sectional modalities, although the equipment is both technically challenging to understand and maintain and expensive to purchase and maintain. Unlike CT, MRI requires general anesthesia for the patient.

Neurological system

The entire central (CNS) and peripheral neurological system is imaged better with MRI than any other modality. MRI provides excellent grey and white matter characterization in the CNS. Because we can discriminate between the cerebrospinal fluid and the spinal cord, certain sequences provide a "myelogram" looking image without the injection of contrast material. Contrast can be injected to enhance the differentiation of mass and normal brain or spinal cord structures.

Non-neurological sites

The excellent soft tissue characterization is not useful solely in the CNS. Many locations in the musculoskeletal system and in the abdomen are suitable for MRI imaging. Bone and supportive structure imaging allows detection of ligamentous tears and meniscal injury in the stifle joint. Characterization of normal bone marrow and tumor is readily evident on MRI images of patients with osteomylitis and bone neoplasia. Vertebral tumors can be imaged with either MRI or CT, but MRI better characterizes the effect on the spinal cord. MR angiography is a growing field of MR specialization which allows detection and excellent spatial characterization of thromboembolic disease and portosystemic shunts in dogs.

Future considerations

I believe that we have only begun to explore the clinical application of CT. There are two major limitations to this expansion; general anesthesia and single slice technology. In some ways these two limitations go hand in hand. Multi-slice CT (4, 16, 64 slice) dramatically reduces scan times, improves spatial resolution in the original plane (axial) and provides a data set where the MPR images (sagittal, dorsal, or any oblique plane desired) have excellent resolution. There are very few facilities with multi-slice CT. This will change in the near future as facilities upgrade their CT equipment from single to multiple system and the "used" market is now full of CT systems up to 16 slices.

Of mild controversy is the utilization of CT for whole body imaging. There are dose considerations in human medicine which seem to be much less relevant for our veterinary patients. In human medicine CT images are merged with combined with positron emission tomography (PET) for whole body detection of metastatic lesions. A single imaging modality to detect and characterize metastatic

lesions makes a lot clinical and financial sense compared to the combination of thoracic radiographs and abdominal US (and may be more sensitive).

MRI is the imaging modality of choice for most, if not all, neurological diseases. Detection of tumors, edema, infarction and characterization of normal grey and white matter are just a few of the many features of advanced MRI imaging. MR angiography and diffusion imaging provides very detailed large and small vessel-related diseases.

References

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