Andrew Denning BVetMed
DVD1 MRCVS, RCVS Recognised Specialist in Veterinary Diagnostic Imaging

Andrew Denning obtained the RCVS Certificate in Veterinary Radiology in 1991 and the RCVS Diploma in Veterinary Diagnostic Imaging in 2009. He became an RCVS Recognised Specialist in Veterinary Diagnostic Imaging in 2012.

Andrew offers a diagnostic imaging referral service from the New Priory Veterinary Hospital in Brighton and works part-time for North Downs Specialist Referrals. He studied for his Diploma while working in general practice.

New Priory Veterinary Practice
The Deneway, London Road
Brighton BN1 1QR
T: 07812 985 140
E: imaging@andrewdenning.co.uk

How to read an abdominal radiograph

Analyzing an abdominal radiograph requires a thorough knowledge of radiographic anatomy and terms used to describe normal and abnormal findings. This paper reviews image acquisition and display, normal radiographic anatomy and how to describe a lesion. The challenge of assessing radiographs for gastrointestinal mechanical obstruction is discussed.

Keywords: Abdomen, opacity, Roentgen signs, DICOM, radiographic anatomy, serosal, pylorus, mechanical obstruction

Introduction

Abdominal radiography is currently used less in clinical practice than it has been in the past because of the increasing availability and use of abdominal ultrasound. However, it still has many advantages (see Box 1), and in many practices it may be the only abdominal imaging modality available. In common with all radiographic techniques, correct patient preparation and position is important and an understanding of radiographic anatomy is critical in successful image analysis.

Patient preparation and positioning

For an elective abdominal radiograph, the patient should be starved for 12 hours to minimise the amount of ingesta in the gastrointestinal tract. Allowing the patient to urinate and defecate will reduce bladder size and the amount of faeces in the colon, both of which could be superimposed upon other abdominal structures. It is useful to ensure the patient’s coat is dry and free of dirt since wet, dirty hair may become visible on the radiograph and mimic abdominal pathology (a tip to identify this is to see if the streaks cross over the abdominal wall).

Although the lateral projection is usually the most helpful, orthogonal views should always be obtained. Chemical restraint is more likely to be required but the extra information thus obtained makes it generally worthwhile. The ventrodorsal projection is preferred because the abdomen is naturally extended with the spine flattened along the table. The patient typically adopts a hunched posture for the dorsoventral projection and the spine becomes magnified because of the large object-film distance, such that abdominal organs are more difficult to differentiate and assess. Both ventrodorsal and dorsoventral projections of narrow, deep-chested dogs such as Greyhounds are often unrewarding because of the superimposition of the abdominal organs.

Careful and consistent positioning is important to ensure that the whole of the abdomen is available to review and that organ appearance is not altered because of the way the patient has been positioned. For the lateral recumbent projections, the back legs should be gently retracted caudally. Radiolucent foam pads can be used to support the cervical and lumbar spine, the sternum and between front and back legs to avoid axial rotation. For the ventrodorsal projection, the patient is supported in dorsal recumbency with a radiolucent trough or sand bags and the pelvic limbs are allowed to rest in a frog-legged position. A foam pad under the spine, and pads under the thighs help to reduce axial rotation (Figure 1).

The x-ray beam should always be collimated to reduce scatter. It should extend from 2-3 ribs cranial to the xiphoid cartilage, to the greater trochanter of the femur caudally and extend in the other direction to the margin of the patient. The beam should be centred immediately caudal to the last rib for dogs, and about two finger widths further caudally for cats (O’Brien 2009).

Exposure settings, processing and image display

Consistent image exposure, processing and display are also important to ensure that any alterations in image appearance are due to the characteristics of the patient.
“One of the most important factors usually overlooked and ignored is the time required to fully evaluate the image”

A low KVP (<70), high mAs technique is used to maximize image contrast. Images are acquired during the expiratory pause, which permits an extended exposure time in most cases. An exposure chart should be used to select the correct exposure settings for the size and type of patient. For film-screen systems, a custom-built exposure chart should be made using a constant mAs and varying KV with tissue depth. For digital systems, the post-processing of image creation disconnects the degree of image blackening from the exposure settings, so an “exposure value” is usually provided by the digital system for each image to indicate the level of exposure. An exposure chart should be obtained directly from the manufacturers of the digital system.

Users of digital systems should select an appropriate algorithm for the size of the patient (for example – large dog abdomen). For film-screen systems, it is important that processing chemicals are kept at the correct temperature and refreshed and cleaned regularly. The film should be in the chemicals for the correct amount of time.

Film-screen systems and automatic processors produce a traditional dry radiograph on a plastic film. This should be displayed on an x-ray viewer. A bright light can be used to look at small relatively overexposed areas although this is not often required for abdominal radiographs.

Digital systems produce a digital image that is viewed on a monitor. The monitor should be DICOM (Digital Imaging and Communications in Medicine) compliant with a resolution of at least 2 megapixels. Medical grade monitors that are DICOM compliant display a wide grey scale range and contrast and have high luminosity. Digital images are saved in a DICOM format (see Box 2) and viewed using software called a DICOM viewer.

Images should be viewed in a darkened room. Extraneous light should be avoided and this can be achieved with a film-screen system by masking the light box around a film and in a digital system by ensuring that other companion monitors (for example, used for the practice management system) have a black background (Figure 2).

Box 1: Advantages of radiography:
- Quick to acquire and relatively quick to analyse
- Can be obtained without chemical restraint in many patients
- If chemical restraint is required, sedation is usually adequate
- Relatively inexpensive
- An overview of the whole abdomen is obtained
- The image can be more readily interpreted remotely by a specialist unlike ultrasound examination

Box 2: DICOM
DICOM stands for Digital Imaging and Communications in Medicine and is an internationally recognized standard developed to permit an open and vendor-independent platform for the communication of medical information and related data (dicom.offis.de/dcmintro.php.en).

From a clinician’s point of view the difference between an image stored as a JPEG (file name ending .jpeg) and as a DICOM (file name ending .dcm) is that JPEG is a compressed image so that the image cannot be altered significantly by the clinician. Another difference is that DICOM also contains a directory with the patient name, date and time of image acquisition input into the digital system at the time the image was acquired.

There are many different types of DICOM viewer software available. The software displays the images with patient name, date and time of acquisition. Common tools available for image manipulation include alteration of brightness and contrast, flipping and rotating, magnification, measuring and annotation. The ability to alter brightness and contrast of the image allows the image to be changed so that the appearance of the area of interest can be improved. For example, the contrast of an abdominal radiograph may be improved to enhance serosal detail or it may be possible for the soft tissue of the abdomen to be displayed and analysed in one setting of brightness and contrast, and the spine and pelvis in another. In some digital systems, the latter is not possible because the file size is compressed before the image is stored.

“Images should be displayed with the same orientation every time”

The images should be displayed with the same orientation every time. Not doing so is a common error. For a lateral projection, the head of the patient should be to the left-hand side of the light box/monitor. For a dorsoventral and ventrodorsal projection, the head of the patient should be at the top of the light box/monitor and the right of the patient should be on the left-hand side of the light box/monitor.

Regardless of the imaging equipment used, one of the most important factors usually overlooked and ignored is the time required to fully evaluate the image.

Figure 1: A Labrador positioned for a right lateral and a ventrodorsal projection of the abdomen showing correct collimation and the use of foam pads and sand bags used to prevent axial rotation.

Figure 2: Paired monitors – a medical diagnostic monitor on the right is paired with a standard monitor for the practice management software on the left. Changing the background on the left to black and minimising the windows of any open software on the computer significantly reduces extraneous light when looking at the radiograph.