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Abdominal Ultrasound

Mini Series

Session 2:

Urinary Tract and Adrenals

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Abdominal Ultrasound Part 2 – Urinary Tract and Adrenals

The Urinary Tract

Kidneys

It is possible with practice to image both kidneys with the animal in right lateral recumbency, but it is often easier, especially in large, deep-chested or conscious patients to roll the animal into left lateral recumbency to scan the right kidney. The left kidney is dorsal and caudal to the spleen, and is usually just at the level of the last rib. The right kidney is further cranial and is found in the renal fossa of the caudate liver lobe, usually at the level of the last intercostal space. The kidneys can be imaged by angling the beam cranially underneath the costal arch, or by using an intercostal approach. They are easiest to identify in a longitudinal plane, and when they are identified, the image is adjusted so that the entire length of the kidney is visible in the ultrasound beam. The beam is then swept from medial to lateral through the kidney, so that the entire kidney is imaged. The probe can then be rotated 90° to obtain a transverse image and then the beam is swept from cranial to caudal, transverse images are often helpful for assessment of the renal pelvis. The hyperechoic renal cortex surrounds the hypoechoic medulla, and they should be distinctly demarcated from each other. Centrally, the renal pelvis is seen as an echogenic disc of tissue in sagittal images, because of its surrounding fat. The pelvic diverticulae and interlobar vessels can be seen as linear echogenicities radiating to the cortex from the central pelvic region. The normal renal cortex has a similar echogenicity to liver, but less than that of spleen (at the same depth, gain settings etc).

Renal size tends to vary with bodyweight in dogs, but can be variable between breeds, so it is usual to make only a subjective evaluation of kidney size in dogs. In cats, the accepted normal length is approximately 4cm.

Renal Abnormalities

Subcapsular fluid - This may be associated with trauma, acute renal failure, infection or neoplasia. A hypoechoic cellular infiltrate can mimic the appearance of subcapsular fluid in lymphoma.

Perinephric pseudocysts - These are seen as large amounts of fluid surrounding one or both kidneys, and are often associated with chronic renal failure, but can be found with normal kidneys.

Renal parenchymal abnormalities

Diffuse renal parenchymal abnormalities may affect the renal cortex or medulla or both, and may be caused by variety of disease processes;

Increased cortical echogenicity is reported with nephritis, renal dysplasia, toxin ingestion and neoplastic infiltrates, and in normal cats with fatty infiltrates. A hyperechoic band at the corticomedullary junction (medullary rim sign) is a non-specific sign, which was originally reported with hypercalcaemic nephropathy, but is commonly seen in other conditions and in normal animals.

Reduced cortical echogenicity, with multifocal hypoechoic areas, nodules or masses may be seen with lymphoma.

Decreased corticomedullary definition often accompanies increased overall renal echogenicity and is seen with congenital renal dysplasia, chronic inflammatory diseases and end-stage kidneys (of a variety of causes). End-stage kidneys are usually also small and irregular.

Focal abnormalities can include;

Renal cysts – these have anechoic contents and strong distal acoustic enhancement. They may be incidental findings if they are few in number and small, but may be associated with polycystic kidney disease

Renal masses – these can be complex or solid, and may be produced by primary or secondary neoplasia (commonly), haematoma, granuloma or abscess (rare).

Renal infarcts – old renal infarcts are typically seen as wedge shaped, well-defined hyperechoic areas of the renal cortex

Renal Pelvic abnormalities

Renal pelvic dilation is seen as separation of the central renal pelvic echoes by an anechoic space, and this is easiest to see in transverse images. Mild renal pelvic dilation may be seen during diuresis in normal animals, more marked renal pelvic dilation can be due to pyelonephritis (usually mild to moderate dilation and the adjacent ureter may also be dilated), or ureteral obstruction, which produces the greatest pelvic dilation, and is progressive over time. Ureteral obstruction may be due to calculi, strictures, neoplasia of the ureter itself or the trigone or inflammation. Renal calculi are usually seen as hyperechoic foci casting a strong distal acoustic shadow.

Bladder

The bladder is best scanned when moderately distended with urine. Longitudinal and transverse scans of the bladder should be routinely performed; in both planes, the beam should be swept backwards and forwards, and left to right, to image the entire width and length of the bladder. Gain settings usually require adjustment for the bladder, as the anechoic urine in the lumen causes strong distal acoustic enhancement, causing the far (dorsal) wall of the bladder to appear artefactually hyperechoic and thickened, unless the gain is reduced to compensate. Slice thickness and side lobe artefacts are commonly seen in the bladder, these can usually be confirmed as artefacts by changing the position of the probe or altering the gain settings.

The normal bladder has a thin wall, with fine layering which is often not apparent on ultrasound. Bladder wall thickness varies with degree of bladder distension, but should be approx 1.5-2.5mm thick in dogs. The ureteral papillae may be seen at the dorsal aspect of the trigone as small, smooth mounds; jets of urine entering from the ureters may occasionally be visualised. The colon is often visualised dorsal to the bladder, and may indent its dorsal wall; it often has hyperechoic, shadowing contents (gas), and should not be confused for bladder calculi (the colon can be followed beyond the bladder and calculi will usually be in the dependent portion of the bladder).

Bladder Abnormalities

Cystic Calculi

Calculi are seen as hyperechoic focal structures in the dependant portion of the bladder casting a distal acoustic shadow; this is usually most pronounced at high frequencies, in the focal zone. Shadowing sediment may also be visualised with ultrasound and can usually be distinguished from calculi by the lack of a discrete ‘stone’ and also, sediment may be suspended by agitation.

Cystitis

In acute cystitis, the bladder may have a normal appearance. In chronic cystitis, wall thickening is usually evident, which is most pronounced cranio-ventrally – this should be interpreted with caution in a non-distended bladder. In polypoid cystitis, wall thickening may be present with multiple small masses which project into the bladder lumen. Large polyps may appear pedunculated. Blood clots can appear similar, and may be attached to the wall, or may be free and so settle in the dependent potion of the bladder. Blood clots usually resolve on serial ultrasound studies.

Bladder Neoplasia

The most common bladder neoplasm is transitional cell carcinoma, although other epithelial and mesenchymal tumours are found in the bladder. Neoplasms are most commonly found in the bladder neck region, as a sessile mass with a verrucose mucosal surface, although they can be found anywhere in the bladder, and may extend into the proximal urethra. The bladder wall may also be diffusely thickened, resembling severe chronic cystitis. Bladder tumours cannot be distinguished on the basis of ultrasound appearance alone, and biopsy is required for differentiation from inflammatory lesions. Where neoplasia is suspected, the sublumbar lymph nodes should be evaluated for metastatic disease.

Ruptured Bladder

A ruptured bladder is best diagnosed by positive contrast radiography. A ruptured bladder may be hard to recognise if the defect is small, as residual urine often remains in the bladder, and the extent of urinary tract damage, especially urethral involvement cannot be fully assessed.

The Prostate Gland

Ultrasound provides complementary information to that of radiology in assessment of the prostate and any associated caudal lumbar or pelvic bony reactions are much more easily evaluated radiographically. Likewise, the urethra is best evaluated with a retrograde urethrogram.

To scan the prostate, the urinary bladder is first identified, and then the beam is swept caudally, through the bladder neck, the entire gland is swept in transverse and longitudinal planes.

The prostate gland surrounds the pelvic urethra, which may run through the centre of the gland, or slightly dorsally. The normal prostatic appearance varies with age and neutering status, but should always be smoothly marginated and bilobed on transverse images. The echogenicity varies but is usually moderate. In neutered dogs, the prostate can be very small and difficult to identify. The distal colon is often seen dorsal to the prostate.

Prostatic size can be easily measured using the electronic callipers on the machine, but normal prostatic size is not fully quantified with ultrasound, so enlargement is best judged in relation to radiology and clinical signs. Ultrasound can be used to monitor prostatic size in relation to assessing resolution or progression of disease.

There is considerable overlap in the ultrasonographic appearance of prostatic hyperplasia, prostatitis and neoplasia, and combinations can be present in a single gland. Because of this, biopsy of multiple sites should be carried out. Differentiation of disease processes is aided by considering margination of the prostate and the sublumbar lymph nodes. Ultrasound can be used to monitor decreases in prostatic size following castration.

Benign Prostatic Hyperplasia

This is a common disease of older dogs, and is often an incidental finding.

Ultrasonographically, the appearance can vary from subtle inhomogeneity of the parenchyma without obvious enlargement, to a marked enlargement, which can be symmetrical or asymmetrical, smooth or nodular and may distort the shape of the gland. The echogenicity of the gland varies, but is usually inhomogeneous, and cysts of varying size are commonly present. Hyperplasia should not disrupt the capsule of the gland, and sublumbar lymph node enlargement is not normally a feature of this disease. Mineralisation is also not usually seen with BPH.

Prostatitis

These have a variable appearance, but usually present with a heterogeneous echogenicity. Poorly marginated areas of hypo- or hyperechogenicity may be present, as many cyst- like structures. Occasionally, abscesses can be extensive. Fibrosis, gas or mineralisation may be visualised as areas of marked hyperechogenicity, which may shadow. The capsule of the gland is usually intact and if lymphadenopathy is present, this is usually mild.

Neoplasia

These can be very variable in appearance; the gland is typically enlarged, has a heterogeneous echogenicity and an irregular shape. Cystic lesions and areas of mineralisation also occur. Prostatic neoplasia is suggested by extension of pathology into the urethra or bladder neck, disruption of the capsule, and sublumbar lymph node enlargement.

Cysts

Prostatic - These can be associated with BPH and are common incidental findings in intact dogs. Occasionally, if they become large enough they can cause obstructions of the ureters or urethra.

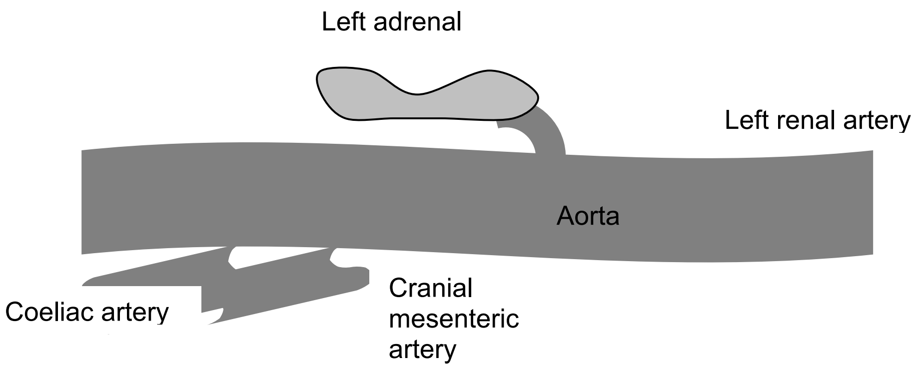
Paraprostatic – these are outside the prostatic capsule, and their attachment can be by a thin stalk, or more broadly based, they may communicate with the prostate and urethra. They can be very large, and careful examination of the bladder neck region may be required to distinguish a paraprostatic cyst from the bladder. Size and contents vary; some can have anechoic or echogenic contents, and may have septae. These can be drained using ultrasound guidance, but usually require surgery to be curative.

Adrenal Glands

These can be approached either from the lateral body wall, using a dorsal plane or from the ventral body wall, using a sagittal plane. They are flattened, bilobed organs found craniomedial to their respective kidneys, and are hypoechoic to surrounding tissues. The phrenicoabdominal artery passes dorsal and the phrenicoabdominal vein passes ventrally to the gland.

The key to locating the adrenal glands is to make small steady movements; they are very small and can easily be missed on a rapid sweep.

The left adrenal gland is usually best found using vascular landmarks. It lies ventrolateral to the aorta, between the origin of the cranial mesenteric and left renal arteries.



Often, a considerable amount of transducer pressure is needed to displace overlying bowel gas. The left kidney is located in sagittal section and then the probe is angled towards the midline, until the aorta is located. The left adrenal will often be in a plane between the kidney and the aorta, and often neither is visible in the optimal adrenal image. The left adrenal is quite variable in its level along the aorta and may be close to the renal artery or cranial mesenteric vein. The gland is normally peanut shaped.

The right adrenal gland is more fixed in location, between the cranial pole of the right kidney and the caudal vena cava; from a sagittal view of the right kidney, the probe is swept medially from the cranial pole towards the caudal vena cava, until the right adrenal is identified just lateral to the caudal vena cava. The right adrenal gland is comma shaped, wide cranially and narrow caudally.

Normal adrenal gland size is much debated; usually the depth of the caudal pole of each gland is measured and in dogs, greater than 7.5mm is suggestive of enlargement, although there is an association between adrenal gland size and body size. In cats, a measurement of approx 4-4.5mm is considered normal.

Measurements of up to 10mm are seen in dogs with non-adrenal disease, presumed to be associated with a stress reaction. Adrenal gland hyperplasia seen in association with PDH usually results in bilaterally symmetrical enlargement, this is usually 12mm or greater but dogs with PDH may have normal sized adrenal glands. Small adrenal gland tumours cannot be differentiated from PDH, but masses greater than 4cm in size suggest neoplasia. The presence of one enlarged gland and one very small gland is also suggestive of an adrenal tumour. Mineralisation is more common with adrenal tumours, but can be seen with PDH. Phaeochromocytomas are seen more frequently than previously thought.

Whenever an adrenal mass is identified, it is important to carefully assess the adjacent vasculature for tumour invasion. Both adrenal glands more commonly invade the vena cava than the aorta because of its thinner walls. Beware of slice thickness artefact mimicking tumour invasion of the vessel. Also, it is important to remember that animals with hyperadrenocorticism are hypercoagulable and so thrombi may form in the vessels without vascular invasion. Involvement of the vessel wall and proximity to an adrenal tumour tend to indicate tumour invasion.

The adrenal glands tend to enlarge following trilostane therapy, and tend to have prominent hypoechoic cortices.