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STOP OR GO: HOW TO DIAGNOSE AND SURGICALLY TREAT URINARY INCONTINENCE

Anatomy and neurophysiology of the bladder/micturition

Urine is produced by the kidneys, and transported through the ureters via autonomic contractions of the ureteral musculature. These contractions are initiated by volume stretch of this musculature. The ureters end in the trigone of the bladder after passing for a short distance in the bladder wall. Urine is collected in the bladder, which consists of different layers mucosa, detrusor muscle and serosa. In the bladder neck the detrusor muscle flows into the urethral muscle in a twining configuration, which helps continence by more closure of the urethral lumen during filling of the bladder.

The process of micturition encompasses a storage and a voiding phase. Urinary continence requires a combination of urinary bladder storage function and a closed bladder neck and urethral outlet. During storage the bladder relaxes and fills, slowly accommodating urine until sufficient stretch of the detrusor muscle signals via de sensory receptors to the higher brain that voiding should be imminent.

The storage phase is dominated by the neurologic sympathetic system, while the voiding phase is dominated by the parasympathetic system. During filling of the bladder stretch receptors of the detrusor are activated and neural input is transported via the sensory part of the pelvic nerve to the spinal cord, also known as the sacral-to-thoracolumbar intersegmental spinal reflex pathway. As a reaction sympathetic neurons are activated and mediate inhibition of bladder activity and contraction of the proximal (internal) urethral sphincter. The sympathetic system acts on the internal urethral sphincter by stimulation of the α-adrenergic receptors, and on the detrusor muscle by stimulation of the muscarinic-cholinergic receptors. This sympathetic system is supported in providing continence by the pudendal motor neurons, which are also activated when the bladder fills. The pudendal nerve induces striated sphincter muscle contraction at the membranous urethra; descending pathways from the lateral pontine region of the brain stem activate these pudendal motor neurons. Also collaterals are sent to the cerebral cortex, where integration at cortical level allows voluntary initiation (for example in territorial marking) as well as inhibition (for example in house training).

Not only neural input helps the urinary system to support continence, but also urethral mucosal blood flow, periurethral collagen, morphology of the internal sphincter and external sphincter muscles.

Diagnostic steps

Incontinence occurs in young and older dogs, and can be defined as involuntary leakage of urine through the urethra. It is most common in bitches, but also occurs in male dogs and in cats. Causes of incontinence can be divided into neurogenic and non-neurogenic disorders, where neurogenic causes usually involve pathology of the upper motor neuron system (for example lumbosacral disc disease) or generalized neural pathology (like dysautonomia). Usually patients are presented with incontinence due to non-neurogenic causes.

The list of non-neurogenic causes is different per signalment. Adult bitches can have urethral sphincter mechanism incompetence (USMI), detrusor instability (bladder storage dysfunction), vaginal pooling, lower urinary tract inflammation, whereas adult male dogs have prostatic disease. In juvenile dogs the causes of incontinence are different: ectopic ureter(s), urethral or bladder hypoplasia, congenital USMI, vaginal anomalies, intersex disorder or patent urachus. In cats there are some comparable diagnosis (ectopic ureter, USMI), but also feline leukemia virus associated incontinence exists.

The list of possible causes is of importance to perform a logical work up of the patient. First we start with a thorough history taking of the owners. It is important to ask for time and frequency of incontinence, time of onset of the problem (age of the patient), active posture or leaking urine during walking and/or a wet sleeping place. Also the colour of the urine is important as is the quantity that the dog leaks. Besides the incontinence the normal micturition pattern (posture, frequency, volume, colour, attractiveness for other dogs) needs to be discussed. Physical examination consists of abdominal palpation and rectal examination. The latter is of importance as this is the most easy, cost effective way
of examining the urethra (and prostate in male dogs) in the pelvic canal. In general it can be stated that routinely an ultrasonographic examination in these patients consists of and examination of the kidneys, ureters, bladder, trigone area, urethra (as far as visible) and in case of a male dog the prostate. Also urine is examined: morning urine to measure specific gravity, and urine that was obtained by cystocentesis for general examination (pH, leucocytes, hemoglobin, erythrocytes, glucose, bilirubin, protein, sediment) and culture. When urethral or bladder hypoplasia, prostatic disease or urachal remnant is suspected a urethrocystography is performed to outline the anatomy of the lower urinary tract. When an ectopic ureter is suspected, a positive outcome of ultrasonography is enhanced when fluid therapy or furosemide is administered to increase the urine flow at the ureteral orifices. If this is not conclusive in identifying the location of the ureteral orifices, contrast radiography or a CT scan (with contrast) can be performed. Vaginal anomalies can be detected by vaginal examination and vaginography.

**Treatment**

Depending on the diagnosis the treatment can be surgical (ectopic ureter, vaginal anomaly) or medical (USMI, detrusor instability, bladder hypoplasia). Per diagnosis the start of therapy differs. In case of an ectopic ureter surgical therapy is the best option: opening the ureter at the level of the trigone in case of the intramural ureter or reimplantation of the ureter into the bladder in case of the extramural ureter. Laser ablation is also described, but there is a tendency of more incontinence post treatment compared to surgical therapy. USMI is usually treated medically by sympathicomimetics (like phenylpropanolamin or efdedin) with or without oestriol. The former has a success rate of 75-90%, whereas the latter (oestriol) as single treatment only works for 40-65% of the cases. However, oestriol may enhance the effect of a sympathicomimetic when given concurrently. Surgical options consist of submucosal injection of biocompatible substances, colposuspension, urethropexy, transobturator vaginal tape inside out (TVT-IO) or Artificial Urethral Sphincter (AUS). Detrusor instability and bladder hypoplasia can best be treated by parasympathicolytics, but the effect can be variable.
STOP OR GO: HOW TO DIAGNOSE AND SURGICALLY TREAT UROLITHIASIS

Urolithiasis is a general term referring to causes and effects of stones anywhere in the urinary tract. Uroliths are usually suspected on the basis of typical findings obtained by history and physical examination. Urinalysis, quantitative urine culture, ultrasonography and radiography are often required to confirm urolithiasis and to determine if uroliths are associated with predisposing disorders of the urinary tract. Uroliths can be found in the pyela, the ureters, the bladder or urethra.

Patients may be presented to your clinic with different histories which may lead to finding urolithiasis as cause. Problems can consist of dysuria, stranguria, hematuria, but surprisingly not all uroliths are associated with clinical signs.

Urine analysis is important to detect the pH and type of crystals in the sediment. However, the type of crystals can differ from the detected stone in the urinary tract.

Urine culture is essential in the work up as concurrent urinary tract infection (UTI) may be detected. However, the way of sampling for UTI differs in case of urolithiasis compared to primary UTI. In urolithiasis, culture can be performed from urine, but in negative urine culture the stone itself or bladder wall may still be positive and this needs to be taken into account during diagnostic workup.

Diagnostic imaging in patients with uroliths may consist of ultrasonography of the urinary tract, where shadowing of the ultrasound waves support evidence of a mineralized object. Sometimes radiography is performed. Not all uroliths are visible on plain radiographs (radiolucent crystals are Cystine, Urate and Xanthine) and, when ultrasound is not available, a contrast study may help in diagnosis.

Four most common minerals found in canine uroliths are magnesium ammonium phosphate, oxalate cystine and ammonium urate. Less common types are calcium phosphate, silica carbonate, xanthine, drugs and drug metabolites. In cats the most common minerals are magnesium ammonium phosphate and oxalate, less common ammonium urate. To detect which urolith is responsible for the clinical findings quantitative analysis of the stone is essential. Stones may be composed of different types of minerals in different layers and this information is essential in nutritional management. In the centre of the stone is the nucleus, which is generally composed of one mineral type. The outer layers can be composed of several minerals.

Treatment
Magnesium ammonium phosphate and ammonium urate can be treated by medical dissolution. The other types of stones can only be removed via endoscopy with or without laser lithotripsy or cystotomy. Different strategies are available to prevent recurrence, but modification of the diet is essential as is increasing water intake.

In case of urethral obstruction the condition can be life threatening. In the male urethra common sites of lodgement are the perineal urethra and the urethra immediately caudal to the penile bone. Retrograde urohydropropulsion followed by removal of the stone via cystotomy is the treatment of choice. Urohydropropulsion is in most cases successful and is less traumatic than urethrotomy or even scrotal urethral stoma.

When stones have a smaller diameter than the intraluminal urethral diameter it is possible to remove the stones by cystoscopy with a stone basket. This procedure has a learning curve, but prevents a cystotomy. As urolithiasis is a chronic condition and recurrence is frequent (depending on stone type) some patients undergo several procedures during their lifetime.

Laser lithotripsy or extra corporal shock wave therapy are novelties in the treatment of urolithiasis. For these procedures expensive instrumentation is needed and therefore not always accessible for many clinics. The advantage of lithotripsy is that also larger stones (too large to remove transurethrally) can be reduced in size and afterwards be removed transurethrally.