Interventional urologic procedures -
Laser ablation of ectopic ureters and laser-lithotripsy

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Advances in ectopic ureter management in dogs

Ureteral ectopia is the most important cause for urinary incontinence in the young female dog. There is a wide range within the degree of incontinence caused by this congenital anomaly of the urinary system. Constant leakage of urine may be associated with regular urination, depending whether a single or both ureteral orifices are displaced caudally to the urinary bladder. In spite of the fact that both female and male dogs are affected the clinical symptoms are much more pronounced in females.

The **first diagnostic goal** is to rule out other obvious causes of urinary incontinence (complete urinalysis and urine culture). Standard radiographic and/or sonographic examination may also help to rule out other underlying causes. The **second diagnostic goal** should be the visualisation of the ureteral orifices that may either be in the right place - "in topos" - within the trigon or outside the right place - ectopic - usually distal to the urinary bladder inside the urethra or the vaginal vestibule. Over the years, advanced imaging techniques have been developed to achieve improved visualisation of the ureteral course and orifice. Today a combination of Contrast Computed Tomography and urethrocystoscopy seem to provide the most detailed information. Luckily in most situations endoscopy alone provides sufficient information for a reliable diagnosis

Over the years it became more and more apparent that incontinence in these dogs can be more than a simple by-pass problem. Unfortunately, ectopic ureters are often associated with other complex anatomical malformations (among others: short urethra, urinary sphincter mechanism incompetence (USMI), primary or secondary abnormalities like hydronephrosis or hydroureter). Some of them can contribute significantly to urinary incontinence. As a consequence, our **third diagnostic goal** should be to evaluate other possible contributing factors to incontinence, keeping in mind that in the majority of cases this goal cannot be achieved sufficiently. And this problem constitutes simultaneously our **first goal for the client information**. The owner must be informed that concurrent structural or functional abnormalities of the urinary system may impede success of any surgery correcting the displacement of the ureteral orifices; and on top of that we may be unable to clarify this situation prior to surgery.

The **therapeutic plan** includes several surgical options. Common to all of them is the goal of re-establishing urinary flow into the bladder. The traditional surgical approach is via an open laparotomy, cystotomy and ureterotomy, sometimes also combined with an urethrotomy. The minimal invasive approach uses interventional transurethral cystoscopy for laser-assisted ablation of the ectopic ureter. Specifically the medial wall of the ectopic ureter is transected with **diode laser** energy (980 nm) under direct visual control, thus moving the misplaced outlet of the ureter to a level proximal to the urethral sphincter into the lumen of the bladder. When working with this type of laser the surgeon must know and understand the tissue penetrating properties of 980 nm laser light in order to avoid any potential pitfalls of unwanted collateral damage to the urethral tissue. **Holmium:YAG** devices are another type of laser used in small animals, mainly for lithotripsy of urinary calculi. This specific wave-length (2100 nm) also has tissue-cutting properties and this laser can be used for surgery of ectopic ureters as well. However, one has to keep in mind that here the manner of tissue dissection differs considerably from that of a diode laser. The mechanical pulses of this laser resemble to some extent the action of a small pneumatic hammer and this needs getting used to.

The advantages of endoscopic laser ablation are evident. Key diagnostics and surgical therapy are carried out entirely during one single anaesthesia. Therapeutic intervention can start immediately after confirming the tentative diagnosis. The patient can remain in the same position throughout the whole procedure. The only tissue lacerated is the thin superfluous ectopic ureteral wall and usually the animal can be treated as an outpatient.

Urethral obstruction

Urethral obstruction can be either functional or mechanical. The consequences depend on whether the obstruction is acute or chronic and partial or complete. Untreated obstruction may be life-threatening and possibly leads to uremia and death within days. Incomplete obstruction can result in prolonged bladder distension and subsequent functional disorders. Clinical signs range from stranguria to the complete inability to urinate.

Intraluminal urethral obstruction may result from calculi, neoplasia, polyps or trauma with subsequent acute swelling, granuloma or stricture formation after wound healing. Reasons for urethral trauma can be surgery, urethroliths, external trauma or urethral catheterization.

The diagnostic plan is influenced by the anamnestic information and depends on available technical means ranging from laboratory examinations over various options of diagnostic imaging techniques to the endoscopic examination. This talk focuses on potentials and limitations of interventional endoscopy. It is important to note that endoscopy of the lower urinary tract allows both diagnostic evaluation and, when indicated, immediate interventional therapy during the very same anaesthesia and without changing the patient's position.

Because of the distinct anatomical differences between the female and the male dog the indications, equipment and limitations diverge clearly between the sexes. Common to both is the necessity for general anaesthesia and the use of devices for constant irrigation and intermittent suction. Whilst in the female dog the complete lower urinary tract can be easily explored with rigid endoscopes, in the male these instruments allow solely the examination of the very distal urethra – depending on body size – up to the distal or proximal end of the penis bone. Examination of the complete male urethra and the urinary bladder requires a small flexible endoscope, preferably with a digital optical system. The rigid endoscopes needed for urethro-cystoscopy are mostly usable also in other endoscopic procedures (ENT examinations, arthroscopy).

Urethrolithiasis in female dogs. The female urethra is less often obstructed by calculi as it is in male animals; only large stones can block close to the distal urethral orifice. Usually they can be flushed back into the bladder, either directly or using retrograde urohydropropulsion. On the one hand, these stones can be removed surgically, performing either conventional laparotomy and cystotomy or a minimal invasive abdominal approach. On the other hand, they can be treated transurethrally by an interventional endoscopic approach using laser energy for intracorporeal fragmentation.

Among the various types of laser energy the holmium:YAG laser has proven best for lithotripsy. With an infrared wavelength of 2100 nm the emitted light has properties of tissue cutting and coagulation and what is noteworthy is its ability to fragment solid material when the transmitting fibre is in direct contact or near-contact. If the distance between fibre tip and stone is larger, the energy is readily absorbed from water. This characteristic makes the technique relatively save for the adjoining bladder tissue. At the end of lithotripsy the fragments can be voided after flushing the urinary bladder or extracted with the assistance of a stone-basket.

While the fragmentation of stones is more or less easy to perform, the cloven hoof of the procedure is the removal of larger fragments through the urethra without lacerating the mucosa with the often razor-sharp fracture lines. Initially, we performed fragmentation by splitting the stone into two larger halves, those into quarters and so forth. The smaller the fragments are, the easier they are blown away by the first laser pulse and disappear from the fibre tip too fast. Meanwhile, we have changed our technique and we now try to ablate the surface of the stone in such a way that we always try to keep it in one single piece and that the ablated material is gravel-like. This is comparable to a continuous peeling of the surface until the whole stone is crumbled. A stone basket can be helpful but is not suitable in very small patients.

Urethrolithiasis in male dogs. Here the usual location of stones is caudal to the penis bone, often wedged in the bony U-shaped end. If cautious catheterisation is not able to mobilize the stone, further efforts should be discontinued in order to avoid additional traumatisation of the urethral mucosa and the situation should be explored with an appropriate rigid endoscope. To achieve a clear view irrigation with saline is necessary, either down the working channel of a shaft or, if the lumen of the urethra within the penis bone is too small for working with a shaft, through a thin flexible catheter advanced parallel to the endoscope. I can be tried to mobilize the stone under visual control manipulating devices, again either passed though the working channel of the shaft or parallel to the endoscope. If this isn't successful, laser lithotripsy is the method of choice to proceed. Energy settings and pulse frequency should be very low in order to protect the adjacent mucosa. Pulse duration should not be too short because stretching of the pulse duration possibly reduces collateral mechanical tissue damage. A sufficient saline irrigation rate helps to abduct thermal energy.

Urethral stricture. Common cause of acquired urethral strictures is a constricting wound healing after various types of trauma (i.e. surgery, blocking uroliths, catheterisation and accidents. There are various recommendations how to treat this condition, ranging from balloon dilatation and stent implantation to surgical excision. Interventional endoscopic laser application is also very suitable to treat this condition, even in smaller patients. The specific wavelength of a holmium:YAG laser makes this type of laser energy superior to the diode laser because there is less tissue penetration i.e. less collateral tissue damage and the reopening force is primarily of mechanical nature and less thermal.