Introduction:
Oftentimes, in veterinary medicine the term urinary incontinence (UI) is used which means the “involuntary passage” of urine and this is term that will be used for this discussion. Dogs may “leak” urine at night or may drip urine continuously. If the cause of the UI is due to decreased urethral closure pressure with no other underlying cause found, the dog is usually diagnosed with urethral sphincter mechanism incompetence (USMI) which is similar to “stress incontinence” in women. Differentiations must be made between pollakiuria, polyuria, and UI because the diagnostic plan for each of these three clinical signs can be quite different in small animals. In dogs, the clinical sign of pollakiuria can be considered a form of urinary incontinence called “urge incontinence.” This is a name veterinarians have also adopted from the human literature to describe these clinical signs. However, ascertaining if a dog is pollakiuria will result in a different set of differential diagnoses and diagnostics compared to a dog that presents with involuntary passage of urine. An animal can also present with multiple problems such as UI and polyuria. Depending on the etiology for the UI, correcting the polyuric disorder can oftentimes lead to significant improvement in UI. For example, a dog with hyperadrenocorticism may present for UI, however treatment of the Cushing’s disease will usually resolve the UI issues.

URODYNAMIC TESTING:
Urethral pressure profile:
Urodynamics can be used to help diagnose USMI for animals that present with UI. A urethral pressure profile (UPP) can assess the urethral closure pressure in dogs. In the author’s opinion, a UPP is recommended for dogs that have been treated for USMI (see below) and are not responding to medications. Furthermore a UPP done prior to correction of an ectopic ureter may help predict if medications will be required after the surgical repair. One can consider a UPP in dogs where medications for USMI may present a higher risk for the patient. Finally, we often perform a UPP in dogs prior to urethral occluder placement. A UPP is rarely performed at the initial onset of UI in dogs where a diagnosis of USMI is very likely. Oftentimes, medications are prescribed as the initial first step if the signalment, history and clinical signs make USMI likely.

Cystometrogram (CMG):
A CMG is a diagnostic to measure bladder fill and compliance and is used in humans to evaluate for overactive bladder and other disorders. Overactive bladder and subsequent “urge incontinence” can occur in dogs from a variety of causes including bacterial cystitis, urolithiasis, neoplasia, polypoid cystitis, or can even be idiopathic. Before performing a CMG, the animal should first be evaluated for the causes mentioned including imaging studies such as radiographs, contrast studies, ultrasound, urine cultures and possibly cystoscopy. If such a cause for the clinical signs is discovered and the signs improve with appropriate therapy then no further testing is likely warranted. However, if no underlying cause is found or if clinical signs persist despite therapy, a CMG may be indicated.

ECTOPIC URETERS:
Ectopic ureters (EUs) are the most common cause of UI in young dogs, but should be considered as a differential in any dog where the history is not known. An ectopic ureter is defined as a ureteral opening in any area other than the normal position in the trigone of the bladder. UI is the most common clinical sign in dogs with EUs and is usually diagnosed in dogs prior to one year of age. Breeds reported to be at risk include the Golden Retriever, Labrador Retriever, Siberian Husky, Newfoundland and English Bulldog. EUs are uncommon in male dogs and, if present, these animals often do not have clinical signs.

A diagnosis of EUs can be made by excretory urography, fluoroscopic urethrography or ureterography, abdominal ultrasound, cystoscopy, helical computed tomography (CT) or a combination of these diagnostic procedures. The latter two are reported to be the diagnostic tests of choice. However, when cystoscopy is used to diagnose the anomaly, laser correction of the ectopic can be performed during the same anesthesia. Other congenital
abnormalities can also occur in dogs with EU, therefore it is essential to evaluate the entire urinary system prior to correction of the ectopic. Urine cultures should always be performed in dogs with suspected EU because urinary tract infections appear to be quite common with this disorder.

The standard treatment for dogs with ureteral ectopia is surgical correction, but postoperative success rates vary between 50-75%. It has been reported that dogs weighing <20kg have a better outcome postoperatively. The poor success rate could be due to a variety of causes including incorrectly identifying the terminal portion of the EU, the presence of multiple ureteral openings, concurrent USMI or a combination of these. Newer less invasive therapies have also been utilized in dogs with EU such as cystoscopic-guided laser ablation for the ectopic ureter. Preliminary reports suggest that urinary continence after this procedure is comparable or better than after surgery, but too few cases have been done to fully evaluate long-term outcome.

URETHRAL SPHINCTER MECHANISM INCOMPETENCE (USMI):
Decreased urethral closure pressure can occur due to lumbosacral disorders such as intervertebral disc disease, degenerative myelopathy, trauma, malformations of the spinal vertebrae, and rare disorders such as dysautonomia. A thorough neurologic examination should be performed on all patients who present for UI. Urethral sphincter mechanism incompetence (USMI) is a diagnosis of exclusion once all other disorders have been ruled out.

UI usually occurs after spaying the female dog, and the onset of clinical signs can vary from immediately after spaying to 10 years after the surgery. Male dogs can present with USMI and are usually more difficult to manage. Nocturia appears to be the most common complaint noted. UI can be daily or episodic and range from mild to very severe. There appears to be a higher risk for UI in larger breed dogs after spaying as compared to small breeds. USMI can also occur in male dogs with a variable age of onset of clinical signs.

The exact cause of USMI is unclear and estrogen deficiency is unlikely to be the sole cause of the UI because estrogen concentrations are similar between continent anestrous dogs and incontinent spayed dogs. It has been reported that progesterone has antagonistic effects on estrogen and this hormone imbalance appeared to affect urethral sphincter pressure values in healthy, intact beagles. Estrogen has been shown to increase urethral sphincter tone in sexually intact and spayed female dogs without UI, but the urodynamic effects of estradiol are still not completely understood. Although some studies have documented normal activity of the external urethral sphincter in dogs post spay, others have shown reduced numbers and decreased total cross-sectional area of the type I fibers in spayed dogs which suggest a weakening of the type I portion of the urethralis muscle.

The diagnosis of USMI can usually be made based on signalment, history and the absence of any other cause(s) of UI found on physical examination and diagnostics. A UPP can be considered for cases not responding to therapy to confirm the diagnosis. It has been hypothesized that other neurologic abnormalities pertaining to the bladder such as an overactive bladder may occur simultaneously and contributes to UI.

Medical management of USMI includes the use of drugs aimed at improving urethral pressures via the alpha-1 adrenoceptors (α1-ARs), such as phenylpropanolamine (PPA 1-2mg/kg/BID) or pseudoephedrine (PD: 1.5mg/kg BID-TID). When performing urodynamic studies in dogs with USMI, changes in maximum urethral closure pressure and functional urethral area after PPA therapy were significantly higher in dogs with USMI on PPA compared to PD therapy. Side effects in dogs include restlessness, anxiety, hypertension and tachycardia. α1-AR agonists are not recommended in patients with cardiac disease or hypertension and should be used with caution and careful monitoring in dogs with kidney disease.

Estrogens may also be used for USMI and these hormones are thought to sensitize the α1-AR to the NE and indirectly result in an improvement in the closure pressure. However, a study analyzing urethral closure pressures in healthy intact beagle dogs found no additional increase in urethral pressure when PPA was added to animals already receiving estriol. The reasons for this are not clear. Although estrogen therapy is usually not as successful as the alpha agonists, these drugs can often be administered 2-3 times per week compared to 1-2 times per day which offers a the client a convenient option. Bone marrow suppression has been described in dogs receiving older generation depot estrogens and in those receiving much higher doses of DES than those for USMI, but owners need to be made aware of this potential complication of estrogen therapy.

Bulking agents (e.g. Coaptite®, Durasphere®, Macroplastique®) can be used for animals that are refractory to
medications or for owners who do not wish to continually medicate their pet. While collagen was the primary bulking agent used for the is procedure, it’s production has been discontinued. Published abstracts evaluating Macroplastique® in dogs appear promising. Dogs are placed under general anesthesia and three to four “blebs” are injected in a circular fashion approximately 1.5 cm distal to the trigone via the cystoscope. Some dogs still require medications after this procedure, but greater continence is usually gained following the implants. The duration of effectiveness varies among dogs and the author will usually try to exhaust medical management prior to using bulking agents. While bulking agents can be effective in older dogs, they rarely last long enough in younger dogs, and urethral occluders have appeared to be a good alternative. The occluders can be surgically placed around the proximal third of the urethra and act as an external occluder to maintain continence. If the occluder alone is not enough, these devices are attached to a port so saline can be infused into the occluder to increase their effectiveness. While large peer reviewed publications evaluating this procedure have not been published, anecdotal experiences using these occluders in dogs have been positive.

**URINARY INCONTINENCE CAUSED BY AN OVERACTIVE BLADDER:**
An overactive bladder (OAB) occasionally results in UI; most often animals do not have “true OAB” and have an underlying cystitis caused by bacteria, cystic calculi, neoplasia, polyps, or drugs. Occasionally, idiopathic OAB can occur and medical management can be beneficial in controlling clinical signs. Further urodynamic studies are warranted to see if idiopathic clinical OAB occurs in dogs but some clinicians (including the author) have had anecdotal success with the use of anticholinergics in otherwise refractory USMI cases. Oxybutinin, tolterodine and some newer anticholinergics as well as tricyclic antidepressants (amitriptyline, imipramine, and clomipramine) have anticholinergic properties which can be considered for treatment of patients suspected of having OAB.

**REFERENCES**