Ectopic ureters (EU) is the most common cause of urinary incontinence in young female dogs; it is also the most common anatomic abnormality associated with incontinence of female dogs of any age. EU is recognized in cats and other large animal species (horse, alpaca etc) but is considered rare. Urinary incontinence is the most common clinical presentation of female dogs with EU. The degree of urinary incontinence is variable ranging from mild and intermittent to continuous and severe. Incontinence and may worsen in recumbent positions, with increased activity and with increased water consumption (swimming, eating snow, drug therapy i.e. steroid administration). The severity of urinary incontinence does not dictate the type and location of the ectopic ureteral orifice(s) nor has it been correlated to treatment outcomes. EU has also been diagnosed as an incidental finding in both male and female dogs with no clinical signs of urinary incontinence. Canine patients diagnosed with EU are usually, generally less than 1 year of age at the time of initial presentation. Females tend to present at a younger age than males. Although females are diagnosed more frequently than males, EU may be more common in males than historically appreciated because affected males frequently are not incontinent as a consequence of the length of urethra distal to the opening of the ectopically displaced ureters. Delayed-onset urinary incontinence has been recently reported in 5 of 22 female dogs diagnosed with congenital EU. It is likely that urinary sphincter mechanism incompetence (USMI) may play a contributing role in some female dogs presenting with delayed-onset urinary incontinence. Although EU is often viewed as a simple plumbing “bypass” problem, it is far more complex due to concurrent anatomical anomalies contributing to urinary incontinence. Recognized anomalies of the urogenital tract associated with EU include, short urethra, indistinct vesicourethral junction (VUJ) resulting in low urethral closure pressure, vaginal and vestibular abnormalities and abnormal formation of the external urethral sphincter and meatus. Abnormalities in the development of the kidney (single agenesis, renal hypoplasia and dysplasia) are encountered in some dogs with EU as well as the finding of hydronephrosis and hydroureter. EU is reported to be over represented in certain breeds of dogs including Siberian husky, Labrador retriever, Golden retriever, Soft-Coated wheaten terrier, Newfoundland, English bulldog, Welsh corgi and Poodles of any size. Related Entlebucher Mountain Dogs affected with EU have been recently described both with and without urinary incontinence. Multiple reports site the diagnosis of EU in littermates, half siblings and other related family members. At this time no specific genetic study has documented the complex genetic relationship resulting in this congenital anomaly. DNA samples are currently being collected from affected Golden retrievers and primary relatives in an effort to determine the genetic mutation. (http://www.greudna.org/). As a note of clinical interest, the Doberman pinscher, another breed over represented with juvenile urinary incontinence is not affected by EU but instead by congenital USMI. It has been reported that a specific breed diagnosed with EU can affected the prognosis and outcome of surgical treatment. All 16 Labrador retrievers diagnosed with EU in recent study regained continence after surgical repair. Bilateral displacement of the ureteral orifices has been reported to occur more frequently than unilateral. In situations of bilateral displacement, the terminal opening of each ureter may not be located at the exact same site distally. A diagnosis of bilateral disease should be made if
each ureteral orifice is displaced even minimally from the normal position at each tip of the trigone. Ureteral catheterization at the time of surgery or during uroendoscopy can aid in the identification of displaced ureters with relatively short intramural tunnels. Early reports suggesting primarily unilateral EU occurred in dogs was likely impacted by limitations of imaging (i.e. lack of uroendoscopy, fluoroscopy and CT-IVU). Most EU in female dogs terminate within the urethra after tunneling from more proximal locations. Diagnosis of displaced ureteral orifices distally but still within the bladder often located near the VUJ has been reported. In the Entlebucher Mountain Dog, EUs located within the bladder were not associated with urinary incontinence but were occasionally associated with hydronephrosis. However, in this breed, termination points of EU located within the urethra were associated with urinary incontinence and sometimes with hydronephrosis.

Until a recent study in 2012, extramural EU have been infrequently reported in both male and female dogs. Extramural EU fail to attach along the dorsolateral aspect of the bladder, completely transverse the bladder wall and open at each tip of the trigone. Extramural EU bypass the bladder and open directly into the urinary tract distal to the trigone (bladder neck or urethra) or directly into the vagina or vestibule. EU uncommonly terminate within the vestibule. EU may terminate directly into the vagina or uterus, but we have not encountered this presentation in our hospital during the last 20 years. A recent report of 60 dogs diagnosed with EU (24 F, 26M) a total of 83 EU were reported. Fifty-seven (68%) of the displaced ureteral orifices were diagnosed as intramural and the remaining 26 (32%) were diagnosed as extramural.

Figure 1. Cannizzo KL: JAVMA, Vol 223, No. 4, August 15, 2003. Schematic diagram of the trigone area of the urinary bladder, bladder neck, urethra, ectopic ureteral pathways (tubular structures), and the most likely locations of the ureteral openings in 24 female dogs with EUs (dark circles). Inset: schematic diagram of the cystoscopic appearance of the vaginal vestibule. Notice the locations of 4 vestibular EUs. L = Left. R = Right. V = Vagina.
The diagnosis of EU in male dogs has traditionally been considered to be rare, but two recent reports suggest that this diagnosis may be more common than previously suspected. In a recent study from Switzerland, Reichler et al. reported 24 male dogs diagnosed with EU. A total of 43 displaced ureteral orifices were identified including 25 intramural EU and 18 extramural EU. Nineteen of the 24 male dogs were diagnosed with bilateral disease. Extramural ureters were considerably more common than this condition reported for female dogs in the same study. Postsurgical follow up on 23 of these male dogs revealed complete continence in 10 and improved continence in 2 dogs with intramural EU. Complete continence in male dogs with extramural ureters was gained in 5 and improved continence in 2. Two dogs with combined intramural and extramural ureters did not regained complete continence following surgery. Bilateral EU were also identified in 15 of 16 male dogs in a recent study from The Ohio State University; more than half of these male dogs were Labrador retrievers. All of the male dogs in this study were diagnosed with intramural EU. Four of the EU were associated with an ectopic ureterocele. Three male dogs did not exhibit urinary incontinence. Surgical correction produced a satisfactory outcome in 11/12 (91%) dogs with urinary incontinence. The clinical diagnosis of EU in dogs occurs in older males compared to younger females with this condition.

Figure 2. Schematic drawing of the trigone area of the urinary bladder, bladder neck, urethra, prostate, normal ureteral opening, ectopic ureteral pathways (tubular structures), and the Locations of the 25 ectopic ureteral openings verified by surgery (dark circles). Termination points for ectopic ureteral orifices from 16 male dogs. Bilateral EU were diagnosed in 15 of 16 male dogs. Ureteroceles are identified with a star (*). L = Left. R = Right.
**Diagnostic Considerations**

The minimal database for incontinent dogs with suspicion of EU should include a complete urinalysis and urine culture. If indicated by other findings, a hemogram and serum biochemical profile may be performed to identify systemic disease processes related to the upper urinary system. Empiric medical management of urinary incontinence using a standard therapy such as alpha-adrenergic agonist, Phenylpropanolamine (PPA) 1.5 mg/kg PO BID to TID, is considered appropriate prior to more invasive diagnostic techniques. Medical therapy is generally not effective as a sole treatment modality in patients diagnosed with EU.

Specific diagnosis and staging of EU and the associated anatomical anomalies is likely to involve more than one type of imaging modality. Survey abdominal radiographs should not be overlooked. Plain abdominal radiographs allow the clinician to determine the size, shape and position of the bladder (i.e., intrabdominal or intrapelvic), and presence or absence of a distinct vesicourethral junction. (VUJ). These findings may influence the diagnosis of pelvic bladder syndrome, which can be associated with EU, or other structural anomalies of the urogenital system.

Sonographic evaluation of the urinary tract provides valuable information regarding the upper urinary tract and bladder. The upper urinary tract is evaluated for the presence and location of kidneys as well as size, structure, architecture and dilation of the renal pelvis. Renal agenesis, hypoplasia and dysplasia have been reported associated with the dysembryogensis of the ureteral bud. In addition, ureteral dilation, hydronephrosis and dilation of the renal pelvis have been reported with both EU and/or ascending urinary tract infection from chronic urinary incontinence. Ureteral dilation and hydronephrosis has been theorized to result from obstruction of the submucosal segment of the intramural EU. Both ureteral dilation and hydronephrosis have been documented in puppies as young as 5 weeks of age suggesting this is a developmental abnormality. The skilled ultrasonographer may be able to follow the ureters from the renal pelvis to the bladder. Ureteral dilatation (greater than .3mm) and tortuosity can be observed. Normal peristaltic motion of the ureters requires that multiple observations and measurement be used to critically evaluate size and structure of each ureter. The terminal opening of the ureter can be challenging to identify. Color flow doppler ultrasonography can be used to identify jets of urine entering the bladder in the region of the trigone. It is not always possible to obtain the necessary images. Evaluation of the bladder, wall thickness and presence of mass lesions or ureteroceles is aided with the use of ultrasound. Ultrasound diagnosis of EU has been previously reported.

Contrast radiography combined with fluoroscopy or Computed Tomography (CT) has been shown to accurately characterize the presence of anatomic abnormalities frequently associated with EU. Excretory urography has long been considered the hallmark method of diagnosis for EU. Excretory urography may provide important information regarding the location, size and morphology of the ureters, location of the ureteral orifices, and evaluation of the upper urinary tract for other associated abnormalities. Lateral, ventrodorsal and oblique radiographic views are necessary to delineate the distal ureteral segment in the pelvic region. However, the diagnosis of ureteral ectopia often remains elusive following appropriate radiographic evaluation. Additional evaluation including pneumocystography, fluoroscopy and retrograde vaginourethrography may provide additional information regarding structure of the urethra, distal ureteral morphology and confirmation of pelvic bladder syndrome. Observing the typical “J” configuration of the ureter as it dorsally enters the trigone does not insure that the ureter opens into the bladder at the normal location at the trigone. Contrast
enhanced CT is considered by many to be the standard for diagnosis of EU in both male and female dogs. Contrast enhanced CT appears to have a significant diagnostic advantage over urethroendoscopy in male dogs due to limitations of the optics offered by the flexible urethroscope.

Urethrocystoscopy is considered the gold standard for the diagnosis of ectopic ureters in female dogs. Transurethral cystoscopy using a rigid cystoscope or a flexible urethroscope allows direct visualization of the lower urinary tract. Transurethral cystoscopy allows accurate diagnosis and classification ectopic ureters and associated congenital abnormalities of the ureteral orifices, bladder, urethra, vestibule, and vagina. This procedure also provides additional information regarding the morphology of the terminal segment of the ureters. Direct visualization of the ureter allows us to determine if the ureter has tunneled through the submucosa and the approximate length of the urethral trough. Endoscopic evaluation of the distal segment of a dilated ureter can also be performed by gently passing an appropriate sized cystoscope through the ureteral orifice into the hydroureter. Transurethral cystoscopy can be successfully performed under general anesthesia in female adult dogs and puppies (larger than 3 kg) using various sizes of rigid endoscopes. The use of a compatible video camera, VCR and monitor allows visualization and documentation of the endoscopic examination.

Because there is a high rate of concurrent abnormalities of the vestibule, careful evaluation is needed to carefully identify structures. Allowing the vestibule to fully distend with fluid is needed for visualisation of the urethral opening and to characterize the vestibulovaginal junction. A dorsoventral band of tissue caudal to the plane of the vaginal opening is common in female dogs with ureteral ectopia and is referred to a paramesonephric septal remnant. These structures are not the same as hymenal remnants though may have been mistaken as such in prior reports. The horizontal bridge of tissue separating the vaginal vault and the urethra is the most caudal site of termination for ectopic ureters. The development of the lower urinary tract is characterized by the cranial migration of the ureteral opening from embryologic tissue that eventually forms this site dorsal to the external urethral meatus to the tissues that will form the trigone of the bladder. This normal migration results in the development of the dorsal wall of the urethra. Ectopic ureteral openings will terminate along this pathway of migration: dorsal of the external urethral meatus in the vestibule along the dorsal wall of the urethra to the trigone of the bladder. The pathways of respective ureters will not cross though they approach midline.

Common urethral abnormalities observed with ectopic ureteral openings include urethral tenting and striping. Urethral tenting describes the appearance of the dorsal mucosa as it “sags” into the urethral lumen as the ureter travels under this mucosa. Urethral striping is a paler coloration of the dorsal urethra resulting from the ureter essentially forming the dorsal wall (lack of normal development). Stripping has a marked distinction from the surrounding mucosa and the normal variation of urethral mucosal coloration should not be over interpreted. Visually following areas of tenting and striping will lead caudally to an ectopic ureteral opening.

Fenestrations within the wall separating the ureter from the urethra will also be readily identified during cystoscopy. Fenestrations may also complicate presenting signs by creating a predisposition for urinary tract infections without significant incontinence. The presence of fenestrations complicates diagnosis by contrast radiography as they allow contrast to be delivered cranially while there remain caudal abnormalities. The identification if the terminal ureteral opening should be based on a continuous mucosal appearance as the ureter joins the surrounding mucosa. Normal ureteral openings have a horseshoe shape; ectopic openings will often have an elongated appearance (trough).
Figure 3. Cystoscopic appearance of two very proximal ectopic ureters. Notice how close the ureteral openings are to each other just distal to the junction of the urethra with the bladder. The urethrovesical junction (UVJ) is not well defined, as is the case in some patients with ectopic ureter.

Figure 4. Cystoscopic appearance of bilateral ectopic ureters. Note that one ectopic ureter is very proximal and one is more distal. The more distal right ectopic ureter also has a trough-like shape.
**Surgical Decisions**

Surgical therapy is reserved for incontinent patients diagnosed with EU when medical management is unsuccessful. Numerous surgical procedures have been published in the veterinary literature focusing on reestablishment of ureteral anatomy within the bladder lumen (ureteral transposition, neoureterostomy and laser ablation of intramural ureters), rerouting urine flow proximal to the urethral sphincter mechanism. In spite of reestablishing urine flow into the bladder lumen, post surgical incontinence occurs in approximately 50% of dogs affected with either intra or extramural EU. Owners/breeders should be warned that many affected dogs have concurrent structural abnormalities of the urogenital system that result in coexisting USMI and may remain incontinent after surgical or minimally invasive correction. Surgical efforts to reestablish continuity of the muscular structures of the trigone and proximal urethra (urethral sphincter mechanism) by surgical excision of the intramural portion of the EU within the trigone and urethra in association with reconstruction of the VUJ may improve the surgical success rate to 70-80% in a group of affected female dogs. However, no difference in outcome was found in a study comparing neoureterostomy with ligation of the distal ureteral segment versus resection of the intramural ureter within the distal urethra. Urinary incontinence persisted in 50% to 70% of the dogs in this study regardless of how the intraustral remnant was handled. Failure to control urinary incontinence has plagued the success of all published procedures to correct EU in female dogs. Improved continence (as high as 100%) has been demonstrated in several studies involving surgical and minimally invasive treatment of EU in male dogs. Submucosal urethral collagen injections can be used with success in some dogs with EU that continue to have urinary incontinence after conventional surgical procedures. The use of urethral bulking treatment with collagen was reported in 5 female dogs following surgery for EU; it was also used in 5 female dogs in lieu of surgery for dogs with intramural EU located in the proximal one-third of the

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Figure 5. Cystoscopy showing two very distal termination points for ectopic ureters. The ectopic ureters are at the junction of the urethra with the vestibule and cingulum. Notice also the wide paramesonephric band that is a common finding in dogs with ectopic ureter.
urethra. The degree of urethral coaptation following collagen implantation was less complete in dogs after EU surgery likely due to the effects of scar formation along the dorsal aspect of the urethra making the submucosal injections more challenging.

Endoscopic laser ablation of ectopic ureters has recently been reported as a minimally invasive procedure to reestablish the ureteral orifice(s) within the bladder lumen. The laser is applied through the biopsy channel of a standard operating rigid cystoscope (19F or 14F outer sheath) to ablate the intralumenal portion of submucosal ureter creating a neo-ureterostomy within the bladder lumen in a more normal trigonal position. Improvement of urinary continence was reported for a median of 18 months in 4 of 4 male dogs following laser ablation EU. In the same study, 13 female dogs were evaluated following laser ablation of EU. Four of 13 female dogs regained complete continence without drug therapy, 5 were completely continent with the use of alpha-adrenergic agonist therapy (PPA), and 4 improved on PPA but remained incontinent. Laser ablation is not expected to result in complete remission of incontinence in some dogs with EU that have an associated USMI. When evaluating outcomes of surgical or minimally invasive procedures to correct urinary incontinence resulting from EU it is important to separate the results of males and females. Multiple studies have reported an increased success in long-term resolution of urinary incontinence in male patients compared to females.

Male and female dogs with persistent or recurrent incontinence after laser ablation or other surgical procedures; urethral bulking agents or placement of an artificial urethral occluding device (AUS) remain the best options for further treatment to control urinary incontinence. Both urethral bulking agents and AUS help to control urine leakage by creating urethral outflow obstruction. In 8 female dogs with EU that had persistent incontinence following EU surgery or urethral collagen implantation, the degree of urinary incontinence improved following placement of an appropriate size AUS externally surrounding the bladder neck. Incremental saline injections (.1-.2 ml) thorough a subcutaneous vascular access port can be performed to provide small controlled increases in external pressure surrounding the bladder neck and proximal urethra. In recent study evaluating the use of AUS, the occluding device attached to a subcutaneous vascular access port was applied to the bladder neck and proximal urethra of 6 female dogs that failed to regain continence following conventional procedures for treatment of EU (4 following neoureterocystostomy and 2 after laser ablation of intramural EU). Urinary continence was markedly improved in 5 of these 6 dogs after placement of an AUS.
References


