



PARTNERING WITH OUR REFERRING PRACTICES

Incontinence

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Normal micturition consists of a *urine storage phase*, when the bladder slowly fills and relaxes while the urethra remains closed, and a *urine voiding phase*, when the bladder contracts and urine is expelled through a relaxed urethra. Appropriate urine storage and voiding depend on the intricate and coordinated interaction of the nervous system, urinary bladder and urethra. Disorders of urine storage usually manifest clinically as *urinary incontinence*, while disorders of urine voiding usually manifest as *urine retention*. Successful treatment of micturition disorders depends foremost on accurate localization and description of the problem, as well as an understanding of the basic associated neurophysiology.

Lower urinary tract anatomy, and neurophysiology of micturition

The key anatomic components of the lower urinary tract (LUT) include: 1) the *detrusor muscle*, the smooth muscle which forms the body and neck of the bladder; 2) the *internal urethral sphincter* (IUS) which is comprised of the smooth muscle of the urethrovesicular junction; 3) the *external urethral sphincter* (EUS) which includes striated muscle encircling portions of the urethra distal to the IUS (position of the EUS varies somewhat by sex and species); and 4) the *ureterovesicular junction*, normally located proximal to the IUS, at the junction of the bladder body and neck. The urethral closure mechanism consisting of the bladder neck and the smooth and striated urethral musculature is often collectively referred to as the “outflow tract” or “outlet.”

The urine storage phase of micturition occurs chiefly under sympathetic (adrenergic) nervous control. The hypogastric nerve (arising from spinal segments L₁₋₄ in the dog, L₂₋₅ in the cat) stimulates detrusor beta receptors, inducing smooth muscular relaxation and permitting filling under low pressure. In contrast, sympathetic stimulation of the alpha-1 receptors of the bladder neck and urethral smooth muscle (the IUS) induces smooth muscle contraction, closing the outlet and maintaining continence. Sympathetic input also modulates and minimizes parasympathetic-mediated contraction of the detrusor muscle. Voluntary input to the striated urethral musculature (the EUS) is supplied via the pudendal nerve (arising from spinal segments S₁₋₃). During the storage phase, this input stimulates nicotinic cholinergic receptors in the EUS, causing contracture and additional closure of the outlet when needed (e.g., during coughing or sneezing; to temporarily override the urge to void when inappropriate).

As bladder filling progresses, information from stretch receptors in the detrusor muscle is passed to higher centers via the pelvic (filling sensation, need to void) and hypogastric (pain, overdistension) nerves. The urine voiding phase of micturition occurs chiefly under parasympathetic (cholinergic) control. The pelvic nerve (arising from spinal segments S₁₋₃) stimulates muscarinic cholinergic receptors in the detrusor muscle, stimulating contraction and raising the intravesicular pressure. Simultaneously, sympathetic input to the outlet is inhibited at the level of the micturition center in

the pons, allowing IUS and EUS relaxation. When intravesicular pressure exceeds outlet closure pressure, voiding occurs. After complete voiding, the system is “reset” for the filling stage to begin again.

Urinary incontinence is defined as the involuntary leakage of urine through the urethra. Incontinence is most common in female dogs, but is also clinically recognized in male dogs and in cats. Most often incontinence is due to failure of the storage phase of micturition, meaning that either the urethral closure mechanism is defective, bladder filling is restricted, or an anatomic abnormality bypasses normal structures. In some patients, multiple mechanisms contribute to urinary incontinence.

Causes of incontinence

Causes of urinary incontinence are traditionally divided into neurogenic and non-neurogenic disorders. Neurogenic causes usually involve the sacral spinal cord, and cause lower motor neuron signs. Non-neurogenic causes of incontinence are associated with anatomic or functional disorders of the urinary tract. Lists of common causes of urinary incontinence are presented in Tables 1a and 1b, and Table 2 provides a summary of characteristics and useful diagnostics associated with common causes of incontinence. A formulary of medications commonly used for management of incontinence and urinary retention is presented at the end of the chapter.

Neurogenic

In dogs with neurogenic incontinence, incontinence is rarely the sole neurologic abnormality on physical examination. For these dogs, treatment of the incontinence and prognosis for resolution or clinical control depend primarily on diagnosis and management of the underlying cause (e.g., surgical management of intervertebral disk herniation; fixation of sacral fracture).

Non-neurogenic

Urethral sphincter mechanism incompetence

Urethral sphincter mechanism incompetence (USMI) is the most common non-neurogenic cause of incontinence in dogs. This type of urethral dysfunction occurs most often in neutered, medium to large-breed adults, but it can also be seen congenitally. Several structural and physiologic factors may play a role in the development and degree of USMI in a given patient:

- Aging and/or relative estrogen lack may affect the collagenous support structures of the urogenital region, decreasing intrinsic tone.
- Abnormal positioning or morphology of the bladder or urethra can contribute to functional failure.
- Urethral alpha adrenergic receptors can decrease in availability and/or responsiveness.
- Obesity and/or vaginal structural abnormalities can be contributory.
- Breed predispositions suggest underlying genetic factors.
- Other hormonal alterations or interactions may play a role in this multifactorial disorder.

In an otherwise healthy, neurologically normal dog with concentrated urine and without LUT inflammation, diagnosis of USMI can be confirmed by positive response to pharmacotherapy aimed at increasing outlet resistance. Both castrated and sexually intact male dogs can acquire USMI, though this is uncommon. Incontinence due to acquired USMI is usually intermittent and most frequent during recumbency, particularly during sleep.

Alpha-adrenergic agonists (e.g., phenylpropanolamine, ephedrine) and estrogen compounds (e.g., diethylstilbestrol, estriol, conjugated estrogens) are the drugs most often used to control USMI. The significant majority (75-90%) of mature female dogs with USMI will respond very well to one or a combination of these therapies. Since they are synergistic, combining their use may produce good clinical effect in a patient that does not respond to either agent alone. Clinical characteristics of alpha-adrenergic agents and reproductive hormones are compared in Table 5.

Estrogens are not recommended for male dogs or for cats; alpha-agonists are the drugs of choice for these patients. Male dogs may also be treated with injectable testosterone, either alone or in combination with an alpha-agonist. Response rate in males is lower than that of females; medical control of USMI in male dogs is effective in less than 50% of dogs treated.

Therapy with depot formulations of gonadotropin releasing hormone (GnRH) analogs has shown promise in management of USMI refractory to alpha-agonists and estrogen compounds. The GnRH analogs cause down-regulation of the production and secretion of follicle stimulating hormone and luteinizing hormone, and may contribute to restoration of continence by several mechanisms. In a recent study, therapy with depot GnRH analogs or depot GnRH analogs plus phenylpropanolamine restored continence within 5-10 days to 12/13 dogs with either USMI refractory to alpha-agonists and estrogen compounds, or an inability to take alpha-adrenergics.

Endoscopic submucosal injection of biocompatible substances (initially Teflon paste, now collagen or extracellular matrix) into the proximal canine urethra is a promising emerging therapy for USMI. These bulking agents protrude into the urethral lumen and improve outflow resistance. A recent review of this technique shows good long-term results in dogs that were refractory to or had intolerable side effects from conventional medical therapies.

Several surgical procedures have been used for management of refractory USMI, including colposuspension, cystourethropexy, and creation of a seromuscular urethral sling. These procedures have relatively high success rates (approximately 50-55% continent and 25-35% clinically improved) immediately following surgery, but continence rate drops significantly over time, and post-operative complications include urine retention severe enough to require reoperation.

Detrusor instability

Detrusor instability (or urge incontinence) represents a failure of the bladder to remain relaxed during the urine storage phase. Instability and incontinence associated with involuntary, uninhibited detrusor contraction is now termed “overactive bladder” in human beings. This disorder is less common than USMI and is characterized by intermittent incontinence that may be associated with activity or excitement. This type of incontinence may be difficult to discriminate from pollakiuria or even inappropriate urination, since dogs will often posture to urinate when stimulated by detrusor contraction. Detrusor instability is rare in small animals, but can occur alone or in combination with USMI in male or female dogs. Bladder storage dysfunction is treated with antimuscarinic (anticholinergic) agents (e.g., imipramine, oxybutynin, dicyclomine) that help to increase bladder capacity and decrease spasticity.

Ectopic ureter

Ureteral termination that bypasses the bladder trigone is termed *ectopic*. Incontinence occurs when the ureter tunnels to a point distal to or empties distal to the trigone, allowing urine to flow into the proximal urethra or the vagina instead of the bladder. Dogs with ectopic ureters usually

demonstrate continuous urine leakage that has occurred since birth, and often have failed to respond to medications prescribed for either USMI or urinary tract infection (UTI). Surgical correction of the ectopic ureter(s) either by nephrectomy and ureterectomy (if unilateral and the associated kidney is severely hydronephrotic) or by ureteral reimplantation into the bladder (if bilateral or the associated kidney is salvageable) is required for clinical improvement of the incontinence. Ureteral ectopia may be unilateral or bilateral, and other anatomic or functional abnormalities are commonly observed concurrently (e.g., reduced bladder capacity, USMI). Thorough evaluation of the urinary tract, including urodynamic assessment prior to surgery when available, is recommended to refine prognosis and predict the need for additional medical management. A significant percentage of animals with surgically corrected ectopic ureters will require postoperative pharmacologic treatment to maintain continence. Ectopic ureters occur most often in female dogs, but are also diagnosed occasionally in male dogs and in cats.

Prostatic disease

Incontinence in male dogs is frequently associated with prostatic disease. Incontinent males should be closely screened for bacterial prostatitis, prostatic neoplasia, and other prostatic disease via rectal palpation, urine/prostatic fluid analysis and ultrasonography.

Cats

Urinary incontinence is a rare clinical problem in cats. Causes include congenital anatomic anomalies, neurologic injury or malformation, viral disease and urethral incompetence. Juvenile cats should be screened for ectopic ureters and vaginoureteral abnormalities. Adults should be tested for feline leukemia virus, once LUT inflammation and polyuria are excluded. Alpha adrenergic agonists are occasionally effective in adult cats with non-neurogenic urethral incompetence. Both urinary and fecal incontinence can occur in the Manx breed due to congenital malformation of the sacrum.

Diagnostic approach to incontinence

History and physical examination (including observed voiding) provide the basis for diagnosis of the cause of incontinence in many small animal patients; signalment alone will narrow the differential list (Table 1b). Problem-specific historical questions are listed in Table 3.

The minimum data base for incontinent animals should include a urinalysis, with a urine culture if indicated by the presence of pyuria, bacteriuria, or lack of concentration. Polyuria may precipitate or exacerbate incontinence by overwhelming bladder capacity; poorly concentrated urine (<1.025 in a dog, <1.035 in a cat) should be confirmed and investigated, if persistent. If the animal exhibits any signs of systemic illness, a complete blood count and serum biochemistry evaluation should also be performed.

Most dogs presented for incontinence do not require imaging as part of the diagnostic approach. Imaging is, however, recommended for:

- incontinent juvenile dogs or cats (less than 1 year of age)
- incontinent male dogs
- dogs or cats whose incontinence closely follows a surgical procedure
- dogs or cats with continuous urine leakage
- dogs or cats with urine leakage from an anatomically abnormal site
- dogs or cats with concomitant recurrent UTI, recurrent vaginitis, hematuria, crystalluria, or azotemia

- dogs or cats for whom surgical correction of incontinence is considered

Choice of imaging modality depends on signalment and clinical signs. Survey radiography will detect radio-opaque uroliths and gross malformations of the urinary bladder, vertebra or pelvis. Excretory urography (including radiography and computed tomography), vaginourethrography and/or urethrocytostomy are helpful in identifying anatomic abnormalities of the ureters and urethra, such as ectopic ureter. Ultrasonography of the prostate is recommended for any incontinent male dog; ultrasonography can also help rule out a trigonal mass interfering with normal outlet closure. Digital vaginal exam, vaginoscopy and/or contrast vaginogram will help evaluate presence, position and severity of vestibulovaginal stenosis, or the presence of vaginal urine pooling.

Specialized urodynamic studies

Urodynamic studies may be indicated and helpful in select patients with urinary incontinence or urine retention. Urethral pressure profilometry (UPP) measures the pressures along the length of the outflow tract and urethra. In some complicated incontinence or urine retention patients, the UPP may be useful for:

- evaluation of suspected USMI refractory to traditional medical therapies
- evaluation of urethral function in patients with anatomic abnormalities (e.g., ectopic ureter)
- perioperative evaluation of surgical treatment of USMI (e.g., urethral bulking, colposuspension)
- confirmation/ localization of urethral spasm

Cystometrography (CMG) measures the pressure within the bladder as it is filled with fluid or gas. Bladder capacity and compliance may be estimated from calculations of infused volume and the pressure slope during filling. Bladder overactivity is diagnosed if early or repeated detrusor contractions are observed in response to filling. Underactivity (or atony) of the bladder is more difficult to assess, as many dogs will inhibit bladder contractions during the study. An atonic bladder, however, would be expected to have an expanded capacity and fill to large volumes at low pressure. In complicated incontinence or urine retention patients, the CMG may be useful for:

- evaluation of suspected USMI refractory to traditional medical therapies
- diagnosis of suspected bladder overactivity
- evaluation of bladder contractile function in neurogenic disorders
- evaluation of incomplete voiding and bladder contractile function in suspected detrusor atony

Relapsing or refractory incontinence

In many incontinent animals, particularly those with uncomplicated early USMI, incontinence is easily controlled with pharmacologic treatment. Other dogs respond initially and later relapse, whereas a small percentage fail to achieve satisfactory remission of clinical signs. Suggested reasons, as well as additional diagnostic and therapeutic options, for relapsing or refractory incontinence are presented in Table 4.

Table 1a.
Causes of urinary incontinence in small animals

Neurogenic	Non-neurogenic
Sacral fracture Pelvic nerve or pelvic plexus trauma Lumbosacral disease Intervertebral disk disease Lumbosacral stenosis Neoplasia Sacral malformation (Manx cats) Feline leukemia virus-associated Generalized peripheral lower motor neuron disease Dysautonomia	Urethral sphincter mechanism incompetence (USMI) Urethral hypoplasia Lower urinary tract inflammation Bacterial cystitis Sterile cystitis Urolithiasis Detrusor instability Ectopic ureter Partial outflow obstruction Uroliths Neoplasia Polyps Patent urachus Vestibulovaginal stenosis/septum Primary detrusor atony with overflow

Table 1b.
Common causes of urinary incontinence by signalment

<u>Adult female dogs</u> USMI Detrusor instability (bladder storage dysfunction) Vaginal pooling LUT inflammation Neurogenic disorders	<u>Adult male dogs</u> Prostatic disease USMI Detrusor instability Neurogenic disorders
<u>Juvenile dogs</u> Ectopic ureter Urethral or bladder hypoplasia Congenital USMI Vaginal anomalies Intersex disorder Patent urachus	<u>Cats</u> Feline leukemia virus associated USMI Overflow Neurogenic disorders

Table 2.
Characteristics of Common Disorders causing Urinary Incontinence

Disorder	Characteristics	Diagnostic methods
Acquired urethral sphincter mechanism incompetence (reproductive hormone responsive or “spay” incontinence)	Medium to large-breed adult dogs, usually female Prior ovariohysterectomy Intermittent urine leakage Resting urinary incontinence Otherwise normal	Response to treatment Urethral pressure profile
Urinary bladder storage dysfunction (detrusor instability, urge incontinence, overactive bladder)	Intermittent urinary incontinence Pollakiuria May appear behavioral or voluntary May be associated with excitement or activity	Response to treatment Cystometrography Cystourethrography
Ectopic ureter	Affected since birth Often continuous urine leakage	Contrast radiography/computed tomography Urethrocystoscopy Vaginouretrography Surgical exploration
Congenital urethral incompetence or hypoplasia	Severe or continuous urine leakage Juvenile animal Wide or short urethra in some cases Ectopic ureter not demonstrated	Cystourethrography Urethral pressure profile
Vaginal abnormality or urine pooling	Urine leakage at rest or when rising Urine leakage following voiding Recurrent or persistent vaginitis Vestibulovaginal stenosis/septum on digital examination	Vaginal examination and vaginoscopy Vaginouretrography
Prostatic disease (male dogs)	Intact or neutered Other signs of prostatic disease or concurrent dysuria Hind limb weakness/ stiff, stilted gait	Abdominal radiographs Ultrasonography Contrast urethrography Prostatic brushing, aspirate or biopsy
FeLV-associated urinary incontinence (cats)	Intermittent urine leakage Anisocoria	FeLV test

Table 3.

Problem-specific historical questions and physical exam guidelines for patients with urinary incontinence or urine retention

History (incontinence)

- When does leakage occur? Nocturnally/when resting or recumbent? Continuously? With excitation? Upon rising?
- How old was the patient when the problem began? In relation to neutering surgery?
- Is the leakage worsening, constant or improving?
- Is the pet able to void normally?
- Is the pet conscious of the dribbling?
- Is the problem worse with a full bladder?
- Is urine volume increased in general?
- Are LUT signs present (pollakiuria, strangiuria, hematuria)?
- Any systemic signs of illness?
- What is estimated water consumption?
- Any history of prior urinary tract problems?
- Any recent abdominal, pelvic or urogenital surgery or trauma?

History (urine retention)

- How old was the patient when the problem began? In relation to neutering surgery?
- Any previous medical problems?
- What is estimated water consumption?
- Any history of prior urogenital disorders (e.g. urinary tract infections, urolithiasis, urethral obstructions)?
- Any systemic signs of illness?
- Any previous back surgery or trauma?
- Any recent abdominal, pelvic or urogenital surgery or trauma?
- How frequent are voiding attempts?
- Is any urine passed during voiding attempts?

Physical examination

- Is the bladder large or small?
- Is it firm or soft?
- Are the urethra and prostate/vagina normal on palpation?
- Is perineal/preputial urine staining/scald present?
- Is the neurologic exam normal?
 - Mentation and cranial nerves
 - Conscious proprioception, spinal reflexes, tail and anal tone, perineal reflexes, bulbourethral/vulvar reflex
 - Pupillary light reflexes
- Is bladder expressible?

Observed voiding

- Can the patient initiate and maintain a normal urine stream?
- What is the residual urine volume following voiding attempts?

Table 4. Potential causes and possible solutions for refractory or relapsing urinary incontinence.

Cause or complicating factor	Possible solution(s)
Inadequate dosage or frequency of medication	<ul style="list-style-type: none"> • Increase dosage within recommended range. • Increase frequency of alpha agonist (up to q 8 hrs) or estrogen (up to q 2 days) as tolerated
Inappropriate medication	<ul style="list-style-type: none"> • Consider change from estrogen to alpha agonist administration • Consider addition of estrogen to alpha agonist administration
Poor owner compliance	<ul style="list-style-type: none"> • Consider switch to long-acting alpha agonist or to estrogens to improve compliance
Underlying urinary tract infection	<ul style="list-style-type: none"> • Monitor for UTI and treat appropriately
Underlying polyuria	<ul style="list-style-type: none"> • Evaluate for common, treatable polyuric disorders (e.g. hyperadrenocorticism, diabetes mellitus)
Mixed disorder of micturition	<ul style="list-style-type: none"> • Consider addition of or trial treatment with anticholinergic agent
Underlying anatomic abnormality	<ul style="list-style-type: none"> • Investigate anatomy with contrast radiography • Consider surgical management of ectopic ureter, pelvic bladder, or vaginal/vulvar abnormality
Underlying neurologic lesion	<ul style="list-style-type: none"> • Investigate for subtle lumbosacral disorder with neurologic examination and imaging studies
Behavioral component or senility	<ul style="list-style-type: none"> • Consider treatments for behavioral disorders or cognitive dysfunction
Refractory urethral incompetence	<ul style="list-style-type: none"> • Consider combinations of medications or surgical treatment to enhance medical management • Consider trial of GnRH analog or duloxetine • Consider urethral bulking agents

Table 5. Comparison of Alpha Agonists and Reproductive Hormones in the Management of Urinary Incontinence

	Alpha Agonists	Estrogens
Effectiveness	75 - 90% excellent results	40 - 65% excellent results
Indications	Males or females, dogs or cats Poor response to estrogen	Female dogs Combination with alpha agonists Recurrent UTI or vaginitis?
Administration frequency	q 8 - 24 hrs	q 2 - 14 days
Residual effects	Short	Possibly prolonged

Adverse effects	Hyperactivity Hypertension Anxiety Tachycardia Anorexia, weight loss	Behavioral change Bone marrow toxicity (rare) Estrus Exacerbation of immune-mediated disease?
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Formulary of agents useful in the management of urinary incontinence

Agent	Classification	Recommended dosage	Possible adverse effects	Contraindications or comments
Diethylstilbesterol* (DES); Stilbesterol*	Reproductive hormone	Dogs: 0.1 - 1.0 mg/dog PO q 24 hrs for 5 - 7 days, then weekly or as needed	Estrus Behavior change Myelosuppression Pyometra in intact female	Males Cats Pregnancy
Stilbesterol* (alternate regimen)	Reproductive hormone	Dogs: 0.04 - 0.06 mg/dog PO q 24 hrs for 7 days, reduced weekly to 0.01-0.02 mg/dog/day	As with DES	As with DES
Premarin*	Conjugated estrogen	Dogs: 0.02 mg/kg PO q 24 hrs for 5 - 7 days, then q 2 - 4 days or as needed	As with DES	As with DES
Estriol*	Reproductive hormone	Dogs: 0.5 - 1.0 mg/dog PO q 24 hrs for 5 - 7 days, then q 2 - 3 days as needed	As with DES	As with DES
Estriol* (alternate regimen)	Reproductive hormone	Dogs: 2.0 mg/dog PO q 24 hrs for 7 days, then reduce daily dose by 0.5 mg each week to establish minimal effective daily dose; then try	As with DES	As with DES

		every other day administration.		
Testosterone cypionate	Reproductive hormone	Dogs: 2.2 mg/kg IM q 4 - 8 <u>weeks</u>	Behavior change Perianal adenoma Perineal hernias, Prostatic disorders Aggression	Cardiac, renal or hepatic disease
Testosterone propionate	Reproductive hormone	Dogs: 2.2 mg/kg IM q 2-3 <u>days</u>	As for testosterone cypionate	As for testosterone cypionate
Phenylpropanolamine (PPA)	Alpha agonist	Dogs: 1.5 mg/kg PO q 8 - 12 hrs, or 12.5-75 mg PO q 8-12 hrs Cats: 12.5 mg/CAT PO q 8-12 hrs, or 1.1-2.2 mg/kg PO q 8-12 hrs	Anxiety Aggression Anorexia Hypertension Tachycardia	Some cardiac disease Hypertension +/- anxiety disorders
Ephedrine	Alpha agonist	Dogs: 1.2 mg/kg PO q 8 hrs	As with PPA	As with PPA
Pseudoephedrine	Alpha agonist	Dogs: 0.2 - 0.4 mg/kg (practically, 15 - 60 mg total dose per dog) PO q8-12h	As with PP	As with PPA
Imipramine	Antimuscarinic, alpha/beta agonist	Dogs: 5 - 15 mg PO q 12 hrs	Sedation Dry mouth Urinary retention GI upset	Seizure disorders Use of other anticholinergic or CNS depressants, Glaucoma, GI obstruction, renal or hepatic disease, cardiac arrhythmias
Oxybutynin	Antimuscarinic	Cats and small dogs: 0.5-1.25 mg total per dose Larger dogs: 2.5 – 3.75 mg total per dose	As for imipramine	Glaucoma, GI obstruction, renal or hepatic disease, cardiac arrhythmias, hypertension
Dicyclomine	Antimuscarinic	Dogs: 5 - 10	As for imipramine	As for

		mg/dog PO q 8 hrs		oxybutynin
Depot leuprolide	GnRH analog	Dogs: 11.25 mg/dog [†]		May be redosed as needed May be used in combination with alpha-agonists
Depot deslorelin	GnRH analog	Dogs: 5-10 mg/dog [†]		May be redosed as needed As for leuprolide
Depot buserelin	GnRH analog	Dogs: 6.3 mg/dog [†]		May be redosed as needed As for leuprolide

* estrogens are not recommended in male dogs or in cats

[†] Doses are from Reichler IM, Hubler M, Jöchle, et al. and were extrapolated from the human doses designed to maintain continence for 6 (deslorelin), 3 (leuprolide), or 2 (buserelin) months. Duration of effect of the depot preparations varied in that report from 1.5 months to 5 years.