Artificial Urethral Sphincters in Dogs

Christopher Adin, DVM, DACVS
Ohio State University
Columbus, OH

- Urethral bulking agents can be applied endoscopically and have a high short-term efficacy, but poor duration of action (1-2 years) in treating canine incontinence
- There are currently no urethral bulking agents available for clinical use in animals, although some are being evaluated by selected programs.
- Colposuspension, the most widely reported method of open surgical therapy for canine incontinence, has a 50% success rate in long term restoration of continence and appears to be somewhat "user dependent" in terms of success rates.
- Use of a canine artificial urethral sphincter provides another method for treating canine incontinence, with a 90% success rate.
- While the AUS has the advantage of being a permanent and adjustable urethral compressive device, long-term complications can include progressive urethral obstruction in some dogs.

Background

Urethral sphincter mechanism incompetence (USMI) occurs in up to 20 % of dogs following ovariohysterectomy. Urethral sphincter dysfunction is also a common cause of failure after surgical repair of ureteral ectopia, with approximately 50% of dogs suffering from continued urine leakage after ureteral reconstruction. Dogs that fail to respond to pharmacologic therapy require surgical intervention. Numerous options exist for the treatment of refractory incontinence in female dogs, though none has achieved uniform success. Pharmacologic therapy is the initial treatment of choice, but alpha agonists and estrogens are associated with a number of potential side effects and must be administered for the remainder of the animal's life. In addition, approximately 27% of dogs are refractory to medical therapy.

Urethral bulking techniques

Historically, urethral bulking techniques were probably the most widely applied therapy for female dogs with incontinence that was refractory to medical therapy. Submucosal injections of a urethral bulking agent could be administered via endoscopic guidance, giving this procedure the advantage of being a "minimally invasive" outpatient therapy. The most widely used agent, cross-linked bovine collagen, had a high degree of efficacy, but effects were short lived and dogs will typically require repeated injections every 1-2 years for the remainder of their lives. Cost was equal to or greater than open surgery due to the high cost of the collagen itself. In the last 2 years, the company that was providing bovine collagen to veterinary hospitals discontinued sales to the veterinary market and the use of this technique has been significantly curbed until another safe bulking agent is made readily available.

In addition to urethral collagen injections, a variety of open surgical procedures have been used with varying success to treat incontinence in female dogs. Examples include sling urethroplasty, cystourethropexy, urethral intussusception, and colposuspension. Unfortunately, surgery alone has produced poor long-term results. Colposuspension is one of the more common surgical techniques practiced by veterinary specialists, but was reported to maintain continence in only 14% of dogs after one year in a recent prospective study and has not exceeded 53% efficacy in other large case series.

Artificial urethral sphincter in dogs:

In our practice, we have switched to the use of a hydraulic urethral sphincter, expanding applications to include male and female USMI, failed ectopic ureter repair, failed collagen injection, and pelvic bladder. The canine artificial urethral sphincter (AUS, Figure 1) was initially created by combining an inflatable silicone vascular occluder (DOCXS, Ukiah California) with a titanium subcutaneous injection port (Le Grande Vascular Access Port, Access Technologies). The device was then modified by widening the cuff to minimize urethral trauma during compression. We also changed the entry point of the actuating (inflation) tubing, making a side entry that would be parallel to the urethra and would allow easier implantation. Inflation of the occluder is performed by injecting fluid into a titanium vascular access port, which is placed in the subcutaneous tissues along the ventral abdomen. The occluders are composed of medical grade silicone and have been used in physiology research for many years. An *in vitro* experiment in our lab demonstrated reliable maintenance of occlusion during a 5 month period of immersion in simulated body fluid when occluders were infused with either isotonic saline or sodium hyaluronate. Following the *in vitro* work, maximal urethral closure pressure (MUCP) and cystourethral leak point pressure (CLPP) were measured before and after application of the HUS to 6 female dog cadavers. MUCP and CLPP were directly proportional to the volume injected into the hydraulic occluder and equaled or exceeded values reported in live, continent dogs after 50% occlusion of the HUS. The data obtained in this cadaver model suggested that urinary continence may be achieved after application of the HUS to spayed female dogs with USMI. Although adjustable, this system is not intended to be patient-controlled. Rather, the HUS would provide a low level, static increase in urethral resistance, similar to that achieved through submucosal collagen injection, but of a more durable nature. The amounts of saline that were injected in the cadaver study were later

modified to smaller volumes (0.1 to 0.2 mLs) based on observations in live animals with USMI. A pilot study was funded by the American Kennel Club to test application in dogs with refractory USMI and long term results (2 years) in 4 dogs were reported.
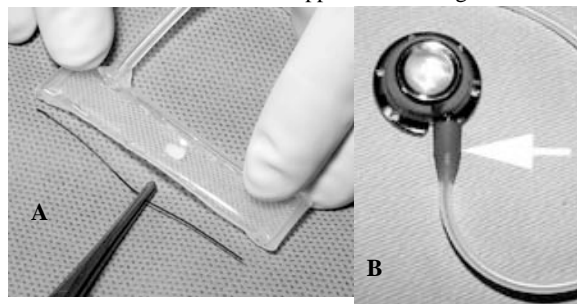
Figure 1 (A and B)

A, An artificial urethral sphincter with side entry tubing is sized by comparing to a piece of suture that was cut to approximate urethral circumference. The sphincter is closed around the urethra by placing a strand of non-absorbable suture material through the suture eyelets in both ends of the cuff. The cuff may then be inflated by injecting fluid into the subcutaneous port, causing mild, static occlusion of the urethra. **B,** The actuating tubing is attached to a titanium subcutaneous injection port using a "boot" (white arrow) supplied by the manufacturer of the port. (modified from Reeves, et al, *Vet Surg*, 2012)

Screening prior to surgery

Complete physical examination, serum chemistry panel, complete blood count, urinalysis/bacterial culture and abdominal ultrasound, should be performed to rule out concurrent disease. Urodynamic studies may be performed to confirm diagnosis of USMI and to obtain baseline information. Additional uroendoscopy or computed tomography is indicated to rule out ureteral ectopia if clinical history in animals with congenital incontinence, but are not routinely performed in animals that develop acquired incontinence after sterilization surgery.

Surgery
Females

After induction of general anesthesia, a caudal midline approach to the urinary bladder is performed, continuing the abdominal wall incision to the pubic symphysis to allow maximal exposure of the urethra. The bladder is retracted cranially and a 2cm section of the pelvic urethra is isolated from the peri-urethral adipose tissue by blunt dissection, approximately 3-4 cm caudal to the trigone. The urethral circumference is approximated by measuring with a strand of suture, then a silicone AUS of equal or larger circumference to the pelvic urethra is selected, *erring on the larger side to avoid excessive compression* (Figure 1). A size chart has been included to aid in selection of the device in female dogs (Table 1), but should only be used as a guide. Prior to placement of the AUS, all air is flushed from the lumen of the balloon and actuating tubing by retrograde filling of the system with isotonic saline, using a 21 gauge catheter. The AUS is then completely filled, tested for leakage, and filling volume is recorded before placing the device around the pelvic urethra, 2 cm caudal to the trigone. The cuff is closed around the urethra by placing 0 to 2-0 polypropylene suture through the eyelets and tying a secure knot. The infusion line is exited through a stab incision in the abdominal wall and is connected to an injection port that is anchored in the subcutaneous tissues of the inguinal area. The abdomen is closed routinely. Dogs are administered analgesics and monitored in the hospital for 24 hours following surgery to monitor for urethral obstruction. Urethral catheterization has not been necessary in our experience, making postoperative management relatively simple and inexpensive.

Males

Surgery is performed through a similar caudal midline approach after a para-prepucial skin incision. It is important to continue the abdominal wall incision to the level of the pubis in order to maximize exposure of the urethra. The bladder is retracted cranially and the prostate is located. A 2cm wide area is dissected around the post-prostatic urethra (caudal to the prostate) and the urethral circumference is measured using a penrose drain or length of suture. A device that is slightly larger in circumference is selected, primed with saline and placed around the urethra as described above for the female dog. In my limited experience, male dogs have required larger devices (12-14 mm luminal diameter), although I have only operated on large breed dogs at this time.

Table 1: Guidelines for selection of artificial urethral sphincter cuffs based on body weight of female dogs (from Reeves, et al, *Vet Surg*, 2012)

Device size	6 x 11 mm	8 x 14 mm	10 x 14mm	12 x 14mm
Median BW	3-6 kg	10-20 kg	20-30 kg	25-40 kg

Follow up

Dogs are allowed to recover for 4- 6 weeks prior to inflation of the cuff. Delay in inflation of the HUS cuff is recommended by physicians to allow revascularization of the dissected portion of urethra and decrease the incidence of urethral atrophy. Thus far, 70-80% of dogs have become continent *without cuff inflation* and inflation of the cuff has primarily been used to improve continence in dogs that have regressed after 1 or more years of follow up.

In dogs with persistent incontinence, the skin above the port is shaved and aseptically prepared before making an injection. 0.9% sodium chloride is injected into the subcutaneous infusion port using a 22 gauge, non-coring needle (Huber needle). Originally, I advised administering 25% of the original filling volume, but found that this volume is excessive in some dogs and will cause incomplete bladder emptying. As a result, I have empirically altered the volume to increments of either 0.1mL or 0.2mL, depending upon the severity of clinical signs that are manifested by the dog at the time of presentation. When the clients are scheduled to

recheck, I advise them not to allow the dog to urinate as they are coming in to the hospital. After the injection, the dog is immediately walked outside and urination is observed to characterize the quality of the urine stream and

Complications and outcome

We have now performed this technique in over 30 animals at Ohio State, including 3 male dogs and one female cat. Outcome for the majority of these animals (27 dogs) was presented in a recent manuscript.[18] Using a continence scale (1 representing constant leakage and 10 representing complete continence), animals improved from a median of 2 preoperatively to a median of 9 at last follow up. The advantage of the technique is that the device is permanent and adjustable, so injections can be performed with minimal expense or invasiveness to increase urethral occlusion if incontinence recurs. As with all procedures that involve implantation of a permanent device, there are several potential complications that may be recognized. In this study, two of 27 dogs developed progressive signs of urethral obstruction that required recommendation of device removal. Gross examination suggested that fibrosis around the device may have contributed to excessive urethral compression, although both dogs could be catheterized easily and obstruction was incomplete. A small number of dogs (2) failed to achieve adequate continence with the device, although this was associated with some compliance problems and difficulty with return for recheck exams or injections in both cases. Overall, the device appears to be approximately 90% effective, but clients should be warned about the potential need for adjustment or removal of the device in some animals.

References

Okkens AC, Kooistra HS, Nickel RF. Comparison of long-term effects of ovariectomy versus ovariohysterectomy in bitches. J Reprod Fertil Suppl 1997;51:227-231.

Arnold S, Arnold P, Hubler M, et al. Urinary incontinence in spayed female dogs: frequency and breed distribution. Schwez Arch Tierheilkd 1989;131:259-263.

Richter KP, Ling GV: Clinical response and urethral pressure profile changes after phenylpropanolamine in dogs with primary sphincter incompetence. J Am Vet Med Assoc 1985;187:605-610.

Mandigers RJ, Nell T. Treatment of bitches with acquired urinary incontinence with oestriol. Vet Rec 2002;149:764-767.

Plum DC, Veterinary Drug Handbook. White Bear Lake, MN Pharma Vet Publishing, 2nd Edition, 1995, pp 209, 547.

Moreau PM, Lappin MR: Pharmacologic management of urinary incontinence, in Kirk RW (ed): Current Veterinary Therapy, X. Small Animal Practice. Philadelphia, PA, WB Saunders Co, 1992, pp 875-877.

Gookin JL, Stone EA, Sharp NJ. Urinary incontinence in dogs and cats. Part II. Diagnosis and management. Compend Contin Educ Pract Vet 1996;18:525-547.

Bushby PA, Hankes GH. Sling urethroplasty for the correction of urethral dilation and urinary incontinence. J Am Anim Hosp Assoc 1980;16:115-118.

Massat BJ, Gregory CR, Ling GV, et al. Cystourethropexy to correct refractory urinary incontinence due to urethral sphincter mechanism incompetence: preliminary results in ten bitches. Vet Surg 1993;22:260-268.

Bertrand SG, Bellah JR, Ginn PE. Clinical, urodynamic and histologic effects of urethral intussusception in clinically normal dogs. Am J Vet Res 1998;59:904-912.

Arnold S, Jager P, DiBartola SP, et al. Treatment of urinary incontinence in dogs by endoscopic injection of Teflon. J Am Vet Med Assoc 1989;195:1369-1374.

Arnold S, Hubler M, Lott-Stolz, et al. Treatment of urinary incontinence by endoscopic injection of glutaraldehyde cross-linked collagen. J Small Anim Pract 1996:37:163-168.

Rawlings C, Barsanti JA, Mahaffey MB, et al. Evaluation of colposuspension for treatment of incontinence in spayed female dogs. J Am Vet Med Assoc 2001;219:770-775.

Holt PE. Long-term evaluation of colposuspension in the treatment of urinary incontinence due to incompetence of the urethral sphincter mechanism in the bitch. Vet Rec 1990;127:537-542.

Sereda C, Adin CA, Archer L, et al. Mechanical and physical properties of silicone hydraulic occluders. ACVS Abstract, 2005.

Adin CA, Farese J, Cross A, Provitola M, Jankunas H, Davidson J: Evaluation of a percutaneously adjustable artificial urethral sphincter in a canine cadaver model. Am J Vet Res 2004; 65: 283-288.

Rose SA, Adin CA, Ellison GW, Sereda CW, Archer LL. Long term efficacy of a percutaneously adjustable hydraulic urethral sphincter for treatment of urinary incontinence in four dogs. Vet Surg. 2009; 38:747-53.

Reeves L, Adin C, McLoughlin M, Ham K, Chew D. Outcome after Placement of An Artificial Urethral Sphincter in 27 dogs. Vet Surg, 2013; 42:12-18.