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ORIGINAL ARTICLE

Long-term outcome of the transobturator vaginal tape inside out for the treatment of urethral sphincter mechanism incompetence in female dogs

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Abstract

Objective: To evaluate the long-term efficacy of the transobturator vaginal tape inside out (TVT-O) in female dogs with urethral sphincter mechanism incompetence (USMI).

Study design: Retrospective study.

Animals: Incontinent spayed female dogs (n = 12).

Methods: TVT-O tape was inserted in 12 incontinent bitches diagnosed with USMI. Follow-up information was evaluated by a telephone questionnaire, and a continence score was attributed.

Results: One year after surgery, 7 of 12 (58%) dogs were completely continent. Two dogs were removed from the long-term analysis (1 dead and 1 lost). At a median follow-up time of 85 months (range, 28-95), 4 of 10 dogs were completely continent without medical treatment. Incontinence recurred in 6 dogs at a median time of 2 months after surgery (range 1-20). Among these 6 dogs, 4 regained continence, and 2 had sporadic episodes of incontinence with additional medical treatment. No postoperative complications were encountered.

Conclusion: TVT-O alone was successful in maintaining long-term continence in 40% of the dogs. Additional postoperative medical treatment was effective in restoring continence in another 40% of the dogs.

Clinical significance: TVT-O provides an alternative treatment of USMI in female dogs that is safe and less invasive than standard surgical techniques.

1 | INTRODUCTION

Urethral sphincter mechanism incompetence (USMI) has been identified as the most common cause of acquired urinary incontinence in female dogs.[1] The urethral mechanism responsible for maintaining continence in female dogs includes urethral smooth and striated muscle tone, elasticity of the urethral wall, physical properties of the urethra (length and diameter), and engorgement of suburothelial venous plexuses.[2] Position of the urinary bladder also plays a role in USMI. The term *pelvic urinary bladder* describes a caudally displaced urinary bladder.[3] This is a congenital anomaly that is associated with a shorter urethral length and dysfunctional detrusor or urethral musculature.[4] A pelvic urinary bladder induces modifications in transference of abdominal pressures to the urethra.[3] Vaginourethrogram is recommended to diagnose this condition, but abdominal ultrasonography also allows evaluation of the position of the bladder neck.[4]

Medical management of USMI consists of increasing the number and sensitivity to estrogens of α-adrenergic receptors in the urethral sphincter or stimulating those receptors with

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an α-agonist.[5] Estrogens increase the sensitivity of the α-adrenergic receptors to stimulation and improve smooth muscle contractility, with 40%–83% of dogs responding favorably.[6,7] The α-adrenergic receptor agonist phenylpropanolamine (PPA) is commonly used to increase urethral tone, and response rates range from 85% to 97%.[8–11]

Various surgical procedures have been described for increasing the urethral resistance or urethral length or to reposition a pelvic bladder more cranially in the abdomen.[2,12] The increase in urethral pressure can be obtained by the use of periurethral slings,[13] transpelvic sling urethroplasty,[14] intraurethral injection of bulking agents,[15,16] and artificial hydraulic sphincter.[17–19] The urethral length can be increased with bladder neck reconstructions.[20] The bladder can be relocated in a more cranial position, where it is exposed to intra-abdominal pressure, adding occluding pressure to the bladder neck.[17] This can be performed by colposuspension,[21] urethropexy,[22] or cystourethropexy.[23] Colposuspension is associated with a success rate of 53%.[24] The success rate is 56% for the urethropexy[22] and 70% for the cystourethropexy.[23]

Stress urinary incontinence in women is mainly treated surgically by minimally invasive procedures involving vaginal placement of suburethral slings. The mid-urethra is thus stabilized when abdominal pressure increases during cough or exercise. The first sling described was the tension-free vaginal tape (TVT). Insertion of the tape by a retropubic route has been associated with a number of complications, including lesions to the urinary bladder, urethra, bowel, nerves, or vessels.[25] To reduce these complications, the transobturator tape (TOT) procedure was introduced. This tape is also located underneath the mid-urethra but runs laterally through the obturator membrane to the upper part of the thigh, from outside to inside.[26] The so-called tension-free vaginal tape inside out (TVT-O), with the passage of the tape through the obturator foramen from inside to outside, was then described.[26] This procedure requires less dissection than the previous TVT procedure and is precise and reproducible.[26] It decreases the risk of perforation of the bladder or urethra and avoids vascular and neurological lesions.[26] In a recent study reporting the 10-year follow-up of the procedure, 97% of the 160 patients declared themselves cured, and 92% were cured according to objective assessment at the 10-year evaluation.[27] No patient required tape release or resection, and no vaginal, bladder, or urethral erosions were recorded.[27]

The use of TVT-O in female dogs was first described in articles published in 2010.[28,29] The first study described the reproducible and accurate placement of the tape in female canine cadavers. Moreover, the procedure was performed in 2 continent bitches without surgical or postoperative complications. A second study evaluated the short-term efficacy of the TVT-O in incontinent female dogs.[29] Six of 7 dogs in this second study were continent at a mean follow-up time of 11.3 months.

The objective of the present study is to report the long-term outcome of the dogs presented in the preliminary study (Claeys et al[29]), with inclusion of additional dogs.

2 | MATERIALS AND METHODS

2.1 | Dogs

Female dogs diagnosed with acquired USMI were included in the study. Seven dogs had been included in the study by Claeys et al.[29] All dogs had a complete physical examination, a urinalysis, a urine culture, and a complete blood analysis (hematology and biochemistry) at admission. Tentative diagnosis of USMI was made by exclusion of other causes of urinary incontinence on the basis of breed, history, and results of imaging and laboratory techniques. Imaging techniques performed to rule out other causes were vaginourethrogram, abdominal ultrasonography, and IV urography or cystoscopy if required. Position of the bladder neck was documented on vaginourethrograms. Diagnosis was then confirmed in all dogs by observation of a flat curve and a low maximal urethral closure pressure (MUCP) on the urethral pressure profiles (UPP). The integrated pressure (IP; area under the curve) was calculated. Retrograde filling cystometry was performed in all dogs to rule out abnormal bladder function. Informed consent was obtained from owners after complete information had been given about the surgical technique and the follow-up procedures.

2.2 | Surgery

The TVT-O tape (Gynecare TVT obturator system; Ethicon, Somerville, New Jersey) was inserted in each dog according to the standard operative protocol described in women[30] and adapted to the dog.[28]

2.3 | Follow-up

A long-term follow-up based on telephone interviews with owners was performed at a minimum of 28 months after surgery. A previously published continence scoring system[31] was used. The continence score was assigned as follows: 1 = incontinent, 2 = continent with sporadic episodes of incontinence, 3 = fully continent. This score was attributed preoperatively, at 1 year postoperatively, and at long-term evaluation. Long-term UPP were also performed in 3 dogs.

2.4 | Data analysis

Descriptive statistics were calculated in commercial software (XLSTAT 2017: Data analysis and statistics with Microsoft Excel; Addinsoft, Paris, France). The Shapiro–Wilk test for normality was performed for each variable. Mean was

calculated for normally distributed data, and median was determined for nonnormally distributed data.

3 | RESULTS

Twelve spayed female dogs (3 mixed breed, 1 Newfoundland, 1 springer spaniel, 1 American Staffordshire, 1 Malinois sheepdog, 1 Australian shepherd dog, 1 border collie, 1 bearded collie, 1 Doberman pinscher and 1 white Swiss shepherd dog) were included. The mean body weight was 30.2 kg (range, 12-63), and the mean age was 4.1 years (range, 2.8-5.0) at the time of surgery.

Clinical signs included urine leakage during sleep (n = 12) and/or effort (n = 3). All dogs had urine leakage several times per day. Eleven dogs had been treated medically before surgery; 3 dogs (dogs 3, 6, 12) had been treated with estriol alone, 4 dogs (2, 4, 7, 10) had been treated with PPA alone, and 4 dogs (1, 5, 8, 11) had been treated with both estriol and PPA. Six dogs were unresponsive to PPA or estriol. Four dogs were partially responsive, but daily urine leakage was still noted. One dog (6) responded to PPA and another (9) did not receive any medical treatment, but owners of those 2 dogs requested a surgical option.

Preoperative blood analyses were unremarkable in all dogs. Preoperative urinalyses were within normal limits, and urine culture was negative in all dogs. None of the dogs had received antibiotics before urine culture. Vaginourethrograms revealed a pelvic urinary bladder in 4 dogs (1, 2, 3, 6). Abdominal ultrasound revealed a pelvic urinary bladder neck in 3 dogs (2, 3 6).

The median preoperative MUCP was 13 cmH_2O (range, 5-28). The mean preoperative IP was 47.5 cm^2H_2O (range, 10-166). Retrograde filling cystometry was unremarkable in all dogs.

3.1 | Surgery and postoperative care

Surgical technique was performed as previously reported.[26] Surgery was performed in 11 dogs, without intraoperative complications. An iatrogenic urethral tear was identified during surgery in dog 2. A 12 Fr Foley catheter (Folysil silicone Foley catheter; Coloplast, Humlebaek, Denmark) was placed for 6 days in the urethra to allow healing by second intention.[27]

Median procedure time for TVT-O was 60 minutes (range, 40-100). Median hospitalization time was 1 day (range, 1-6).

3.2 | Outcome

Nine dogs were continent immediately after surgery (Table 1). Three dogs (1, 8, 10) lost small amounts of urine during sleep for 2-4 postoperative days before becoming completely continent. One month after surgery, 10 of 12 (83%) dogs were completely continent without medical treatment. One year after surgery, 7 of 12 (58%) dogs remained completely continent. Dog 4 died 1 year after surgery from unrelated reasons, and dog 9 was lost to follow-up after 13 months; both of these dogs were continent (until death or last phone call) 1 year after surgery but were excluded from the long-term analysis.

At a median follow-up time of 85 months (range, 28-95), only 4 of 10 dogs remained completely continent without medical treatment. Incontinence recurred in 6 dogs at a median time of 2 months after surgery (range, 1-20); they all received medical treatment. Dogs 2, 3, 8 and 10 received oral PPA (1.5 mg/kg once daily initially then adapted), dog 11 received ephedrine (1 mg/kg twice per day) because PPA and estriol were ineffective, and dog 12 received estriol (1 mg once daily). Among those 6 dogs, 4 (2, 3, 11, 12) were continent with the addition of medical treatment

TABLE 1 Continence scores[a]

Dog	Breed	Preoperative CS		1-year CS		Long-term CS[b]		Recurrence, mo
		No MT	MT	No MT	MT	No MT	MT	
1	Newfoundland	1	1	3	…	3	…	…
2	Mixed breed	1	1	1	3	…	3	2
3	English springer spaniel	1	1	3	…	1	3	20
4	American Staffordshire terrier	1	1	3	…	Dead	…	…
5	Belgian malinois	1	1	3	…	3	…	…
6	Australian shepherd	1	3	3	…	3	…	…
7	Mixed breed	1	1	3	…	3	…	…
8	Mixed breed	1	1	1	3	…	2	1
9	Border collie	1	…	3	…	Lost	…	…
10	Doberman pinscher	1	1	1	2	…	2	7
11	White Swiss shepherd	1	1	1	1	…	3	1
12	Bearded collie	1	1	1	3	…	3	1.5

…, no data; CS, continence score; MT, medical treatment.
[a] 1 = incontinent, 2 = continent with sporadic episodes of incontinence, 3 = fully continent.
[b] median time = 85 months

(continence score 3). Two dogs (8, 10) were continent with sporadic episodes of incontinence (continence score 2) despite the addition of medical treatment; the degree of incontinence was subjectively assessed to be less severe than it had been preoperatively for these 2 dogs. No long-term complications were reported.

3.3 | Long-term UPP

UPP (Table 2) were performed long-term in only 3 dogs (3, 6, 7). Dog 3 was presented for recurrence of incontinence, whereas dogs 6 and 7 were continent. For dog 3, values of MUCP and IP were consistent with the diagnosis of USMI 22 months after surgery. For dog 6, values of MUCP and IP remained higher than preoperative values 18 months after surgery. For dog 7, values were comparable to those observed preoperatively despite the fact that the dog was continent.

4 | DISCUSSION

At long-term follow-up, TVT-O alone was effective in maintaining continence in 40% of the dogs. Those results are less encouraging than the initially reported short-term results in which 6 of 7 bitches were continent postoperatively.[29] However, additional postoperative medical treatment was often effective. The results obtained in dogs are less encouraging than those observed in women (92% objectively cured at the 10-year evaluation).[27]

The reason for recurrence remains hypothetical. The elasticity of the tape may be responsible for a loss of tension of the tape with time.[29] It is also possible that the initial inflammatory reaction increased urethral resistance temporarily.[29] Indeed, the median time of recurrence was very short (2 months). The tension placed on the tape intraoperatively may also play a role in recurrence. The tape is indeed adjusted while performing an imitation of the "cough test" performed in women. Pressure is applied on the caudal abdomen while the tape ends are pulled. Position of the tape is judged satisfactory when only a few drops of urine are leaking during application of pressure. This maneuver is not standardized, and tension applied on the tape is therefore subjective and variable. Position of the urinary bladder may also play a role in recurrence. However, only 4 dogs had a pelvic urinary bladder, and 2 of them were continent long-term. The small number of dogs presenting a pelvic urinary bladder does not allow us to make any conclusion about its implication on the rate of recurrence.

Holt[24] evaluated the long-term effects of colposuspension in 150 incontinent female dogs, with a follow-up period ranging from 6 months to 8.9 years (mean, 2.8). Fifty-three percent of the dogs were completely continent, and 37% were improved. Nine dogs became continent or improved initially but relapsed later. Postoperative complications occurred in 17 bitches and included increased frequency of micturition, slight tenesmus, and pain during first defecation. In the study of Currao et al,[19] continence was achieved in 67% of dogs after hydraulic occluder placement. With inflations, 92% of dogs had a "functional" continence score, and 77% of dogs were completely continent. Moreover, 61% of dogs required addition of medical treatment to maintain continence. Urethral obstruction by urethral stricture formation (in 17% of dogs) is the major complication described with this procedure. This complication has not been observed with the TVT-O procedure. Postoperative vaginourethrograms were initially performed and were unremarkable.[29] Some radiographic views revealed a slight narrowing of the distal urethra, which was not correlated with an increase in urethral pressure on the UPP.[29]

Long-term complications in women include persistence of groin pain (0.6%), persistence of voiding dysfunction (0.6%), overactive bladder (14%), and dyspareunia (4.3%).[27] No patient required tape release or resection in the same study with a 10-year follow-up.[27] Results of the present long-term study confirmed that TVT-O is safe and that the polypropylene tape is well tolerated in dogs. No long-term infection (secondary to urethral or vaginal erosion) was identified, and no dog required removal of the tape. Deschamps and Roux[32] reported a variant of the TVT-O in 12 dogs. They used a curved Reverdin needle and a 6-mm nylon tape instead of the commercially available kit. Two bitches developed fistula on the path of the tape, which may not be sufficiently inert compared to the well-tolerated polypropylene tape of the TVT-O kit.[29,32] Postoperative dysuria was also reported in 7 of 12 dogs in that study. A possible reason for the dysuria is that the free ends of the tape were knotted together, potentially inducing excessive compression of the urethra. Dysuria required catheterization of the urethra in

TABLE 2 Results of UPP of 3 dogs in which UPP was performed long term[a]

Dog	MUCP, cmH_2O			IP, cm^2H_2O		
	Preoperative	Short term[b]	Long term	Preoperative	Short term[b]	Long term
3	3	7	12	34	70	22
6	6	20	43	69	163	126
7	7	13	16	59	85	58

IP, integrated pressure; MUCP, maximal urethral closure pressure; UPP, urethral pressure profile.
[a] Median, 18 months postoperatively. At the time of long-term UPP, dog 3 was incontinent, whereas dogs 6 and 7 were continent.
[b] 3 months.

4 dogs, and a second surgery was required in 1 dog to decompress the urethra by cutting the tape knots.[32] In our standard TVT-O procedure, the tape is left unfixed in the subcutaneous tissue. No dysuria was observed, and all dogs were discharged from the hospital the day after surgery (except for dog 2 with urethral tear).

The mechanism of action of the tape is not completely understood. Urodynamic measurements were compared preoperatively and at 1 and 3 postoperative months in 7 dogs; MUCP as well as IP (which represents urethral resistance) were significantly increased postoperatively.[29] Unfortunately, only 3 long-term UPP were performed because owners were not willing to come back for a recheck and to perform another procedure under anesthesia, especially if their dog was continent. Statistical analysis was therefore impossible. One hypothesis advanced by Claeys et al[29] is that the tape has an obstructive effect, which causes an increase in urethral resistance locally. The increased urethral pressure was, however, located in the mid-urethra, whereas the tape is located more caudally.[29] Another hypothesis would be that the tape restores some structural support of the urethra, similar to what happens in women.[29] Indeed, stress urinary incontinence in women can be explained by the "hammock hypothesis." The urethra is separated from the extra-abdominal region by a supportive layer (hammock) composed of the endopelvic fascia and the anterior vaginal wall. These structures form the layer against which the urethra is compressed closed when it is forced in a caudal direction. If the supportive tissues are firm, compression of the urethra by increases in abdominal pressure is rapid and effective. If the suburethral layer is lax and moveable, compression is not as effective, and transmission of abdominal pressure to the urethra would be decreased.[33] In our dogs, the urethral pressure curves obtained at 1 and 3 months postoperatively could lead to the hypothesis that urethral sphincter function was restored by the placement of the tape. The lack of support of the urethra has, however, not yet been investigated as a possible cause of incontinence in dogs.

Various types of minislings (also called *single-incision slings*) have recently been developed in human medicine.[34] They are inserted by a single vaginal incision and fixed to the pelvic wall tissue with special anchors without passing through the groin, therefore avoiding skin incisions.[35] Their potential advantages include a lower complication rate because the tape stops at the pelvic floor, less adverse reaction to foreign material because of the reduced length of the tape, and less pain. The short-term success rate seems comparable to the TVT-O, but long-term results may not be as favorable with some of those minislings, probably because it is more difficult to adjust tension on those tapes.[35]

The major limitation of the present study is the low number of cases. A higher number of cases would obviously be required to reach a conclusion on the efficacy of the TVT-O, especially with the potential learning curve of the procedure. Montera et al[36] evaluated the learning curve of a resident surgeon performing transobturator tape procedures for stress urinary incontinence in women. Ten procedures were required for a resident surgeon to learn the TVT-O procedure. In our study, all the surgical procedures were performed by 1 board-certified surgeon (SC) who had performed the TVT-O in 12 canine cadavers and 2 continent beagle dogs before the clinical cases.[28] Our results are therefore probably not related to inexperience of the surgeon. Other limitations include the retrospective nature of the study and the subjective nature of owner questionnaires. We decided to use the 3-degree score described by Noël et al[31] because we found it less subjective than more complex scores such as a 10-degree score previously described.[19] In the context of a long-term telephone questionnaire, it may be difficult for owners to remember details regarding the degree of their dog's incontinence that may have occurred many years ago. A simplified score (incontinent, continent, or continent with sporadic episodes of incontinence) was easier to assign from owners' answers.

In conclusion, recurrence is common after TVT-O placement in dogs. However, addition of medical treatment can result in continence in 80% of the dogs. USMI is a multifactorial condition, and its treatment remains challenging. TVT-O is one of the options available for the surgical management of USMI in dogs. It is less invasive than standard surgical techniques requiring an abdominal approach, and it has not been associated with postoperative complications in a limited number of cases.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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