Retrograde catheterization of the urinary bladder in healthy male goats by use of angiographic catheters

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OBJECTIVE
To identify and evaluate 3 types of angiographic catheters for retrograde urinary bladder catheterization in healthy male goats.

ANIMALS
12 sexually intact yearling Alpine-cross bucks.

PROCEDURES
Three 5F angiographic catheters of the same length (100 cm) and diameter (0.17 cm) but differing in curvature at the tip were labeled A (straight tip), B (tip bent in 1 place), and C (tip bent in 2 places). During a single anesthetic episode, attempts were made to blindly pass each catheter into the urinary bladder of each goat. Order of catheters used was randomized, and the veterinarian passing the catheter was blinded as to catheter identity. The total number of attempts at catheter passage and the total number of successful attempts were recorded.

RESULTS
Catheter A was unsuccessfully passed in all 12 goats, catheter B was successfully passed in 8 goats, and catheter C was successfully passed in 4 goats. The success rate for catheter B was significantly greater than that for catheter A; however, no significant difference was identified between catheters B and C or catheters A and C.

CONCLUSIONS AND CLINICAL RELEVANCE
2 angiographic catheters were identified that could be successfully, blindly advanced in a retrograde direction into the urinary bladder of healthy sexually intact male goats. Such catheters may be useful for determining urethral patency, emptying the urinary bladder, and instilling chemolysing agents in goats with clinical obstructive urolithiasis. (*Am J Vet Res* 2016;77:1295–1299)

Retrograde catheterization of the urinary bladder is a common, straightforward, and essential procedure in the management of many disorders of the urinary tract in most animal species. The procedure is used to obtain urine samples for analysis, allow decompression of the bladder, and facilitate contrast imaging of the lower urinary tract. Urinary catheterization is of particular importance in male small ruminants for determining the patency of the urethra and during attempts to dislodge obstructing uroliths.

Urinary bladder catheterization in male artiodactyl species is considered impossible with conventional straight-tipped catheters because of the presence of a urethral recess.[1] In small ruminants, this recess is located within the caudal portion of the urethral wall at the level of the ischiatic arch and is approximately 0.5 cm deep.[2] Ultrasmall-diameter endoscopes (outer diameter, 2.5 to 2.8 mm) can be used to visually examine the junction of the urethral recess and the more proximal urethra. A guidewire can be passed via the endoscope into the proximal portion of the urethra and urinary bladder, then the scope is withdrawn and a catheter is placed over the wire into the proximal portion of the urethra and bladder. Many endoscopes of sufficiently small size are not long enough to reach the urethral recess. Such small-diameter, longer endoscopes (nephropyeloscopes) are expensive, fragile, and not conducive to use in large animal veterinary practice. Also, a guidewire that is more than twice the length of the endoscope is required to complete the procedure.

Alternatively, a curved tipped catheter can be used to bypass the urethral recess. Thus far, reports on such use in ruminants have been limited to a single report[3] of urinary bladder catheterization. In that report, a human femoral angiography catheter with a curved tip was successfully passed into the urinary bladder of a healthy goat, a healthy calf, and 3 dysuric goats; however, all catheters were passed under fluoroscopic guidance. Although that reported study[3] was limited in scope, it provided evidence that it is possible to pass a urinary catheter into the urinary bladder of a goat in a retrograde direction by use of a catheter with a curved tip.

In the authors' clinical experience with using various human angiographic catheters in small ruminants, some tip configurations can be passed without fluoroscopic guidance and successfully bypass the urethral recess with minimal manipulation, whereas

other catheters are less useful for this purpose. Additionally, some of the catheters used by the authors in the past would be considered cost-prohibitive for routine use. After discovering some moderate-length angiographic catheters that were fairly economical, we chose to evaluate various catheter designs for their suitability for a blind approach to cystic catheterization in male goats.

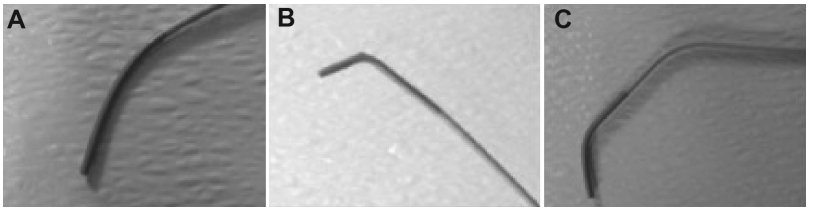

Figure 1—Photographs of the tip of 3 types of angiographic catheters (A, B, and C) evaluated for use in retrograde catheterization of the urinary bladder in goats.

The purpose of the study reported here was to identify and evaluate 3 types of angiographic catheters for retrograde urinary bladder catheterization in healthy male goats. The selected catheters differed in severity of the angle and length of curvature of the tip. We hypothesized that it would be impossible to blindly pass a straight catheter into the urinary bladder and possible to blindly pass 2 other types of curved-tip angiographic catheters retrograde up the urethra and into the urinary bladder of male goats. The primary objective was to determine whether an angiographic catheter could be blindly used for retrograde catheterization of the urinary bladder in male goats. Additional objectives were to assess whether one type of catheter could be passed more readily than the others and whether clinical experience would have an impact on the success of urinary bladder catheterization.

Materials and Methods

Animals

Twelve healthy sexually intact yearling Alpine-cross bucks with a mean body weight of 36 kg (range, 30 to 42 kg) were purchased from a single farm for use in the study. The goats had no history of urinary tract disorders, and results of physical examination and urinalysis were unremarkable. Each goat was randomly assigned to 1 of 3 groups by drawing of cards, with each group housed in a separate pen. The urethral process of each goat had been amputated prior to initiation of the study. The Institutional Animal Care and Use Committee at Oklahoma State University approved all procedures performed.

Angiographic catheters

Three types of commercially available angiographic catheters (all 5F) were selected and identified as catheter A[a], B,[b] and C[c] **(Figure 1)**. Catheters were all of the same diameter (0.17 cm), color, and length (100 cm) and were indistinguishable except for the curvature of the tip. Catheter A had a straight tip and was selected as a control catheter that was believed would not bypass the urethral recess. Catheter B had a single bend at the tip, and catheter C had a double bend.

Preparation for catheterization

During a single anesthetic episode, each of the 12 goats underwent 3 attempts at catheterization (1 for each of the 3 catheter types). Order of catheter passage (A, B, or C) was assigned via a block design to ensure that the number of first passage opportunities was equal for all 3 catheter types. Catheterization was performed over a 48-hour period; 6 goats underwent catheterization (2 by a moderately experienced clinician and 4 by a highly experienced clinician) in the first 24 hours, and another 6 goats underwent catheterization (2 by a highly experienced clinician and 4 by a moderately experienced clinician) in the second 24 hours.

Food was withheld from goats for 24 hours prior to catheterization. For the procedure, each goat was sedated with a combination of diazepam (0.2 mg/kg, IV), butorphanol (0.1 mg/kg, IV), and ketamine (4 mg/kg, IM). Lumbosacral epidural anesthesia was aseptically provided by use of an 18-gauge, 5-cm needle and 2% lidocaine solution (1 mL/6.8 kg). Each goat was maintained in sternal recumbency for 5 minutes and then positioned in left lateral recumbency, after which the penis was exteriorized and aseptically prepared.

Two clinicians were chosen to perform the catheterizations on the basis of their different degrees of experience passing urinary catheters in goats, as determined by the number of years in food animal practice (high degree of experience, > 20 years; moderate, 5 years). An assistant prepared the catheters, timed the catheter attempts, and ensured that the clinicians were blinded as to which catheter was being passed. In preparation for passage of each catheter, a guidewire (diameter, 0.035 cm; length, 100 cm) was initially inserted to straighten the tip to the level of the urethral recess, which also helped to blind the clinicians to catheter identity.

Catheterization

Clinicians passed a 3.5F closed-ended tomcat catheter into the distal portion of the urethra of each assigned goat. Approximately 2 mL of an equal mixture of sterile saline (0.9% NaCl) solution and sterile surgical lubricant[d] was infused through that catheter into the distal portion of the urethra to provide distention and lubrication prior to test catheterization. The tomcat catheter was then withdrawn.

The assistant oriented the angiographic catheter containing the guidewire in such a way that the curvature of the tip was in the plane of the urethral recess, with the direction of the tip in a craniodorsal

position. Once the catheter tip reached the urethral recess, a sterile surgical marker was used to make an external mark on the catheter at the level of the glans penis. A sterile ruler was then used to withdraw the catheter from the urethra 6 cm from the mark made at the level of the glans penis. The guidewire was withdrawn 4 cm, allowing for curvature of the catheter tip if present. The catheter was then handed by the assistant to the clinician.

The assistant used a stopwatch to allow the clinician 30 seconds to advance the catheter into the urinary bladder. This was done by moving the catheter in and out of the urethra with a stroke length of approximately 6 cm, making slight changes in the rotational position of the catheter with each attempt. An attempt was defined as a single movement of the catheter that either resulted in the catheter lodging within the urethral recess or bypassing the recess and entering the urinary bladder. Attempts to pass the catheter were terminated at the end of the 30-second period or when the catheter advanced into the urinary bladder. Total number of attempts to pass the catheter was recorded for each catheter evaluated. To ensure that the catheter was in the urinary bladder, the guidewire was removed and a 3-mL syringe was used to aspirate urine from the bladder.

Once attempts had been made to pass all 3 catheters, goats were moved to small crates for recovery where they were maintained in sternal recumbency until they could fully stand. All goats were observed for signs of dysuria between 6 and 12 hours after the procedure and were monitored every 12 hours thereafter until they were no longer dysuric. Dysuria was defined as straining to urinate, vocalizing while urinating, and stamping feet while urinating.

Statistical analysis

A 3 X 2 contingency table was created, and the χ^2 test was used to compare proportions of successful or failed catheterization attempts among the 3 catheter types. Bonferroni correction was performed to account for multiple comparisons after a significant association was identified. Two-way comparisons among catheter types were performed by use of the Fisher exact test and Bonferroni correction. The Mann-Whitney *U* test was used to determine whether a difference existed in number of overall successful attempts at catheterization among catheters. Values of $P < 0.05$ were considered significant.

Results

Each catheter type was used once in each of 12 goats. Therefore, each catheter type was used a total of 12 times in the study. The number of goats in which attempts to pass the urinary catheter during the 30-second period were successful was the same for both the operator with a moderate amount of experience with urinary catheterization of goats and the operator with a high amount of experience: 0 of 6 goats for catheter A (straight), 4 of 6 goats for catheter B (single curvature), and 2 of 6 goats for catheter C (double curvature). Thus, the overall success rates were 0 of 12 for catheter A, 8/12 for catheter B, and 4 of 12 for catheter C. The overall difference between catheters A and B was significant ($P = 0.001$) but was not significant between catheters B and C ($P = 0.22$) or catheters A and C ($P = 0.09$).

Median number of attempts made by the moderately experienced clinician (n = 5 goats) and highly experienced clinician (6 goats) within the 30-second period to pass catheter A was 40 and 48.5, respectively, to pass catheter B was 12 and 11, and to pass catheter C was 26 and 38.5. These values did not differ significantly between clinicians. The number of attempts made by the moderately experienced clinician for 1 goat was not recorded. The median number of attempts made by both clinicians for goats in which successful catheterization was achieved was 4 (range, 1 to 26; n = 7 goats) for catheter B and 8 (range, 1 to 29; 3 goats) for catheter C ($P = 0.73$). Successful passage involved significantly ($P < 0.001$) fewer attempts (median, 6) than did unsuccessful passage (median, 25.5).

To determine the effect of repeated catheterization on success of a given catheter, catheter evaluation order was analyzed. Again, passage of catheter A failed in all goats, regardless of evaluation order. Passage of catheter B was successful in 2 of 4 goats when used first, 4 of 4 goats when used second, and 2 of 4 goats when used third ($P = 0.22$). Passage of catheter C was successful in 0 of 4 goats when used first, 2 of 4 goats when used second, and 2 of 4 goats when used third ($P = 0.22$). There was no discernible effect of evaluation order on outcome.

Discussion

The purpose of the present study was to evaluate the feasibility of passing different types of angiographic catheters to facilitate blind retrograde catheterization of the urinary bladder in male goats. To the authors' knowledge, only 1 previous report[3] exists involving 1 type of angiographic catheter for retrograde urethral catheterization with fluoroscopic guidance in a small number of goats. Results of the present study indicated that blind retrograde urethral catheterization of the urinary bladder was possible with 2 types of curve-tipped angiographic catheters.

The 3 different angiographic catheters used in the present study were selected on the basis of their degree of curvature at the tip, cost, and availability to practitioners. Our clinical experience before the study began suggested that the greater the curvature of the tip, the more likely the catheter would successfully bypass the urethral recess and enter the urinary bladder. The degree of the bend (regardless of whether there was 1 bend or 2) was most acute in catheter B. Therefore, curvature of the catheter tips from straight to most acute was A, C, and B.

As expected, catheter B was significantly more likely to advance into the urinary bladder than was

catheter A, the control catheter. The lack of a significant difference between catheters B and C was unexpected. Clinical experience with catheter B suggested to us that it should have been superior to catheter C, and indeed, successful catheterization was achieved in 8 of the 12 goats with catheter B versus 4 goats with catheter C. Although it is possible that there truly was no significant difference, our best explanation for the lack of a significant difference between these 2 types of catheters was the small number of goats used in this study.

To limit the influence of confounding variables on the study findings, goats were selected of the same age and breed, purchased from the same farm, housed identically, and received the same feed. However, this uniformity may have decreased the external validity for application to goats of other breeds and sizes, managed in different ways.

In addition to the angiographic catheters themselves, the experience of the clinician performing the catheterization was also evaluated in the present study. To maximize the probability of successful catheterization, 1 clinician with a moderate degree of experience and another with a high degree were used. Interestingly, no significant difference between these 2 clinicians was identified. This finding was not expected because in the authors' clinical impression, more experienced clinicians typically have greater success in passing urinary catheters than do less experienced clinicians.

Factors that may have contributed to the success of catheter passage in the present study included distention lubrication of the distal urethra, insertion of a stylet within the catheter, and provision of a lumbosacral epidural anesthesia. The effect from the lubrication not only decreased drag on the catheter but also may have resulted in mild dilation of the proximal aspect of the urethra, facilitating passage of the catheter. However, ultrasonographic evaluation of the diameters of the distal and proximal portions of the urethra before and after instillation of lubricant would be needed to confirm this possibility.

The stylet allowed the curve in each of the catheters to be straightened during introduction of the catheter into the distal portion of the urethra. When the catheters were advanced aggressively without a stylet, the curvature of the catheter generally folded over on itself, likely traumatizing the urethral mucosa. Insertion of a stylet and judicious advancement of the catheter was intended to limit urothelial abrasions by the catheter.

The lumbosacral epidural anesthesia provided complete relaxation of the penis and peripenile tissue, which facilitated exteriorization of the penis. In addition, it provided analgesia to the area and immobilized the hind limbs, which prevented the goats from struggling during the procedure. When catheters are passed without lumbosacral epidural anesthesia, goats can strain during the procedure. Our clinical impression has been that straining of the goat during catheterization increases the likelihood of the catheter bypassing the urethral recess. Therefore, it is possible that provision of lumbosacral epidural anesthesia may have actually decreased the success of the catheters by preventing straining. Additional studies are needed to test this hypothesis.

The angled shape of the curved angiographic catheters evaluated in the present study may lead to injury of the urothelium with repeated passage, particularly in an inflamed urethra as is commonly encountered in animals with obstructive urolithiasis. Additionally, the catheters evaluated are designed for intravascular use. Whether prolonged contact between the catheter and the urothelium might induce irritation or injury is unknown. Catheters were not left in place in the study, nor have the authors used them as in-dwelling catheters in clinical applications. The catheters have been used to drain a distended urinary bladder to alleviate the emergency nature of urinary obstruction and to instill chemolytic agents in goats for which surgical urinary diversion is not a financial option. A suggestion to decrease trauma to the distal portion of the urethra when using these catheters and to ease their passage is to use a stylet to straighten the catheter tip.

Obstructive urolithiasis is a serious disease of small ruminants.[4–6] The ability to determine the patency of the urethra can be helpful when treating animals in which obstructive urolithiasis is suspected. One way to effectively determine the patency of the urethra is by passing a catheter up to or beyond the level of the urethral recess into the urinary bladder. Catheters B and C in the present study could be used for this purpose. The authors have used catheter B effectively in clinical situations to determine urethral patency and to relieve urinary bladder distention for prevention of immediate surgical intervention. We have also used catheter B to instill chemolytic agents in patients in which such agents could be safely administered (ie, those with an intact urinary bladder). However, because the goats used in the present study were healthy males, the ability to generalize our findings to goats with obstructive urolithiasis is limited. An additional consideration is the fact that the goats used were sexually intact males, which would likely have had a larger urethral diameter than would goats castrated at an early age.[7] Additional studies are needed to evaluate the efficacy of these catheters in a larger number of small ruminants, including those with clinical obstructive urolithiasis.

Acknowledgments

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Footnotes

a. Imager II 5F selective catheter GEN (1.70 mm), Boston Scientific, Marlborough, Mass.
b. Imager II 5F selective catheter Bern (1.70 mm), Boston Scientific, Marlborough, Mass.
c. Imager II 5F selective catheter H1 (1.70 mm), Boston Scientific, Marlborough, Mass.

d. Surgilube, Savage Laboratories, Fougera Pharmaceuticals Inc, Melville, NY.

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