

STANDARD ARTICLE

Outcome and complications in goats treated by perineal urethrostomy for obstructive urolithiasis: 25 cases (2010-2017)

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Background: Obstructive urolithiasis commonly affects male goats. Perineal urethrostomy (PU) can be a permanent treatment option but is generally considered undesirable because of the risk of stricture of the urethral stoma. Limited information exists regarding long-term outcome and complications in goats undergoing PU for treatment of obstructive urolithiasis.

Objectives: To determine short-term and long-term outcome and complications in goats undergoing PU for treatment of obstructive urolithiasis.

Animals: Twenty-five client-owned goats.

Methods: Multi-institutional retrospective case series.

Results: Of the 25 goats, 13 (52%) were alive at the time of follow-up. Mean time from surgery to follow-up was 34 months (range, 4-65). Nine goats (36%) died between discharge and follow-up with a mean survival time of 46 days (range, 5-120). Cause of death in 7 of 9 (78%) goats was related to urolithiasis. Goats treated by use of a modified proximal perineal urethrostomy (MPPU) were significantly more likely to survive at least 150 days postoperatively ($P < .01$). The most common postoperative complications were hemorrhage (10/25 [40%]) and surgical site infection (3/25 [12%]). Hemorrhage was significantly associated with MPPU ($P < .0001$). Stricture of the surgical stoma occurred in 7 of 22 (32%) discharged goats. Mean time to stricture was 65 days (range, 10-240).

Conclusions and Clinical Importance: Perineal urethrostomy can provide effective long-term resolution of obstructive urolithiasis in goats. Re-obstruction or stricture seems most likely within the 1st 2 months after surgery. MPPU may provide better long-term results but should be approached cautiously because it can be associated with life-threatening hemorrhage.

KEYWORDS

caprine, obstruction, urethrostomy, urinary

1 | INTRODUCTION

Obstructive urolithiasis is a common condition in male goats. With the increasing popularity of goats as pets, veterinarians frequently are faced with the challenge of providing a treatment option for obstructed goats that maximizes the long-term survival and comfort of the animal. Determining the most appropriate method of treatment requires careful consideration of many factors, and no single approach

is best in all cases.¹ Perineal urethrostomy (PU) provides a permanent alternative mode of urinary egress but generally is considered an unattractive long-term solution for goats because of complications including stricture of the urethral stoma, urine scalding, and cystitis.²⁻⁴ Treatment of obstructive urolithiasis in goats frequently requires multiple surgical interventions for many reasons including displacement of the cystostomy tube from the urinary bladder, re-obstruction, and persistent urethral obstruction.⁵ In cases where other surgical or medical treatment options have failed, PU can provide resolution of urinary obstruction. Other indications for PU include animals with

Abbreviations: MPPU, modified proximal perineal urethrostomy; PU, perineal urethrostomy.

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evidence of urethral rupture, urethral stricture, or urethral obstruction with multiple stones that are not conducive to dissolution with urine acidification. Limited long-term follow-up information is available regarding complications and outcome of goats treated by PU for obstructive urolithiasis.^{2,4,6} Reported survival in goats 1 year after PU is highly variable and ranges from 3 of 18 to 9 of 10 animals.^{2,4,6} The purpose of our study was to determine long-term survival (>1 year) and complications in goats treated by PU. We hypothesized that PU can provide an effective surgical option for long-term recovery for goats with obstructive urolithiasis.

2 | MATERIALS AND METHODS

2.1 | Criteria for case selection

Medical records of all goats admitted to 4 veterinary medical teaching hospitals between January 2010 and July 2017 were reviewed. Goats that underwent PU for treatment of obstructive urolithiasis and owners of which could be contacted for follow-up were included.

2.2 | Medical records review

The following information was gathered from the medical records: signalment, body weight, admission date, duration of hospitalization, dietary history, onset of clinical signs of urinary obstruction before presentation, previous treatment for urinary obstruction, surgical procedure, perioperative complications, and date and cause of death.

2.3 | Follow-up information

Follow-up information was obtained by telephone interview with owners. Owners were asked if the goat had experienced any complications related to the PU including stricture, urine scalding, cystitis, re-obstruction, and infection. If the goat had experienced stricture, information was obtained regarding the time to development of the stricture relative to the PU, any treatment sought, and the outcome of such treatment. If the goat died, they were asked for details regarding death to determine if it was related to urolithiasis.

2.4 | Statistical analysis

Descriptive statistics were calculated for the data. The Shapiro-Wilk test showed the data to be non-normally distributed and thus median (range) is reported. A Fisher's exact test was used to examine the association between PU surgical approach (modified proximal perineal urethrostomy [MPPU] versus traditional high or low PU) and complications and survival.

3 | RESULTS

3.1 | Animals

Twenty-five goats underwent PU and met the inclusion criteria for the study. The cases came from 4 university hospitals: Kansas State University (n = 4), University of Missouri (n = 6), Oklahoma State

University (n = 9), and Texas A&M University (n = 6). One goat, from the University of Missouri, was lost to follow-up and excluded.

All of the goats were male, 20 Wethers and 5 Bucks. Breed distribution of goats included 13 Boer or Boer crosses, 5 Pygmy or Pygmy crosses, 3 Anglo Nubians, 2 Nigerian Dwarfs, 1 Alpine, and 1 Oberhasli. The median age of the goats was 20 months (range, 3 months to 11 years). The median weight of the goats was 46 kg (range, 11-110 kg).

3.2 | History

Of the goats, 20 of 25 had received ≥ 1 previous treatments for obstructive urolithiasis. Previous treatments included urine acidification with PO ammonium chloride (3), urethral process amputation (12), retrograde urethral catheterization and irrigation (3), cystocentesis with instillation of Walpole's solution (6), laser lithotripsy (1), ultrasound-guided percutaneous catheterization of the urinary bladder (2), tube cystostomy (10), bladder marsupialization (1), and PU (3).

The median time from onset of clinical signs to hospital admission was 2 days (range, <1-12 days). PU surgery was performed within 24 hours of admission in 16 of 25 (64%) cases. In 9 of 25 (36%) cases, PU surgery was delayed, although the goat received initial surgical treatment by tube cystostomy (8/9) or bladder marsupialization (1/9). For these 9 goats, the mean time between admission and PU surgery was 13 days (range, 2-33 days). Of the 21 goats for which dietary information was available, 15 (71%) were fed some form of grain or concentrate, 4 (19%) received alfalfa hay as a portion of the diet, and 7 (33%) were fed exclusively grass hay or pasture grass.

3.3 | Treatment

Three different PU surgical approaches were used. Eleven goats (11/25 [44%]) were treated by MPPU.⁶ The remaining 14 goats were treated using a high or low PU with the urethral mucosa spatulated to the skin in 7 (7/28 [28%]) and the stump of the transected penis sutured to the skin without any spatulation of the urethral mucosa in the remaining 7 (7/25 [28%]).^{7,8} The MPPU approach was used at 3 institutions. All 4 institutions reported performing at least 1 high or low PU with spatulation of the urethral mucosa, whereas 2 institutions used a high or low approach without any spatulation of the urethral mucosa. The median duration of hospitalization was 8 days (range, 0-41 days). Three goats died before discharge from the hospital. Of the goats that survived to discharge, 12 (12/22 [55%]) goats were released with instructions to be given either ammonium chloride (AniMed ACH Products, Inc, Winchester, Kentucky) or a rumen fermentation enhancer (AniMed ACH Products, Inc) to promote urine acidification.

3.4 | Postoperative complications

The most common postoperative complications were hemorrhage (10/25 [40%]), surgical site infection (3/25 [12%]), and re-obstruction of the proximal urethra (2/25 [8%]; Table 1). Hemorrhage was significantly associated with MPPU ($P < .0001$). Hemorrhage was reported in 8 of 11 (73%) goats that had MPPU performed and was severe enough to require blood transfusion in 2 of the goats. Three goats (3/25 [12%]) did not survive to discharge. Two goats were euthanized

TABLE 1 Complications reported in goats treated with PU for obstructive urolithiasis

	Number affected	Complications	Number affected
Traditional high or low PU (n = 14)	2	Hemorrhage	8
	1	Surgical site infection	0
MPPU (n = 11)	3	Re-obstruction proximally	2
	4	Stricture of urethral stoma	3
	0	Wet rear limbs	4
	5	Urine scald	1
	2	Cystitis	0
	1	Renal failure	0
	6	Death related to urolithiasis	1

Abbreviations: MPPU, modified proximal perineal urethrostomy; PU, perineal urethrostomy.

at 1 and 5 days postoperatively because of re-obstruction of the proximal urethra. One goat died 10 days postoperatively from anesthetic complications during a 2nd procedure to investigate surgical site hemorrhage.

3.5 | Long-term outcome and complications

Among the 22 goats that survived to discharge, the most commonly reported complication was stricture of the surgical stoma (7/22 [32%]). The mean time to stricture of the stoma was 65 days (range, 10-240 days). Goats that had MPPU were significantly more likely to live at least 150 days without stricture of the urethral stoma ($P < .01$). Other reported complications included urine scalding (6/22 [27%]), re-obstruction of the urethra (5/22 [23%]), wetting of the rear limbs (4/22 [18%]), and cystitis (2/22 [9%]; Table 1).

Four of the 5 goats in which re-obstruction was reported were successfully treated by retrograde urethral catheterization and lavage to dislodge hard, spherical, non-dissolvable stones obstructing the proximal urethra. Of the 7 goats with urethral stricture, 6 were treated. The stricture was successfully relieved in 2 goats using balloon dilatation with 1 goat requiring 3 separate treatments at approximately 1-month intervals; 2 goats underwent revision of the PU at a more proximal location but 1 of the revised stomas formed a stricture 18 days later; 1 goat was successfully treated by catheterization of the urethral stoma; 1 goat underwent bladder marsupialization; and 1 goat was treated with ammonium chloride but continued to strain and died after hemorrhaging at the surgical site.

Nine goats (9/22 [41%]) died between the time of discharge and follow-up, with a mean survival time of 46 days (range, 5-120 days). The cause of death in 7 of 9 (78%) goats was attributable to complications from urolithiasis. Causes included renal failure (1), aspiration of ammonium chloride (1), peritonitis associated with uroabdomen (1), surgical site leakage with infection (2), and stricture of the urethral stoma (2). Mean survival time for the 7 goats that died of complications related to urolithiasis was 35 days (range, 2-120 days). In 2 of the 9 goats, the cause of death was considered unrelated to urolithiasis. One was used for exhibition at a terminal show shortly after discharge from the hospital, and 1 goat was found dead in the pasture 96 days postoperatively, and no necropsy was performed. Of the 7 goats that died of causes related to urolithiasis during the follow-up period, 2 (29%) goats lived >60 days with a mean survival of 113 days

(range, 105-120 days), whereas 5 (71%) goats died by 60 days postoperatively, with a mean survival of 15 days (range, 2-49 days). Of the goats with no history of previous treatment for urinary obstruction, 3 of 5 (60%) goats were alive at the time of follow-up, whereas 1 goat had been euthanized because of PU surgical site infection and 1 goat died 18 days postoperatively after experiencing stricture of the PU site. The mean postoperative survival time for the 5 goats that had not previously been treated for urinary obstruction was 26.4 months (range, 18 days to 65 months) compared to 15 months (range, 2 days to 51 months) for those that received at least 1 previous treatment for urinary obstruction.

Thirteen goats were alive at the time of follow-up with a mean survival from the time of surgery of 34.5 months (range, 4-65 months). Ten of the 13 goats had survived >1 year with a mean survival time of 37.5 months (range, 18-65 months). The 3 remaining goats with midterm survival had a mean survival from surgery of 4.5 months (range, 4-5 months).

4 | DISCUSSION

We found that although the risk of complications associated with PU is high, it can be a viable long-term treatment for obstructive urolithiasis in goats, particularly those in which other treatments have failed. Two previous studies investigating the long-term outcome of sheep and goats treated by PU concluded that the procedure does not provide a favorable long-term solution in small ruminants with obstructive urolithiasis.^{2,4} In 1 of the studies, 3 of 18 (17%) animals discharged were alive 1 year postoperatively.² In contrast, the long-term outcome in the other study was better with 4 of 8 (50%) animals still alive at the time of follow-up at least 1 year later with a mean survival time of 34 months.⁴ Another previous study reported favorable long-term results using a modified surgical approach with the urethrostomy site still patent after 1 year in 9 of 10 goats.⁶ In our study, goats were treated using similar surgical techniques to those described in the previously reported studies. We hypothesized that PU can provide an effective surgical option for long-term recovery in goats with obstructive urolithiasis. Our findings support this hypothesis with 10 of 22 (45%) discharged goats surviving at least 1 year postoperatively with a mean survival of 37.5 months, and 13 of

25 (52%) goats still alive at the time of follow-up with a mean survival time of 34 months.

Although the long-term survival reported here is similar to an outcome that previously was considered unfavorable,^{2,4} the goats in those studies had either received no previous treatment for urolithiasis or conservative treatment only using amputation of the urethral process, urine acidification, or both. Unfortunately, many goats are treated by PU after other treatments have failed.⁶ In our study, 20 of 25 goats had received ≥ 1 previous treatments for obstructive urolithiasis including ultrasound-guided percutaneous catheterization of the urinary bladder (2), tube cystostomy (10), bladder marsupialization (1), and PU (3).

Unfortunately, the small number of cases in our study makes it difficult to determine whether previous treatment for urinary obstruction had a substantial effect on survival and complications. Goats in which other treatment options failed to resolve the urethral obstruction may be more likely to experience complications with subsequent PU for multiple reasons. For example, goats with calculi that are not conducive to dissolution using urine acidification and have failed to respond to treatment with tube cystostomy or bladder catheterization may be more likely to experience obstruction of a subsequent PU site by additional calculi. It is also possible that goats with a ruptured urethra receiving temporary treatment by tube cystostomy or urinary bladder catheterization sustain sufficient damage to the urethral mucosa and surrounding tissues that a subsequent PU is more likely to become infected or form a stricture. Thus, it is possible that the large number of goats in our study with a history of unsuccessful previous treatments, recurrent urinary obstruction, or both may have contributed to the rate of complications and mortality in our study. Although it is problematic to compare different surgical procedures, in the report of goats treated by vesico-preputial anastomosis, all received previous surgical treatment for urinary obstruction and 3 of 4 goats survived at least 1 year postoperatively.⁹ The goats in that study also experienced multiple complications including ascending cystitis (2/4), abscess formation (1/4), and stricture of the stoma (1/4).⁹

In our study, approximately one-third of the goats that were discharged (7/22 [32%]) died of complications associated with urolithiasis within a relatively short period of time (mean, 35 days). In 2 of these cases, the cause of death was related to stricture of the urethral stoma. Stricture of the urethral stoma is one of the most common complications goats experience after PU.^{2,4,6} A previous study reported that 8 of 18 (44%) small ruminants re-obstructed within 1-8 months after PU surgery but did not specify whether obstruction was related to stricture formation.² In our study, stricture of the stoma was the most commonly reported complication in discharged goats with a mean time to stricture of 65 days and a median of 42 days (range, 10-240 days). These findings are similar to those previously reported in 7 sheep and goats for which the median time to stricture was 104 days (range, 7-240 days).⁴ In our study, stricture of the urethral stoma was successfully treated in 5 of 7 animals but required a 2nd surgery in 2 goats. Although treatment in these cases was successful, it required an investment of time and money from the owners, which can be economically or logistically difficult. Percutaneous and surgical tube cystostomy also carry high risk of complications and failure with 10 of 10 and 13 of 25 goats in 1 report requiring a 2nd

surgical intervention because of tube displacement, persistent or recurrent obstruction, and urethral rupture.⁵ Owners considering PU should be warned that there is a risk additional procedures will be required to maintain patency of the urethral opening.

The propensity of goats to experience stricture after PU has led veterinarians to seek new surgical techniques. Multiple surgical approaches for PU are described in small ruminants.^{1,2,4,6,8,10} The more commonly described technique involves making the approach near the level of the ischial arch and either spatulating the urethral mucosa to the skin or simply suturing the transected penile stump to the skin.^{2,4,8} Although this technique is similar to that used in 14 of the goats described here, the other 11 goats had MPPU performed.⁶ The MPPU is technically challenging and carries a high risk of hemorrhage but has the advantage of providing a surgical stoma less prone to stricture.⁶ It seems likely that in our study, MPPU was selected more frequently for pet goats because longevity was a primary concern. In our study, 8 of 11 (73%) goats that underwent MPPU experienced some hemorrhage, with 2 requiring blood transfusion. However, the risk may be justifiable because the goats treated using the modified approach went a mean of 112 days without stricture compared with a mean of 29 days for the goats treated by 1 of the other 2 approaches.

Dietary changes and urine acidification are used to help prevent re-obstruction in goats with urolithiasis.³ In our study, 18 of 25 (72%) goats were fed some form of grain, alfalfa hay, or treats, which may have predisposed them to development of obstructive urolithiasis. However, no information about postoperative dietary changes was collected. Although 12 of 22 discharged goats were prescribed a urine acidifying agent, most (11/14 for which the calculus type was identified) were reported to have calcium carbonate stones, which do not respond to urine acidification. One study recommended that, whenever possible, a cystostomy followed by dietary management is a more effective long-term management strategy than PU in small ruminants.⁴ Unfortunately, cystostomy or dietary management was reported to be previously unsuccessful treatments in nearly half of the goats in our study, possibly because the obstructing uroliths were of a composition that was refractory to medical dissolution.

The mineral composition of uroliths is a critical consideration for the management of obstructive urolithiasis in goats.¹¹ As mentioned earlier, goats with non-dissolvable calculi such as calcium carbonate may be at higher risk of re-obstructing proximal to the PU site because any additional or newly formed uroliths cannot be eliminated by urine acidification. Historically, urolith analysis has not been routinely performed at the contributing institutions, but our clinical impression is that hard, non-dissolvable calculi are found in the minority of goats presenting with obstructive urolithiasis. An investigation of the mineral composition of naturally occurring uroliths in sheep and goats presented at Texas A&M University found that the most commonly encountered urolith composition was amorphous magnesium calcium phosphate in combination with struvite (39% of cases).¹² The Minnesota Urolith Center reported that goats in the Northeast, West, and Southwest geographic regions have a higher risk of developing calcium carbonate stones.¹¹ Because our patient population originated primarily from the Midwest, these goats may be at lower risk of developing calcium carbonate stones than goats from other geographic regions. Veterinarians and owners should monitor goats

with non-dissolvable calculi carefully in the days after PU because these goats appear particularly prone to re-obstruction.

In conclusion, our results corroborate previously reported outcomes for small ruminants treated by PU using different surgical techniques. Although several surgical approaches to treat obstructive urolithiasis are available and provide long-term resolution with fewer complications,^{9,10,13-15} PU remains an important treatment for goats in which other options have failed or are deemed likely to fail. Owners should be made aware of the common short- and long-term complications associated with PU so that they can make informed decisions and be alert to possibly life-threatening complications. The common perception that goats treated for obstructive urolithiasis by PU experience catastrophic stricture may be related to the emphasis of the earlier literature placed on this particular complication. As surgical and case management techniques have advanced, goats treated by PU may survive for long term, suggesting that the conventional wisdom regarding PU as a salvage procedure perhaps should be revisited. Prospective research is needed to determine the effects of surgical approach, surgeon experience, previous urolithiasis treatments, and concurrent conditions in goats treated by PU for obstructive urolithiasis.

CONFLICT OF INTEREST DECLARATION

Authors declare no conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

HUMAN ETHICS APPROVAL DECLARATION

Authors declare human ethics approval was not needed for this study.

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