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CASE REPORT

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Buccal mucosal graft urethroplasty in five male dogs with penile urethral stricture at the bulbus glandis

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Abstract

Objectives: To evaluate the feasibility of correcting penile urethral strictures at the bulbus glandis using buccal mucosal graft (BMG) urethroplasty in dogs.

Study design: Prospective clinical trial.

Animals: Five male dogs with urethral strictures located at the bulbus glandis.

Methods: Urethrotomy was performed throughout the entire length of the urethral stricture including ~0.5 cm healthy urethra proximal and distal. The scarred tissue and unhealthy mucosa of the strictured urethra were completely excised. The graft was harvested from the buccal mucosa and tubularized at the stricture site using a urethral catheter as the skeleton. The catheter was maintained for 14 days after surgery and removed when no urethral leakage was identified on a positive-contrast retrograde urethrogram. The dogs were discharged after spontaneous urination was confirmed. Six months postoperative follow-up was completed for all dogs with repeated positive contrast urethrogram and an owner questionnaire to score urinary function and quality of life.

Results: The five dogs recovered well following surgery and only one dog experienced a minor complication. All dogs were able to urinate normally after catheter removal. No evidence of leakage was identified on a 14 day postoperative retrograde positive contrast urethrogram and clinically at a median follow-up time of 182 days (range, 182–186). All owners scored the urinary function as excellent and ranked their satisfaction very high 6 months after the procedure.

Conclusion: Buccal mucosal graft urethroplasty has positive outcomes for dogs with penile urethral strictures.

1 | INTRODUCTION

Urethral stricture is a common consequence of injuries caused by urethroliths, inappropriate urethral catheterization, and other external trauma, such as pelvic fractures or surgical injury.[1] Stricture caused by congenital diseases or chronic urethritis is also occasionally observed.[2,3] Dogs with a urethral stricture often show clinical signs of stranguria, prolonged urination, and pollakiuria. Retrograde positive contrast urethrography or urethroscopy can help provide a definitive diagnosis.[4] Various surgical and non-surgical interventions have been reported regarding stricture location. Treatment options for urethral

Abbreviations: ALT, alanine aminotransferase; AUASI, American Urological Association Symptom Score; BMG, buccal mucosal graft; BUN, blood urea nitrogen; CBC, complete blood count; PDS, polydioxanone suture; QoL, quality of life; SD, standard deviation.

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TABLE 1 Sequential summary data for five dogs showing the cause and length of urethral strictures.

Dog	Signalment	Cause	Length
1	Pomeranian 8.5 kg, 11 years	Urethral catheterization	0.92 cm
2	Pomeranian 9.3 kg, 6 years 2 months	Penile urethral surgical intervention for removal of urethral calculi	0.93 cm
3	Chihuahua 12.2 kg, 9 years	Penile urethral surgical intervention for removal of urethral calculi	0.97 cm
4	Pit Bull 18.3 kg, 11 years	Penile urethral surgical intervention for removal of urethral calculi	1.10 cm
5	Mixed breed 21 kg, 6 years	Penile urethral surgical intervention for removal of urethral calculi	1.33 cm

strictures include urethral resection and primary anastomosis. The strictured part of the urethra is excised, followed by the connection of healthy urethral ends, or to perform an urethrostomy. Urethrostomy can be performed at the penile, scrotal, or perineal locations. Scrotal urethrostomy is preferred because of its relatively superficial location and minimal complications.[4] In humans and dogs, urethral balloon dilatation and stent placement at the stricture site are available as alternative treatments.[5–9] The main complications of balloon dilatation are requiring multiple dilatations with recurrence of the stricture, incontinence, weak urine stream, and urethral trauma.[5,6,10] The most frequently reported complication with urethral stent placement is the formation of granulation tissue. Recurrent stricture, stent fracture, stent migration, and tumor ingrowth have been also reported.[11–17] Various autologous tissue grafts have been used in humans to replace the damaged urethra at the stricture site. Several complications associated with different graft types including recurrent stricture, fistula, stone formation, hair growth, and graft contraction have been reported.[18,19] Bladder mucosal grafts have been associated with complications such as recipient site mucosal prolapse, bladder epithelium protrusion causing meatal stenosis and urinary obstruction, delayed wound healing at the donor site, and the requirement of a complex technical procedure to access the harvest site.[20,21] Buccal mucosal graft (BMG) has been one of the techniques commonly used for urethroplasty in humans, experimental canine studies, and published clinical case reports in cats, demonstrating highly effective and successful results, with fewer complications than those of other graft types.[22–25]

To the best of our knowledge, this is the first study to evaluate the use of BMG urethroplasty to correct penile urethral strictures at the bulbus glandis in dogs. Based on the described advantages, we hypothesized that BMG urethroplasty can be used as a primary procedure to correct penile urethral strictures in dogs.

2 | MATERIALS AND METHODS

2.1 | Case selection

The inclusion criteria for this prospective study were male dogs with urethral strictures located at the bulbus glandis, diagnosed at the Kasetsart University Veterinary Teaching Hospital Hua Hin, Thailand between 2020 and 2022 (Table 1). The dogs were prospectively enrolled in the study with written consent and participation of their respective owners. Preoperative physical examinations and complete blood count (CBC), serum creatinine, blood urea nitrogen (BUN), alanine aminotransferase (ALT), blood gas and electrolyte analysis, urinalysis, and urine microbial culture were performed for each dog according to standard practices.

All dog owners provided written consent for their animals to participate in this study according to the protocol approved by the Kasetsart University Institutional Animal Use and Care Committee (approval number: ACKU62-VET-028).

2.2 | Surgical procedures

Surgery was performed under general anesthesia. Anesthesia was induced with subcutaneous morphine (0.2 mg/kg) and intravenous alfaxalone (2 mg/kg). Isoflurane was used for anesthesia maintenance throughout the surgery with the assistance of a circular oxygen system following endotracheal intubation. A constant-rate infusion of fentanyl (10 μg/kg/h) was also administered throughout surgery. All dogs were positioned in dorsal recumbency with their pelvic limbs extended and abducted. The prepuce was washed with 0.12% chlorhexidine as an antiseptic solution and intravenous cephalexin (22 mg/kg) was used for prophylactic antibiotics. Retrograde urethral catheterization (Buster dog

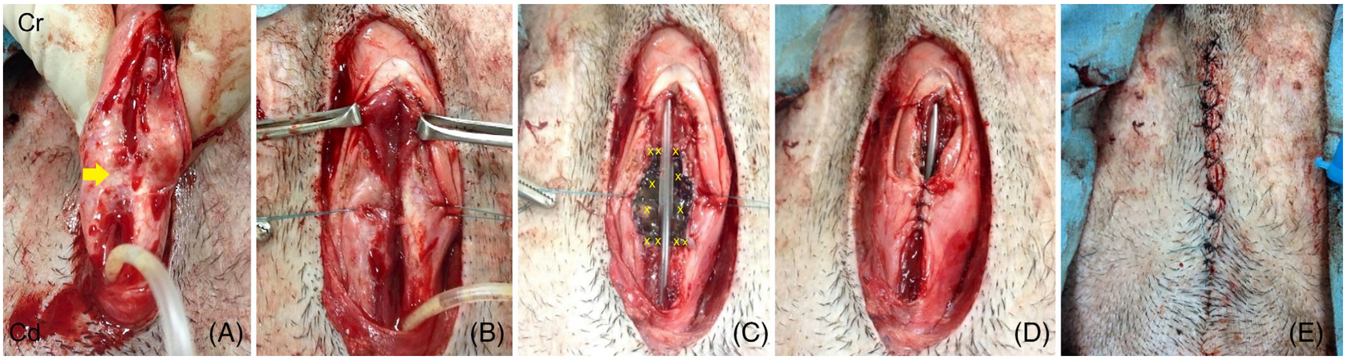

FIGURE 1 (A) An incision is shown along the ventral surface over the stricture site of the urethra (arrow). (B) Proximal and distal aspects of the entire urethral stricture area are exposed. (C) Circumferential spongioplasty is performed by embedding the buccal mucosal graft in the stricture site and connecting it to the proximal and distal healthy ends of the urethra. (D) Tubularization of the graft and urethra over an intermittent urethral catheter is performed. (E) The mucosal layer, subcutaneous tissue, and skin of prepuce are then closed.

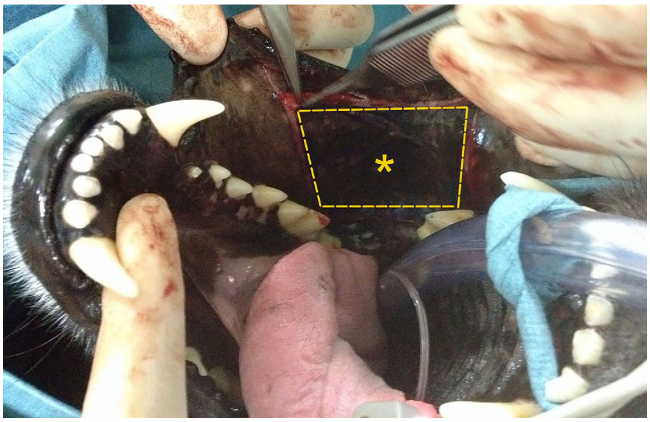

FIGURE 2 A square-shaped piece of buccal mucosal tissue (asterisk) was harvested for urethroplasty from the cheek area (dotted line).

catheter; Kruuse) was performed to identify the urethra and determine the stricture area. Midline preputial skin incisions were made proximally and distally along the urethral line. Dissection was continued through the subcutaneous tissue and the preputial mucosa to expose the penile shaft. The bulbus glandis and the corpus spongiosum were incised along the ventral surface until the urethra was fully exposed. Urethrotomy was performed by opening the urethra over the entire length of the stricture area and ~0.5 cm proximally and distally into the healthy urethra (Figure 1A). The scarred tissue and unhealthy mucosa of the strictured urethra were completely excised using Metzenbaum scissors (Figure 1B). The length of the urethral stricture site and the width of both healthy urethral ends were measured to determine the optimal BMG size required for augmentation.

2.3 | Graft harvest and application

The oral cavity was rinsed with 0.12% chlorhexidine solution to reduce oral contamination. A square piece of buccal tissue was harvested from the oral mucosal layer, using a scalpel and scissors. During harvesting, the parotid and zygomatic papillae were identified to avoid injury to the orifices and ducts of these glands (Figure 2). To account for the contracture rate of the buccal mucosa, the dimensions of the harvested graft were increased by 10% compared with the previously measured size of the urethral stricture area. The excised graft was trimmed, and the undesired fat tissue under the mucosa was removed to create a thin graft layer. Bleeding at the donor site was managed by gauze compression and was left open without suturing for second intention wound healing. The graft was soaked in 0.9% normal saline solution before being used immediately for implantation.

2.4 | Urethral reconstruction

A surgical loupe with a 2.5× magnification was used to visualize the urethroplasty procedure. To ensure proper control and optimal graft handling, stay sutures were initially placed at both ends of the graft. The mucosal layer of the graft was placed on the corpus spongiosum and bulbus glandis, covering the stricture area. To achieve proper alignment and manipulation, anastomoses were performed at both ends of the graft with healthy urethral segments. This was accomplished by using a simple interrupted pattern with 5-0 polydioxanone (PDS; Johnson & Johnson International), allowing for appropriate apposition and graft stretching. To minimize the dead space and promote successful engraftment, the buccal mucosa was secured using simple interrupted suture pattern with intermittent tacking of the underlying corpus spongiosus and bulbus glandis (Figure 1C). A preguided intermittent urethral catheter was placed across the repair area and used as a tube-shaped core to form the structure. Thereafter, tubularization of the graft and lateral borders of the urethra was performed over the catheter with 5-0 polydioxanone using an interrupted pattern to create the urethral lumen. The corpus spongiosum and bulbus glandis mucosa were closed with several simple interrupted sutures, and the graft was fixed to the corpus spongiosum with 5-0 polydioxanone using a simple interrupted pattern to provide sufficient blood supply to the graft (Figure 1D). The mucosal layer of the prepuce and the subcutaneous layer were sutured with 4-0 polydioxanone (PDS; Johnson & Johnson International) using a simple continuous pattern. The skin was closed with a 4-0 polyamide monofilament suture (Dafilon; B. Braun Surgical), in a cross-mattress pattern (Figure 1E). The catheter was attached to the prepuce using a Chinese finger trap pattern with 4-0 polyamide monofilament suture.

2.5 | Postoperative management

Postoperatively, amoxicillin-clavulanate (15 mg/kg) was administered orally every 12 h for 2 weeks as an empirical broad-spectrum antibiotic. Morphine was administered subcutaneously every 4–6 h for three consecutive days, and carprofen (4.4 mg/kg) was administered orally every 24 h for the following 5 days for pain management. An Elizabethan collar was fitted to all dogs immediately after recovery from anesthesia to prevent self-mutilation of the surgical site. The clinical signs and vital parameters (including heart rate, respiratory rate, mucous membrane characteristics, capillary refill time, and rectal temperature) of each dog were monitored, and daily observations regarding bladder distention and healing at the graft donor site (via oral examination) were recorded. Clinicopathological tests were repeated three days postoperatively. The catheter was left in place for 2 weeks to bridge the reconstruction site and reduce the risk of wound healing complications secondary to urine leakage and scalding. The urine output from a closed urinary system, in which the catheter was connected to a urine collection bag, was monitored every 4 h. A retrograde positive contrast study using iohexol (300 mg I/mL) (Omnipaque; GE Healthcare Thailand), diluted 50:50 with sterile saline at a dose of 5 mL/kg, was performed 2 weeks after surgery on all dogs to confirm the absence of leakage at the surgical site, after which the catheter was removed. After catheter removal, spontaneous urination and urinary bladder distension were monitored every 6 h by observation, urinary bladder palpation, and ultrasonography (once daily). All dogs were discharged three days after the urinary catheter removal and confirmation of spontaneous urination. The hospitalization duration for all dogs was 17 days.

2.6 | Follow-up

A second positive contrast retrograde urethrography was performed at 6 months postoperatively on all dogs. Dog owners were interviewed regarding the smoothness of urination using a modified version of the American Urological Association Symptom Score (AUASI) questionnaire,[26] which evaluates the frequency, intermittency, incontinency, weak stream, and straining of urination. Scores ranged from 0 to 5; a total score of 1–5 was excellent, 6–12 was good, and 13–25 was poor. The quality of life (QoL) score for each dog[27] as evaluated by its owner, varying from "delighted" to "unhappy", was also recorded.

3 | RESULTS

3.1 | Animals

Five male dogs were included in this study including three neutered and two intact dogs. These dogs presented with symptoms including urinary incontinence, hematuria, and stranguria. A definitive diagnosis of penile urethral stricture at the bulbus glandis was made based on retrograde positive contrast urethrography using iohexol (Figure 3A). The cause of the penile urethral stricture located at the bulbus glandis was urethral catheterization in one dog (Dog 1) and penile urethral surgical intervention for the removal of urethral calculi in four dogs (Dogs 2, 3, 4, and 5). The clinical signs reported by the owners were stranguria, prolonged urination, and outflow incontinence (all dogs). On physical examination before surgery, one dog exhibited abdominal pain along with a palpable urinary bladder, and mild bladder enlargement on ultrasonography (Dog 5). Preoperative blood examination results (±SD) of the mean complete blood cell count among all dogs were 15264.00 ± 2418.10 cells/μL (reference interval, 5050.00–16760.00 cells/μL). The mean BUN and creatinine concentration values among all dogs were 30.80 ± 4.14 mg/dL (reference interval, 7.00–27.00 mg/dL) and 1.58 ± 0.25 mg/dL (reference interval, 0.50–1.80 mg/dL), respectively. Blood gas and electrolyte analysis results were unremarkable. Negative urine cultures were observed for all dogs. The lengths of the strictures ranged from 0.92 to 1.33 cm. The mean length of the stricture was 1.01 ± 0.18 cm.

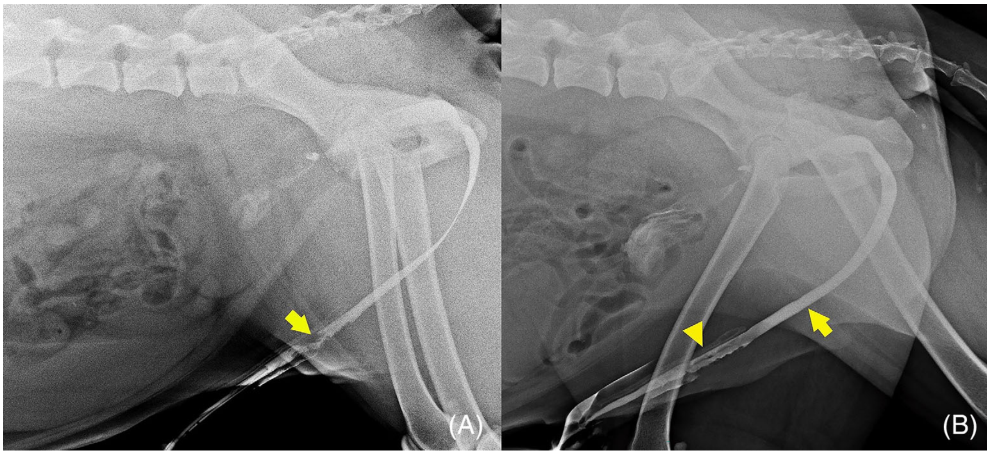

FIGURE 3 (A) A penile urethral stricture at the bulbus glandis (arrow) was identified on a lateral retrograde positive contrast urethrogram. No leakage along the urethral graft area was identified via positive contrast radiography 6 months after surgery. (B) The diameter of the buccal mucosal graft urethral segment (yellow arrowhead) is compared to the adjacent urethra (yellow arrow).

3.2 | Urethral reconstruction and outcome

All dogs recovered from anesthesia without any unexpected events. Postoperatively, four dogs (Dogs 2, 3, 4, and 5) showed good wound healing without wound dehiscence or complications at the surgical site. One dog (Dog 1) experienced bruising and swelling in the surgical area, including the penis, which healed well within 2 weeks. All dogs ate normally 1 day after the operation. The urine output values for all dogs were between 1.43 and 1.90 mL/kg/h (reference range, 1.00–2.00 mL/kg/h). Proper wound healing at the harvested BMG donor site was observed in all dogs within 1 week after surgery. Unremarkable clinicopathological results were obtained by blood gas and electrolyte analyses. The skin sutures were removed on postoperative day 10. Neither urethral stricture nor urine leakage along the area of the graft were identified on retrograde positive contrast urethrography 2 weeks postoperatively, after which the indwelling catheter was removed. All dogs were able to urinate without any apparent complications, such as dysuria or stranguria.

3.3 | Follow-up

At a median follow-up of 182 days (range, 182–186), ~6 months after surgery, the dogs had no urethral stricture or any urethral abnormalities on the retrograde positive contrast urethrography. The diameter of the urethra where the graft was placed was compared with that of the adjacent normal urethral parts, and minimal differences were observed (Figure 3B). The mean percentage (±SD) decrease in the adjacent urethral luminal diameter was 10.04% ± 0.05%. All dogs were able to urinate without difficulty. Interviews with dog owners were conducted to determine the scores for urination difficulty (AUASI) and QoL. The results of the AUASI questionnaire are presented in Table 2; all the dogs had a score of 0 (normal urination). Excellent score index values were obtained for each dog from the overall evaluation. The QoL scores for each dog are presented in Table 3, with QoL scores reported as “delighted”.

4 | DISCUSSION

Buccal mucosal grafts were successfully used to repair penile urethral strictures at the bulbus glandis of male dogs. Based on clinical and radiographic assessments, only one minor complication was observed, namely bruising and swelling in the surgical area. No major complications were encountered.

The location and size of the stricture resulted in difficulty in providing correction in these dogs because its structure was located at the ventral groove of the os penis, where the penile bone restricts urethral expansion. These factors limit urethral mobilization for anastomosis. A scrotal urethrostomy is commonly chosen as the standard procedure for a urethral stricture in this location, and is generally associated with minimal side effects, including hemorrhage and stricture formation. However, a notable disadvantage is that scrotal urethrostomy requires the neutering of dogs, which can occasionally be objectionable by owners.

Treatment via balloon dilation has been described for dogs with urethral strictures with reported adverse effects.[28] To the best of our knowledge, there are no other reports of dogs with urethral strictures at the bulbus glandis that have been managed using balloon dilation. The successful use of nitinol urethral stents for the treatment of traumatic penile urethral strictures in dogs has also been reported.[28] However, limited urethral expansion due to physical restrictions associated with the os penis, development of polypoid tissue and restenosis at the stent ends have been reported as complications.

TABLE 2 Modified American urological association symptom score index (AUASI).

Urinary symptoms	Not at all	About 1 time in 5	About 1 time in 3	About 1 time in 2	About 2 times in 3	Almost always
1. Frequency	0	1	2	3	4	5
How often has your dog had to urinate again less than 2 h after he finished urinating?						
2. Intermittency	0	1	2	3	4	5
How often has your dog stopped and started again several times when he urinates?						
3. Incontinency	0	1	2	3	4	5
How often has your dog shown inability to control urination?						
4. Weak stream	0	1	2	3	4	5
How often has your dog had a weak urinary stream?						
5. Straining	0	1	2	3	4	5
How often has your dog had to push or strain to begin urination?						

Note: Total score 1–7 = excellent; 8–19 = good; 20–35 = poor.

TABLE 3 Modified quality of life score. How would you feel if your dog had to live with a urinary condition the way it is now, no better, no worse, for the rest of his life?

Level of satisfaction	Quality of life score
Delighted	0
Pleased	1
Mostly satisfied	2
Mixed	3
Mostly not satisfied	4
Unhappy	5

In the present study, BMGs were used for urethral reconstruction. Buccal mucosa has been suggested as an appropriate source of graft tissue for urethral reconstruction, particularly in complicated cases, and its popularity as the graft of choice for bulbar urethroplasty has increased.[3,23,28,29] A BMG was chosen because of its excellent features as the histological characteristics of buccal mucosal tissue include thick and thin epithelia that are well-organized with vascularized lamina propria, making this tissue suitable for graft acceptance at the embedded site.[25,27] The elastin in the thick epithelium provides graft durability and facilitates graft handling.[22]

Furthermore, BMGs are easily harvested, hairless, and can tolerate urine and infection.[22,30] The similar composition of the buccal mucosa and urethral mucosa means that BMG can be easily attached to the urethral bed.[24]

Based on the features and the reports of using BMG for bulbar urethroplasty in humans, we modified this technique to repair penile urethral strictures at the bulbus glandis in dogs. This modified technique is effective in treating urethral strictures of varying lengths and results in a restored urethral size similar to that of a healthy urethra. The appropriate size of the harvested graft was determined for each dog. The adjustment in size of the graft relative to the defect was based on an approximate contracture rate of 8.40% in length and 9.50% in width, as observed in the buccal mucosa.[31] Furthermore, cases with excessively affected urethral length result in insufficient buccal mucosal collection; therefore, a combined buccal and lingual mucosal graft could be feasible for repairing intermediate or long urethral strictures.[32]

In human urethroplasty, BMGs are usually categorized into two types: patch grafts (including onlay and inlay) and tubular grafts.[33,34] The main difference between the onlay and inlay techniques is that, in the inlay technique, the graft is spread and fixed over the urethral plate.[35–37] Tubular grafts often fail due to inadequate graft take, as they are not circumferentially surrounded by vascularized tissue, resulting in a relative deficiency in blood supply on either side of the graft bed despite adequate dorsal and ventral support.[24,34,38] Thus, owing to greater blood supply, patch grafts provide better outcomes than tubular grafts.

Based on these reasons, we chose to utilize the patch graft urethroplasty technique for graft placement in all dogs in our study. The three most common approaches for bulbar urethroplasty utilizing BMG are the dorsal, ventral, and lateral aspects of the penis.[39] In the present study, a ventral technique was used because of the superficial position of the affected urethra and the absence of the retractor penis muscle. Surgical access to the urethra using this approach is also facilitated by the absence of urethral obscuration by the os penis, which is anatomically different from that in humans. Furthermore, there is little cavernous tissue and no bulbospongiosus muscle surrounding the urethra in this region, which minimizes hemorrhage.[40,41] Successful use of gauze tied around the base of the penis and caudal to the bulbus glandis has been reported.[42] As it may provide a tourniquet effect, making it a potentially beneficial option when used in conjunction with the BMG urethroplasty to minimize intraoperative bleeding.

In summary, to the best of our knowledge, this is the first report on the use of BMG urethroplasty to relieve penile urethral strictures at the bulbus glandis, where surgical intervention is difficult in dogs. This technique is highly effective for dogs undergoing urethroplasty for penile urethral strictures, providing a successful outcome with an excellent quality of life. One limitation of this study was that the assessment of outcomes was based solely on clinical evaluations and radiographic findings. Direct evaluation of the histological incorporation of the graft was not possible because histopathological examination was not performed. However, given the favorable graft properties and satisfactory clinical outcomes, BMG urethroplasty should be considered a viable treatment option for male dogs with penile urethral strictures.

AUTHOR CONTRIBUTIONS

Jareonsuppaperch A, DVM: Identified suitable medical records, recorded demographic information, compiled all data, interpreted data, drafted and revised the manuscript, and gave final approval of the version to be published. Assawateerakiat T: Contributed to the design of the study, performed radiographic measurements, performed data curation and interpreted data. Sasaki N, DVM, PhD: Contributed to the design of the study and drafted and revised the manuscript. Yippaditr W, DVM: Contributed to the design of the study, was responsible for the surgical management of the case, oversaw data collection, provided intraoperative photographs, interpreted data, provided scientific, in-line editing of the manuscript, and gave final approval of the version to be published. All authors provided a critical review of the manuscript and endorse the final version. All authors are aware of their respective contributions and have confidence in the integrity of all contributions.

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CONFLICT OF INTEREST STATEMENT

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

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