



Novel surgical spoon for urocytolith removal during canine cystotomy

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ABSTRACT

Cystotomy is a common surgical procedure to remove urocytoliths from the urinary bladder, but retrieval of urocytoliths is limited to improvised use of available surgical instruments or off-label devices. There is an unacceptable incidence of incomplete urocytolith extraction, which can necessitate additional surgery and exacerbate morbidity. To improve urocytolith extraction, three novel 3D-printed surgical spoons underwent a pilot proof-of-concept trial in Northwest Arkansas veterinary clinics. Postoperative questionnaires provided to those veterinarians recorded favorable experiences using one or more of the surgical spoons in two dogs weighing 23 to 34 kg. The most favored surgical spoon from the trial underwent strategic design modification to evaluate in dogs weighing less than 23 kg. The cystotomy spoon is a 12.0 cm shaft with a spoon on each end, one spoon narrower (1.4 cm at widest dimension) than the other (2.0 cm at widest dimension). The cystotomy spoon was 3D printed using Dental Surgical Guide resin and entered a proof-of-concept trial at the University of Missouri Veterinary Health Center. Faculty surgeons and residents will use the spoon during canine cystotomies and complete a postoperative questionnaire to record expert opinion on the efficacy and usefulness of the spoon. We hypothesize that these surgeons will view the spoon as effective and user-friendly for urocytolith extraction. We anticipate that these surgeons may have constructive input for design improvement. Once perfected, this surgical spoon will provide a specific device for canine urocytolith removal and positively impact the standard of healthcare for dogs requiring a cystotomy.

ABDOMINAL RADIOGRAPHY OF UROCYSTOLITHS

Below is an image of a canine abdominal radiograph taken at Faithful Friends Animal Clinic, Rogers, Arkansas.



INTRODUCTION

- Urolithiasis may occur in any part of the urinary tract. Struvite, calcium oxalate, and urate are the most common urocytoliths seen in dogs.
- Clinical signs of bladder uroliths include stranguria, hematuria, discomfort, and potentially urinary obstruction.
- Abdominal radiography is useful for diagnosing urolithiasis if the urocytoliths are radiopaque. Radiolucent uroliths may require ultrasonography for diagnosis.
- Cystotomy is performed to remove urocytoliths from the urinary bladder. Common methods for removing small uroliths are retrograde flushing and the use of off-label devices such as tablespoons, teaspoons, and gallbladder spoons. These spoons may push small urocytoliths toward the urethra, making visualization of remaining stones difficult.
- Retained urocytoliths due to incomplete removal necessitate subsequent operation leading to potential postoperative complications and additional patient discomfort.
- To improve efficiency and effectiveness of urocytolith removal, three novel surgical spoons were strategically designed, and 3D printed at the University of Arkansas, to maneuver gently in the lumen and neck of the urinary bladder to extract urocytoliths that are migrating to the urethra.
- Pilot proof-of-concept trials at two veterinary clinics in Northwest Arkansas demonstrated efficacy of urolith extraction during canine cystotomy. Favorable experiences were reported upon using the 3D-printed surgical spoons while performing cystotomy on a 23 kg mixed breed terrier and a 34 kg blue heeler.

OBJECTIVE

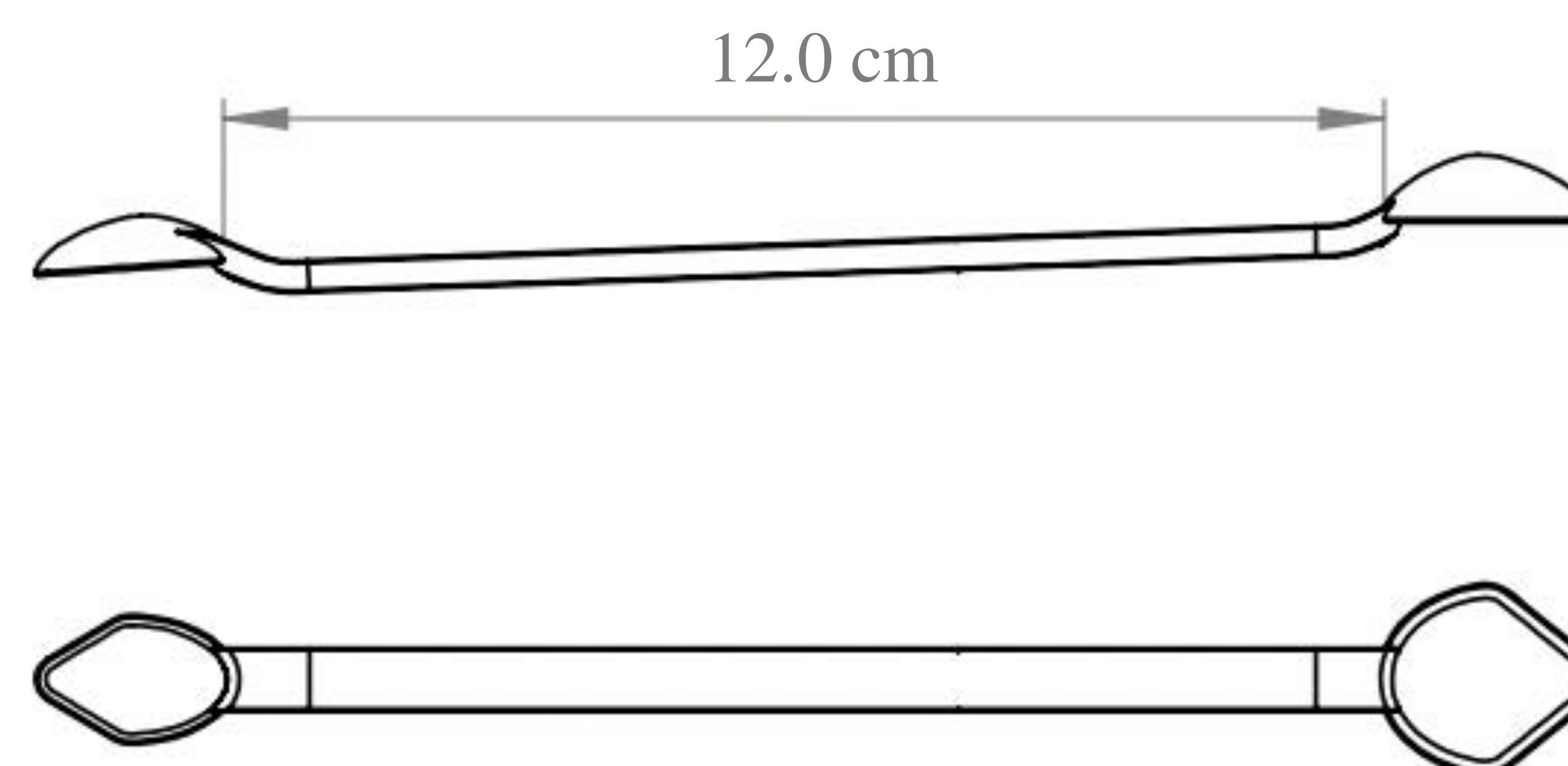
1. To modify the design and material of the current version of the canine cystotomy spoon.
2. To determine the efficacy of the final model through a proof-of-concept trial at the University of Missouri Veterinary Health Center.

CANINE UROCYSTOLITHS

Below is an image of canine uroliths extracted during a cystotomy at the Veterinary Health Center, Columbia, Missouri.

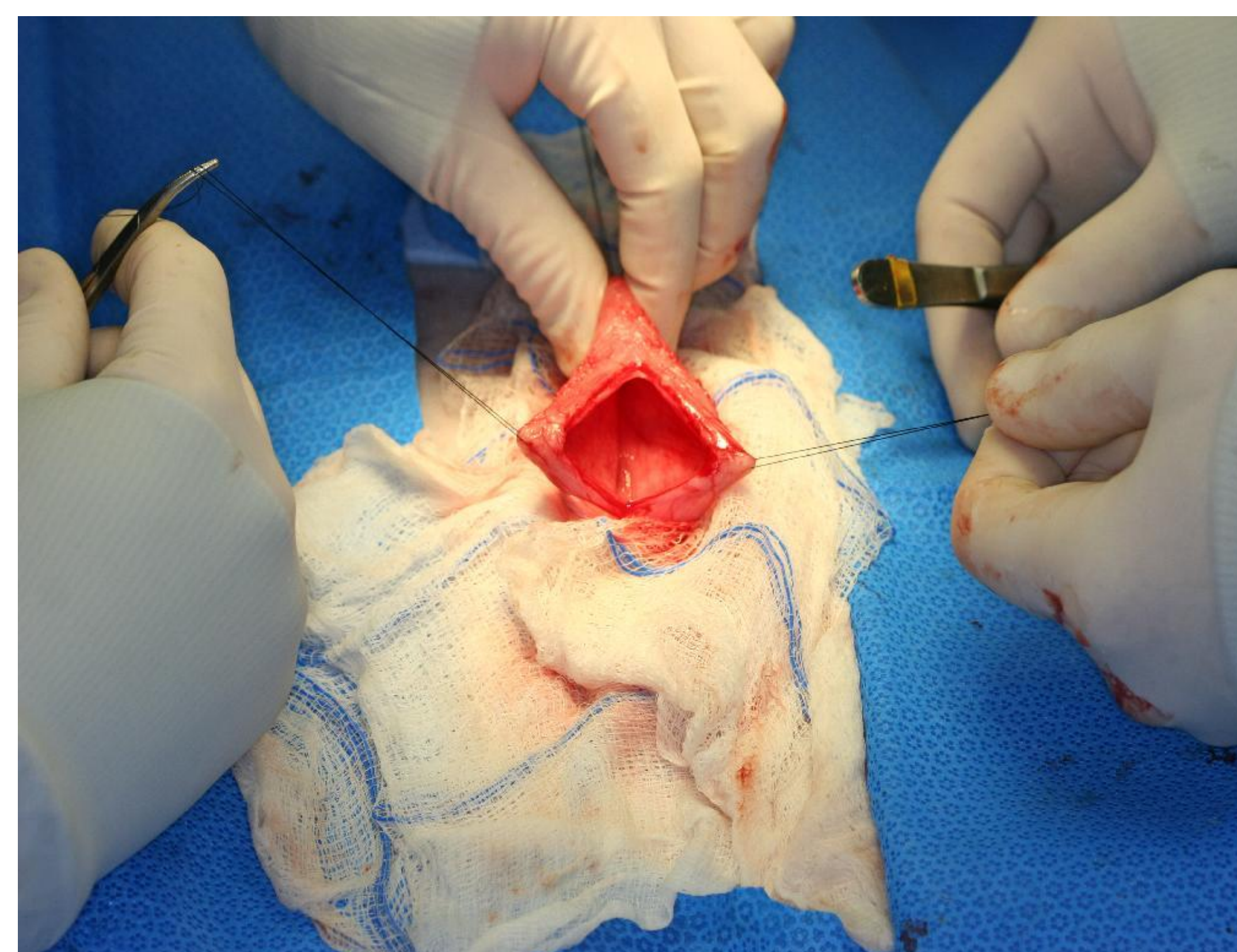


NOVEL CYSTOTOMY SPOON



CYSTOTOMY SURGERY

Below is an image of a canine cystotomy performed at the Veterinary Health Center, Columbia, Missouri.



HYPOTHESIS

1. We hypothesize that the cystotomy spoon will be effective for removal of urocytoliths in dogs weighing <11 kg (narrow end of the spoon) and in dogs weighing 12 to 34 kg or greater (wide end of the spoon).
2. We hypothesize that surgeons at the University of Missouri Veterinary Health Center will rate the cystotomy spoon as user-friendly.

MATERIAL AND METHODS

- Design modification was performed on SolidWorks to improve access into urinary bladders of small dogs, maximize maneuverability, and access to the trigone of the urinary bladder.
- NextGen at the University of Missouri 3D printed the cystotomy spoon into Dental Surgical Guide resin.
- The cystotomy spoon will be steam sterilized prior to each surgery.
- The participants will be dogs currently in need of cystotomy and will undergo preoperative abdominal radiography for diagnosis and visualization of the urocytolith(s).
- Faculty surgeons and surgical residents will complete a postoperative questionnaire to collect appropriate findings on their experience with and the efficacy of the surgical spoon.
- Species, breed, age, body weight, diagnostic imaging evaluation, previous history, and composition of urocytoliths will be analyzed with the postoperative questionnaire results to determine possible correlations.
- Analysis of the postoperative questionnaire will determine if the cystotomy spoon was a useful method of urocytolith removal, user friendly for the surgeon, and appropriate for the patient's urinary bladder size.

ABDOMINAL ULTRASONOGRAPHY OF UROCYSTOLITHS

Below is an image of an abdominal ultrasound performed at the Veterinary Health Center, Columbia, Missouri.



CURRENT RESULTS

- Cystotomies were performed on two dogs, a 4 kg mixed breed, and a 10 kg Cavalier King Charles Spaniel.
- One veterinary surgeon utilized retrograde flushing and manual extraction in addition to the cystotomy spoon, while the other did not utilize additional extraction methods.
- Both veterinary surgeons reported the cystotomy spoon to have the same effectiveness and amount of urocytoliths removed compared to other spoons.
- One veterinary surgeon reported the narrower end of the cystotomy spoon was more effective, while the other reported the wider end.
- Both veterinary surgeons reported the cystotomy spoon to be useful, size appropriate, and had minimal tissue drag utilizing both ends of the spoon.
- The veterinary surgeons are willing to use the cystotomy spoon again after rating the spoon as "excellent" and "good."

FUTURE DIRECTIONS

Evaluations at the MU Veterinary Health Center will continue. Design modifications will be made for continued use in dogs and evaluation in cats and other species.

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