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Research Article

EVALUATION OF A BALLOON-EXPANDING METALLIC STENT IN THE FELINE URETHRA: A CADAVERIC STUDY

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ABSTRACT

The use of less invasive techniques for the treatment of urinary tract obstructions, such as the placement of a self-expanding metal stent (SEMS) or a balloon expanded metal stent (BEMS), has gained popularity, and it has proven to be a safe, fast and effective method to restore urethral patency in dogs. However, there are only a few studies emphasizing the possible benefits of this technique in cats, taking into account their anatomical peculiarities. The study was carried out with twelve cadavers of the feline especies. An evaluation of the urethral diameter was performed using retrograde uretrocistography. The 0.36mm hydrophilic guidewirethat was inserted into the urethra and advanced to the bladder was passed through the catheter. With the guide correctly positioned, the catheter was removed and a balloon expandable stent (BEMS), was introduced with the aid of this guide. The product used varied in diameter, being the smallest 2 mm and the largest 3.5 mm. At the end, a control radiograph was performed to assess if the stent location was adequate. In the radiographic evaluation, it was observed that the distal urethra had a diameter between 1 and 3 mm with a mean of 2.08 mm. In all patients, a balloon-expandable stent was used and the retrograde urethral probing was performed, with the aid of the hydrophilic guide wire for the passing of the stent delivery system. The radiographs performed at the end of the procedures showed the positioning at the distal urethra, as recommended, with the location starting from the intrapelvic, on the distal ischium floor. The use of urethral stent is a minimally invasive technique that may be an alternative to surgical treatment to restore urethral patency in cats. Retrograde stent implantation, using hydrophilic guidewire, was feasible in this non-obstructed cadaveric cats study. An in vivo study is required to test the effectiveness of this technique.

INTRODUCTION

Obstructive idiopathic cystitis is often observed in male cats due to their anatomical conformities, such as the small size of the urethra and its great predisposition to form calculi, plugs and stenosis (Baines *et al*., 2001; Brace *et al*., 2013; Hadar *et al*., 2011; Radhakrshnaj 2017). It is commonly observed in the hospital routine, and the patients usually present signs, such as hematuria and dysuria, having different etiologies (Baines *et al*., 2001; Brace *et al*., 2013; Corgozinho *et al*., 2007; Choi *et al*., 2009). Urethral obstruction in cats has as its principal causes the urethral stenosis due to chronic urethritis or trauma related to probing, urolith-induced injury, or a congenital anomaly (Baines *et al*., 2001; Corgozinho *et al*., 2007; Hadar *et al*., 2011).Cats, when frequently obstructed, require medical intervention to restore the urethral flow, which is based on urethral catheter and bladder lavage (Brace *et al*., 2013; Choi *et al*., 2007; Choi *et al*., 2009). And when urethral stenosis occurs, the management becomes challenging, having as treatment options the perineal penectomy and urethrostomy surgery (Baines *et al*., 2001; Hadar *et al*., 2011).

The use of less invasive techniques for the treatment of urinary tract obstructions, such as the placement of a self-expanding metal stent (SEMS) or balloon expanded metal stent (BEMS), has gained popularity, and it has proven to be a safe, fast and effective method to restore urethral patency in dogs, but with only a few studies emphasizing the possible benefits of the

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technique in cats, taking into account their anatomical peculiarities (Brace *et al*., 2013; Christensen *et al*., 2010; Choi *et al*., 2007; Hadar *et al*., 2011). It is suggested by Hadar *et al* that the placement of a urethral stent in felines, when there are cases of urethral stenosis, is a viable alternative to surgery, especially if the clinical history is consistent with urethral trauma with secondary stenosis. However, additional studies with long-term follow-up to evaluate the use of BEMS or SEMS in cats with urethral stenosis are needed, since there are just a few reports in the literature.

Although studies with the use of stents are limited and precarious in veterinary medicine, this technique has been commonly used in medicine, and in some cases used in dogs with positive results. Nevertheless, in cats, up to the present moment, there hasn´t been any consistent study on the technique of implantation and complications of urethral stents. Therefore, this study aims to standardize a technique for stent implantation in cats, making it relevant the possibility of having a new treatment for animals affected by this disease. The method proposed in this study allows a characterization of the technique for the implantation of the stent in the feline urethra, which was performed first in a cat cadaver with the purpose of defining the implant insertion method.

MATERIAL AND METHODS

The study was carried out with twelve cadavers of the cats, male, intact or castrated, free of urinary tract diseases, originated from two university veterinary hospitals and donated by their tutors to participate in the study. They were frozen and stored in a freezer from the moment they were received and then thawed in running water for the experiment. They were free of any diseases of the urinary tract that could interfere with the results.

Evaluation of the Urethral Diameter

An evaluation of the urethral diameter was performed using retrograde uretrocistography, with the cadavers positioned in lateral and ventrodorsal Recumbency. A digital radiography apparatus[1] and as contrast Iohexol Hovione[2] diluted 50:50 in isotonic sodium chloride solution 0.9%[3] and calculated 6 to 8 ml / kg was used to distend the bladder and urethra. After this evaluation, it was possible to estimate the sizes of stents to be implanted.

Positioning of the Stent

The cadavers were placed in lateral Recumbency, and penile exposure was performed to realize the urethral catheterization with a 24G catheter[4] and the contrast that had been inserted for the radiography was removed. Through the catheter, the 0.36mm hydrophilic guidewire[5] that was inserted into the urethra and advanced to the bladder was passed. With the guide correctly positioned, the catheter was removed and a balloon expandable stent (BEMS) produced in 316LVM surgical steel with microporous and polymerless surface[6] (Figure 1) was introduced with the aid of this guide. The product used varied in diameter being the smallest 2 mm and the largest 3.5 mm, based on the urethral diameter previously evaluated in uretrocistography. Then, the hydrophilic guidewire was removed and the balloon inflated through a 20 ml syringe with a single and consistent pressure for approximately 10 seconds to reach close to the 9 atm pressure which is the manufacturer's recommendation (Figure 2). Subsequently, with the stent already positioned, the balloon dilatation catheter was deflated and removed. At the end, a control radiograph was performed to assess if the stent location was adequate.

RESULTS

Twelve cadavers of male cats, without breed, were selected, being 8 castrated and 4 intact and free of any diseases of the urinary tract. Classified in a single heterogeneous group in relation to age, weight and reproductive status. The animals had small, medium and large size, with an n average of 4.05 kg and a minimum weight of 1.80 kg and a maximum of 6.40kg.

In the radiographic evaluation, it was observed that the distal urethra had a diameter between 1 and 3 mm with a mean of 2.08 mm (Figure 3), but the evaluation system (soft wear used to evaluate the images) measured only whole values, so the measured size in the contrasted radiography was evaluated in order to estimate the stent sizes to be used associated with the radiographic measures. In all patients, a balloon-expandable stent was used and the retrograde urethral probing was performed with the aid of the hydrophilic guide wire for passing the stent delivery system. There was no resistance to the insertion of the stent into the distal urethra in any of the cadavers. Twelve stents were placed whose characteristics are described in Table 1.The radiographs performed at the end of the procedures (Figure 4) showed the positioning in the distal urethra as recommended, with location from the intrapelvic urethra on the distal ischium floor.

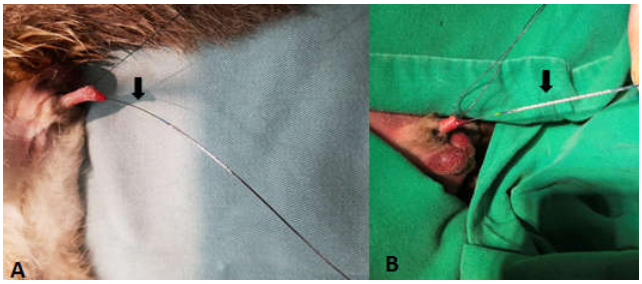

Figure 1 Retrograde approach of the urethral stent implantation technique in the cat cadaver. (A) Hydrophilic guidewire that was inserted into the urethral diameter and advanced to the bladder to guide the passage of the stent. (B) Balloon-expandable coronary stent produced in surgical steel, being inserted into the distal urethra.

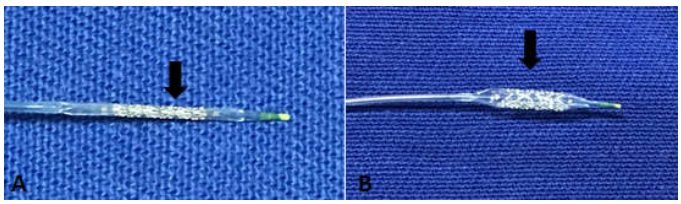

Figure 2 Balloon expandable stent. (A) BEMS delivery system deflated. (B) After inflating the balloon.

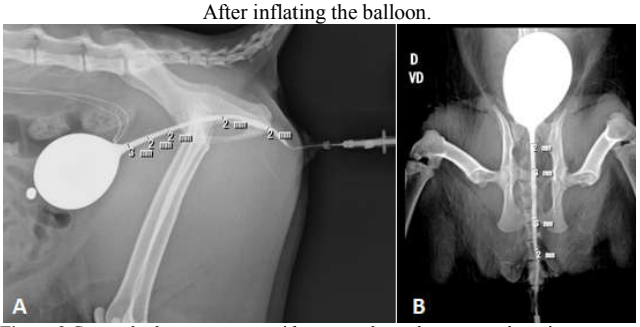

Figure 3 Cat urethral measurement with retrograde urethrocytography using contrast diluted in isotonic solution to distend the bladder and urethra. (A) Lateral radiographic image. (B) Ventrodorsal radiographic image.

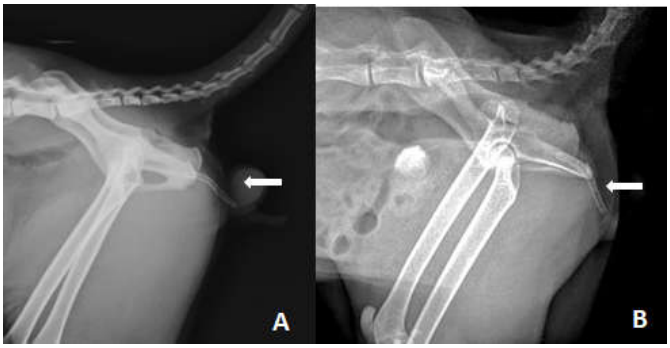

Figure 4 (A and B) Lateral radiographic image evaluating the stent already positioned in the distal urethra.

DISCUSSION

There is no standardized technique for the implantation of the urethral stent in cats, reported the use in 8 cats, being this the study the one with the highest number of patients reported in the literature (Brace *et al*., 2013). However, because it is a retrospective study, the implementation of various techniques, such as the retrograde urethral access, percutaneous anterograde urethral access, percutaneous urethral access for cystolithotomy and abdominal lateral urethral access were repeated. In our study, a retrograde approach with urethral catheterization in cats of different sizes was used. This approach would be the simplest way to place a stent, but with difficulties in passing the penile urethra of some cats. The use of the hydrophilic guide wire for the catheterization and the stent placement was extremely important in our study, we believe that this is a key point to making the retrograde access a successful approach in obstructed cats (Brace *et al*., 2013).

A case where the retrograde hydrophilic guidewire was used has been described, but the access was done with anterograde cystourethroscopy. The results denote that in male cats, the placement of a stent with the SEMS method requires an anterograde approach, this because the small diameter of the urethra can't accommodate the relatively large pre-implantation diameter (2mm) of the SEMS delivery system (Hadar*et al*., 2011). In a female cat there was no difficulty implanting a stent with the SEMS system [3]. In another report, the implantation of a BEMS was chosen, justifying that the penile urethra is too small to accommodate the delivery system needed to implement a SEMS (Newman *et al*., 2009). In our study, we used only the BEMS implantation system, due to its smaller thickness (1.67 mm), making it viable to pass the stent even in patients with smaller urethral diameters.

In this study, patients did not present urinary tract morbidities, so the location of the stents was varied, but it remained in the distal urethra (penile), aiming at the implantation in this area where the urethral diameter is smaller and with a greater predisposition to develop stenosis, due to urethral catheterization in patients with obstructive idiopathic cystitis. We chose this region as the focus of our study based on the fact that suspected stenosis is distributed from the medial to the distal region, whereas neoplastic obstructions were distributed in the proximal region of the urethra (Brace *et al*., 2013). Studies report the use of a BEMS in a patient with obstructive idiopathic cystitis, but the stenosis after several catheterizations happened in the proximal urethra (Choi *et al*., 2009), which goes against our hypothesis. We believe that data on the use of stents in patients with obstructive idiopathic cystitis is still precarious in the literature, requiring further studies on this topic.

In another study, anterograde percutaneous urethral access was used with the help of a fluoroscope, describing it as a quick and minimally invasive technique, but did not report if there was an attempt through the retrograde route (Choi *et al*., 2009). We used the digital radiography method to evaluate the ideal position of the stent. The use of a real-time image aided in the implantation method, mainly to locate possible stenosis, and, indeed, there were no signs of stenosis observed in this study. We believe that in vivo studies require an imaging system during the procedure to ascertain the correct position of the stent in the stenosis region.

Some factors should be considered regarding the choice of the stent to be used, it is shown that the balloon-expandable metallic stent (BEMS) offers the advantage of practical placement, but there is a lack of flexibility in this format (Newman *et al*., 2009). As a benefit, they are considered to be short and more practical in placement than SEMS (Hill *et al*., 2014). As an aggravating fact, studies point out that BEMS may result in urethral rupture du'ring balloon expansion, while SEMS will expand more smoothly and, thus, be less likely to migrate (Brace *et al*., 2013).. It is referred that the SEMS have a pre-defined expansion pressure and are more malleable to fit the wall of the urethra, decreasing the chance of migration [9]. Stent migration is uncommon according to the experience of Brace *et al*. (2013) and Hadar*et al*. (2011) that followed up with radiographs obtained up to 6 months after the stent placement in their report, and did not reveal any evidence of migration or fracture of the stent. As being a cadaveric study, it was not possible to evaluate complications in our study.

In order to reduce complications, it is reported that the diameter of the stent is the same diameter as the normal (non-dilated) distended urethra and should be determined using uretrocistography. Yet, the length should be evaluated with the objective of restoring urethral patency minimizing the area of the implant in the healthy urethra, thus, consequently, decreasing signs of incontinence after the procedure (Brace *et al*., 2013). As a limitation of our study, we can consider that the radiographic measurement has inherent flaws in the software used, regarding the small diameter of the urethra and the radiographic magnification. This is because of the fact that our measurements were of complete numbers and not fractionated, making it difficult to measure the urethral diameter accurately.

CONCLUSION

In conclusion, the use of the urethral stent is a minimally invasive technique that may be an alternative to surgical treatment in order to restore urethral patency in cats. The retrograde stent implantation, using the hydrophilic guidewire, was feasible in this non-obstructed cadaveric cats study. An in vivo study is required to test the effectiveness of this technique.

Manufacturers

1. Radrex-i, Toshiba medical, Japan.
2. Omnipaque, Farmassa, Shanghai, China.
3. LinhamaxPhysiological, Eurofarma, Ribeirão Preto, Brazil.
4. Insyth, Bd, Juiz de Fora, Brazil.
5. Galeo Hydro, Biotronik, Berlin, Germany.
6. Yukon Choice, Translumina, Hechingen, Germany.

Conflicts of Interest

The authors declare no conflicts of interest.

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