Evaluation of intraluminal pressure in cystorrhaphies with and without intestinal serosal patch supplementation from canine cadavers

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ABSTRACT

PURPOSE: To evaluate the maximal intraluminal pressure (MIP) supported by canine cadaveric urinary bladders that underwent cystotomy followed by cystorrhaphy, with and without serosal patching-supplementation.

METHODS: Two groups (n=8 each) were formed, and in one (conventional) the cystotomy was closed with cushing pattern. In the other group (serosal), the same procedure was performed, and a piece of jejunum was used for the construction of the serosal patching over the cystorrhaphy. MIP was measured by means of an invasive blood pressure transducer with closed stopcock attached to a multi-parameter monitor. At the end of each measurement, the bladder body circumference was assessed.

RESULTS: Mean±SD MIP sustained for the conventional and serosal groups were 28.88±5.08 and 65.38±10.99 mmHg, respectively (p<0.0001). Bladder circumference did not change significantly between groups (p=0.35) and did not correlate with MIP assessed in conventional (p=0.27; r=0.4379) and serosal groups (p=0.37; r=-0.3637).

CONCLUSION: Serosal patch–supplemented cystorrhaphies were able to sustain intraluminal pressures 55.8% higher, than non-supplemented cystorrhaphies in specimens from canine cadavers.

Key words: Urinary Bladder. Cystotomy. Pressure. Dogs.
Evaluation of intraluminal pressure in cystorrhaphies with and without intestinal serosal patch supplementation from canine cadavers

Introduction

In veterinary medicine, urinary bladder procedures are commonly performed, being the main indication associated with removal of cystic calculi. Other indications include extirpation of masses, ureteral reimplantation, correction of traumatic rupture, and intramural ectopic ureters1.

Total cystectomy is indicated in cases where neoplastic diseases compromise extensive areas of the urinary bladder2-4. Smaller tumors and traumatic rupture demand resection of necrotic tissue by means of partial cystectomy. In such conditions, the preservation of the vesical trigonal area allows the full recovery of its function and size, four to six months following the removal of approximately 70 to 90% of its wall1,5,7.

If after partial cystectomy the remaining vesical tissue is questionable, intestinal serosal patching over the suture line may be recommended as a supplemental procedure6. This technique refers to placement of a healthy segment of intestine in direct serosal-to-serosal contact, effectively creating full-thickness coverage, reducing the risk of leakage from hollow organs7. In addition, mesothelial cells and vessels from the serosa provide healing support to the diseased tissue5.

Serosal patching has been described as a supplemental technique for the correction of abdominal and caudal thoracic esophageal defects10,11; however, it has being mainly recommended in intestinal diseases12-14. In one study, the use of a serosal patch over intestinal anastomosis did not increase the survival of dogs with peritonitis, when compared to individuals that did not receive such supplementation15. Notwithstanding, another research showed that serosal patch–supplemented intestinal anastomoses were able to sustain intraluminal pressures 65.8% higher, than non-supplemented anastomoses in specimens from canine cadavers16.

Although recommended in the veterinary literature, results of intestinal serosal patching over cystorrhaphies have never been described experimentally or in a clinical setting1. Therefore, the present study aimed to evaluate the maximal intraluminal pressure supported by canine cadaveric bladders that underwent cystotomy followed by cystorrhaphy, with and without serosal patching-supplementation.

Methods

This study was approved by the Ethics Committee on Animal Use of the UFMT, Cuiaba (protocol 23108. 025215/14-2).

The experiment was accomplished ex situ. Urinary bladders and intestines were harvested from dogs immediately after euthanasia via IV infusion of propofol for reasons unrelated to the study.

Urinary bladders and intestines (jejunum) were placed in saline solution 0.9% and stored at 5°C for a period of 48 hours, as previously described16, in order to respect the period of rigor mortis. Considering that the urethral prostate of males could impair the results, for standardization reasons, only specimens from bitches were used.

Experimental design

Cystotomies of 2.5 cm long were created in empty urinary bladders. Two groups (n=8 each) were formed, and in one (Conventional) the cystotomy was closed with a double appositional pattern of cushing with 3.0 polyglycolic acid suture (PolySuture®, Polycryl, São Sebastião do Paraíso, Brazil). In the other group (Serosal), the cystorrhaphy was performed as aforementioned before, and a piece of jejunum was used for the construction of the serosal patching over the cystorrhaphy (Figure 1C and D).

The construction of the serosal patch was performed by placing the antimesenteric margin of the intestine over the cystorrhaphy line, and a simple continuous partial thickness suture line was used to attach it to the bladder wall1. The sutures applied for the serosal patch construction were placed at 5mm away from the cytorrhaphy line. All surgeries were performed by the same surgeon, and in order to avoid bias, the execution of each surgical procedure was performed interchangeably between the groups.

The maximal intraluminal pressure (MIP) of each urinary bladder was assessed by means of an invasive blood pressure transducer with closed stopcock (GaBmed®, TP00941, São Paulo, Brazil) (Figure 1A) attached to a multi-parameter monitor (GE Healthcare®, Dash 4000, Little Chalfont, United Kingdom) for digital reading of the results. In all occasions, the transducer was attached to an indwelling urinary catheter at the same level of the urinary bladder.

Two indwelling urinary catheters (number 6) were introduced into the urethra and a modified Sultan suture (2-0 nylon) was placed around them, in order to avoid leakage between the catheters. In addition, the same suture pattern was applied to the ureters, in order to avoid return of liquids. An infusion pump (Insight®, EFF 311, Ribeirão Preto, Brazil) (Figure 1B) was attached to one of the catheters and saline solution was delivered at a rate of 999 mL/h16. The tip of the other catheter was attached to the pressure transducer.

The MIP was stablished when leakage occurred from the cystorrhaphies and the constructs. The wetting of a Whatman paper (Whatman®, Grau 1, Little Chalfont, United Kingdom) placed over the cystorrhaphies and the constructs was used to confirm the

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leakage of liquid. The surgeon was always blind to the readings depicted by the monitor, and the MIP was recorded by two different observers. At the end of each measurement, the bladder body was wrapped with metric tape to assess the bladder circumference. Afterwards, a full thickness sample of vesical tissue was harvested for histological analysis. During the harvesting, when perforations of the urinary vesicle caused by the suture pattern were observed, the sample was discarded.

**Statistical analysis**

The Shapiro-Wilk test was used to assess data normality. Two tailed and unpaired Student’s T test was used to compare values of MIP and of filled bladders circumference between groups. Correlations between the bladder diameter and the MIP were evaluated by Person’s test (GraphPad PRISM 4.0®, San Diego, CA, USA). In all occasions, differences were considered significant when p<0.05.

**Results**

Data were normally distributed and (p>0.10) the results are expressed as mean±standard deviation. The MIP for the conventional group was 28.88±5.08 mmHg (ranging from 21 mmHg to 34 mmHg) and 65.38±10.99 mmHg (ranging from 54 mmHg to 81 mmHg) in the serosal group. The serosal group achieved 55.8% higher values of MIP, in comparison to the conventional group, being this result significant (p<0.0001) (Figure 2).

After filling, the urinary bladder body circumference of the serosal group was 14.43±6.57 cm and 11.98±3.13 cm in the conventional group (p=0.35). Correlation between the bladder diameter and MIP was not observed in conventional (p=0.27; r=0.4379) and serosal groups (p=0.37; r=-0.3637).

**FIGURE 1** - A. Blood pressure transducer with closed stopcock. B. Infusion pump. C. Full-filled urinary bladder supported by serosal patch over the cystorraphy. D. Complete system showing the infusion pump, indwelling urinary catheters, serosal patched-urinary bladder and pressure transducer.

**FIGURA 2** - Mean and individual dispersion of values of maximum intraluminal pressure (mmHg) in conventional and serosal groups. Student T test.
Discussion

The highly demand of surgical interventions involving the urinary bladder in humans and animals, the complications associated with such procedures, and the scarcity of researches describing the results of the serosal patching in urinary procedures motivated us to develop this study.

In dogs, the physiologic intravesical pressure ranges from 10 to 30 cm H2O, varying with the animal position, being equivalent to 7.3 to 22 mmHg17. Such values are lower than the average values described in our results, once in physiological conditions, the increase in the intraluminal pressure induces the opening of the urethral sphincter, allowing the emptying of the bladder. With our experimental model, the urethra was closed, in order to avoid leakage. Such procedure allowed that the bladder reached its maximal intraluminal pressure forcing the leakage to occur towards the suture line.

The technique presented herein can be easily accomplished following the conventional cystorraphy. In addition, mesothelial cells and vessels from the serosa provide healing support to the diseased tissue. Serosal patching has been described as a well succeeded supplemental technique when employed to different organs and species5,8,10-16,18-20. However, one study showed that the use of a serosal patch over intestinal anastomosis did not increase the survival of dogs with peritonitis, when compared to individuals that did not receive such supplementation15.

An experimental research in intestines from canine cadavers has been shown that serosal patch–supplemented intestinal anastomoses were able to sustain intraluminal pressures 65.8% higher, than non-supplemented anastomoses16. In this regard, the serosal patch–supplemented cystorraphies sustained maximum intraluminal pressures 55.8% higher, than the nonsupplemented cystorraphies, providing evidence that such technique may be used to protect against bladder leakage, preventing the onset of uroabdomen. Although not reported in the results, the MIP recorded in discarded constructs of the Serosal group (due to perforations) were higher than the ones observed in bladders of the Conventional group, in which such intercurrence was not observed.

Abdominal pressure is the effect of the forces exerted around and over the urinary bladder by surroundings organs21, being that such pressure may increase during forced coughing21,22. In addition, active and passive forces aroused by the detrusor muscle have to be considerate, independently of any external force exerted to the urinary bladder wall23. Although such forces have not been addressed in our study, one should consider that during physiological conditions, the urinary bladder volume may reach the leak-point pressure during the postoperative period, reinforcing the benefits of the serosal patching.

The infusion of saline was delivered at a rate of 999mL/h in all occasions. This methodology allowed that the rate of fluids delivered to all bladders was the same, without causing pressure changes16. The absence of correlation between the diameter of the filled bladders and the MIP showed that the vesicle area did not influence in the assessment of pressures. Such finding is in agreement with the Stevin’s law, which describes that the hydrostatic pressure does not depend on the shape of the container, being influenced only by the fluid density, the height of the point where the pressure is exerted, and the acceleration of gravity.

The limitations of the present study are related to the non-physiological method adopted in our assays and the use cadaveric specimens, which can behave differently from the living tissue. Post-operative data of the procedure described herein, obtained from living laboratory animals and patients in a clinical setting are warranted to confirm the real benefit of patching over cystorraphies.

Conclusion

Serosal patch–supplemented cystorraphies were able to sustain intraluminal pressures 55.8% higher, than non-supplemented cystorraphies in specimens from canine cadavers.

References


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