Evaluation of intraluminal pressure in cystorrhaphies with and without intestinal serosal patch supplementation from canine cadavers[1]

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DOI: http://dx.doi.org/10.1590/S0102-865020150100000008

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ABSTRACT

PURPOSE: To evaluate the maximal intraluminal pressure (MIP) supported by canine cadaveric urinary bladders that underwent cystotomy followed by cystorraphy, 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 cystorraphy. 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 cystorraphies were able to sustain intraluminal pressures 55.8% higher, than non-supplemented cystorraphies in specimens from canine cadavers.

Key words: Urinary Bladder. Cystotomy. Pressure. Dogs.

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 ureters[1].

Total cystectomy is indicated in cases where neoplastic diseases compromise extensive areas of the urinary bladder[2-4]. 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 wall[1,5-7].

If after partial cystectomy the remaining vesical tissue is questionable, intestinal serosal patching over the suture line may be recommended as a supplemental procedure[8]. 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 organs[8]. In addition, mesothelial cells and vessels from the serosa provide healing support to the diseased tissue[9].

Serosal patching has being described as a supplemental technique for the correction of abdominal and caudal thoracic esophageal defects[10,11]; however, it has being mainly recommended in intestinal diseases[12-14]. 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 supplementation[15]. 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 cadavers[16].

Although recommended in the veterinary literature, results of intestinal serosal patching over cystoraphies have never been described experimentally or in a clinical setting[1]. Therefore, the present study aimed to evaluate the maximal intraluminal pressure supported by canine cadaveric bladders that underwent cystotomy followed by cystorraphy, 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 described[16], 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 cystorraphy was performed as aforementioned before, and a piece of jejunum was used for the construction of the serosal patching over the cystorraphy (Figure 1C and D).

The construction of the serosal patch was performed by placing the antimesenteric margin of the intestine over the cystorraphy line, and a simple continuous partial thickness suture line was used to attach it to the bladder wall[1]. The sutures applied for the serosal patch construction were placed at 5mm away from the cytorraphy 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/h[16]. The tip of the other catheter was attached to the pressure transducer.

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

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 patter were observed, the sample was discarded.

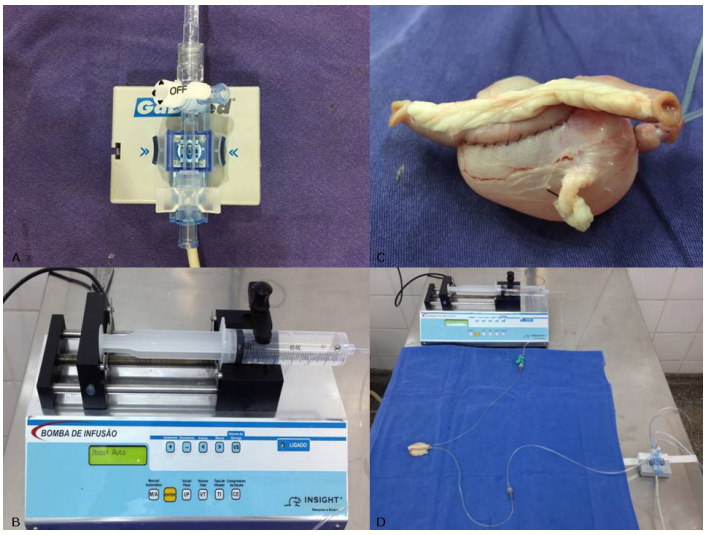

FIGURE 1 - A. Blood pressure transducer with closed stopcock. **B**. Infusion pump. **C**. Full-filled urinary bladder supported by serosal patch over the cystorraphy. **D**. Complete system showing the infusion pump, indwelling urinary catheters, serosal patched-urinary bladder and pressure transducer.

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 ocasions, 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 ($p=0.37$; $r=-0.3637$).

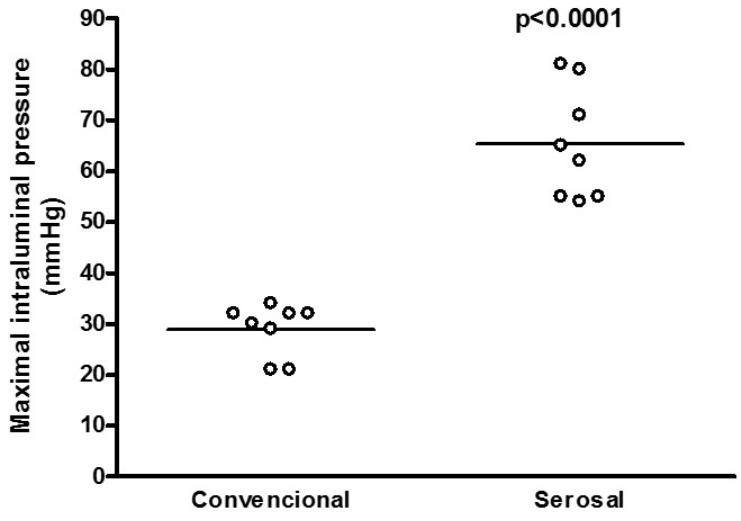

FIGURA 2 - Mean and individual dispersion of values of maximum intraluminal pressure (mmHg) in conventional and serosal groups. Student T test.

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 H_2O, varying with the animal position, being equivalent to 7.3 to 22 mmHg[17]. 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[9]. Serosal patching has being described as a well succeeded supplemental technique when employed to different organs and species[1,5,8,10-16,18-20]. 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 supplementation[15].

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 anastomoses[16]. In this regard, the serosal patch–supplemented cystorraphies sustained maximum intraluminal pressures 55.8% higher, than the nonsuplemented 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 organs[21], being that such pressure may increase during forced coughing[21,22]. 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 wall[23]. 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 changes[16]. 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

1. Cornell KK. Cystotomy, partial cystectomy, and tube cystostomy. Clin Tech Small Anim Pract. 2000 Feb;15(1):11-6. doi: 1 0.1053/svms.2000 7300.
2. Clark PE, Stein JP, Groshen SG, Miranda G, Cai J, Lieskovsky G, Skinner DG. The management of urethral transitional cell carcinoma after radical cystectomy for invasive bladder cancer. 2004. J Urol. 2004 Oct;172(4 Pt 1):1342-7. doi: 10.1097/01.ju.0000138208.07426.19.
3. Kanaroglou A, Shayegan B. Review: Management of the urethra in urothelial bladder cancer. Can Urol Assoc J. 2009 Dec;3(6 Suppl 4): 211–4. PMID: PMC2792442.
4. Boston S, Singh A. Total cystectomy for treatment of transitional cell carcinoma of the urethra and bladder trigone in a dog. Vet Surg. 2014 Mar;43(3):294-300. doi: 10.1111/j.1532-950X.2014.12104.x.
5. Pozzi A, Smeak DD, Aper R. Colonic seromuscular augmentation cystoplasty following subtotal cystectomy for treatment of bladder necrosis caused by bladder torsion in a dog. J Am Vet Med Assoc. 2006 Jul;229(2):235-9. doi: 10.2460/javma.229.2.235.
6. Schwarz PD, Egger EL, Klause SE. Modified cup-patch ileocystoplasty for urinary bladder reconstruction in a dog. J Am Vet Med Assoc. 1991 Jan;198(2):273-7. PMID: 2004989.
7. Duel BP, Gonzalez R, Barthold JS. Alternative techniques for augmentation cystoplasty. J Urol. 1998 Mar;159(3):998-1005. doi: 10.1016/S0022-5347(01)63820-5.

8. Crowe DT. The serosal patch: clinical use in 12 animals. Vet Surg. 1984 Jan;13(1):29-38. doi: 10.1111/j.1532-950X.1984.tb00755.x.
9. Jones SA, Gazzaniga AB, Keller TB. The serosal patch: a surgical parachute. Am J Surg. 1973 Aug;126(2):186-96. PMID: 4721542.
10. Thal AP, Hatafuku T, Kurtzman R. New operation for distal esophageal stricture. Arch Surg. 1965 Apr;90(4):464-72. doi: 10.1001/archsurg.1965.01320100008003.
11. Mendelssonh P, Magalhães A, Goldenberg S. Serosal patch of the gastroesophageal junction: an experimental study in dogs. Acta Cir. Bras. **1998 Jul**;13(3):135-44. dx.doi.org/10.1590/S0102-86501998000300001.
12. Kobold EE, Thal AP. A simple method for management of experimental wounds of the duodenum. Surg Gynecol Obstet. 1963 Mar;116:340-4. PMID: 14033976.
13. Hirota K, Harkins HN. Intestinal covering method for gastrointestinal defects: experimental study. Surgery. 1965 Dec;58(6):1013-21. PMID: 5852979.
14. Fontes CER, Taha OM, Fagundes DJ, Filho OP, Ferreira MV, Mardegan MJ. Estudo do reparo do ferimento de colon com o lado seroso da parede de jejuno, utilizando cianoacrilato e cola de fibrina. Rev Col Bras Cir. 2006 Mar;33(2):68-73. dx.doi.org/10.1590/S0100-69912006000200003.
15. Grimes J, Schmiedt C, Milovancev M, Radlinsky M, Cornell K. Efficacy of serosal patching in dogs with septic peritonitis. J Am Anim Hosp Assoc. 2013 Aug;49(4):246-9. doi: 10.5326/JAAHA-MS-5870.
16. Hansen LA, Monnet EL. Evaluation of serosal patch supplementation of surgical anastomoses in intestinal segments from canine cadavers. Am J Vet Res. 2013 Aug;74(8):1138-41. doi: 10.2460/ajvr.74.8.1138.
17. Takayama K, Takei M, Soejima T, Kumazawa J. Continuous monitoring of bladder pressure in dogs in a completely physiological state. Br J Urol. 1987 Nov;60(5):428-32. PMID: 3427316.
18. Hosseini SV, Abbasi HR, Rezvani H, Vasei M, Ashraf MJ. Comparison between bladder serosal and mucosal patch in duodenal injuries repair in dogs. J Invest Surg. 2009 Mar;22(2):148-53. doi: 10.1080/08941930802713068.
19. Fontes CE, Bandeira COP, Ferreira MV, Nigro AJT, Campos LF, Senhorini Jr S. Estudo comparativo do tratamento de ferimento de colón de coelho com reparo seroso da parede de jejunum e sutura primária. Acta Cir. Bras. 2000 Mar;15(1):55-60. dx.doi.org/10.1590/S010286502000000100009.
20. Briscoe JA, Bennett RA. Use of a duodenal serosal patch in the repair of a colon rupture in a female Solomon Island eclectus parrot. J Am Vet Med Assoc. 2011 Apr;238(7):922-6. doi: 10.2460/javma.238.7.922.
21. Miklos JR, Sze EH, Karram MM. A critical appraisal of the methods of measuring leak-point pressures in women with stress incontinence. Obstet Gynecol. 1995 Sep;86(3):349-52. PMID: 7651641.
22. Lane TM, Shah PJR. Leak-point pressures. BJU Int. 2000 Nov;86(8):942-9. doi: 10.1046/j.1464-410x.2000.00947.x.
23. Resnick NM, Brandeis GH, Baumann MM, DuBeau CE, Yalla SV. Misdiagnosis of urinary incontinence in nursing home women: prevalence and a proposed solution. Neurourol Urodyn. 1996;15(6):599-618. doi: 10.1002/(SICI)1520-6777(1996)15:6<599::AID-NAU2>3.0.CO;2-A.

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Received: Jun 12, 2015
Review: Aug 14, 2015
Accepted: Sep 14, 2015
Conflict of interest: none
Financial source: none

[1]Research performed at Veterinary Hospital, Department of Surgery, Universidade Federal do Mato Grosso, Cuiaba-MT, Brazil. Part of Master degree thesis, Postgraduate Program in Sciences Veterinarians, UFMT. Tutor: Roberto Lopes de Souza.