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SUTURES USING POLYGLACTIN 910 AND TITANIUM STAPLES: URINARY AND UROLITHOGENIC ASPECTS IN EXPERIMENTAL ILEOCYSTOPLASTIES IN DOGS

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ABSTRACT

Urinary disorders are an important finding in ileocystoplasty, especially uroliths and crystalluria, and partly related to the type of suture material involved in this procedure. The aim of this study was to determine whether there are differences in the formation of uroliths and urinary crystalloid after ileocystoplasty in dogs, performed by suturing with nonabsorbable titanium staples and suture with polyglactin 910, noting their impact on renal function and urinary changes in the constitution difference in surgical time. Twelve healthy dogs were used and divided into two groups. In each animal was selected a segment of terminal ileum for bladder augmentation. In group A the suture of the detubelized ileal segment to the bladder was made with polyglactin 910 and in group B and the suture was made with titanium clips. We observed the presence of struvite crystals in 11 animals and the formation of large amounts of mucus in urine in all of them. In conclusion, no significant differences between groups in the formation of urinary crystals and uroliths after surgery, group A showed longer duration of surgery and no evidence of change in renal function in both groups.

KEYWORDS: Cystectomy; mechanical suture; sutures; urinary calculi.

SUTURAS COM POLIGLACTINA 910 E GRAMPOS DE TITÂNIO: ASPECTOS URINÁRIOS E UROLITOGÊNICOS NA ILEOCISTOPLASTIA EXPERIMENTAL EM CÃES

RESUMO

Alterações urinárias são um importante achado nas ileocistoplastias, sobretudo os urólitos e a cristalúria, e em parte, estão relacionados ao tipo de material de sutura envolvido neste procedimento. O objetivo deste estudo foi verificar se existe diferença na formação de urólitos ou cristalóides urinários após ileocistoplastia em cães, realizadas por meio da sutura com grampos inabsorvíveis de titânio e sutura com poliglactina 910, observando o impacto destes na função renal, alterações na constituição urinária e a diferença de tempo cirúrgico. Foram utilizados 12 cães saudáveis distribuídos igualmente em dois grupos. Em cada animal foi selecionado um segmento de íleo terminal para ampliação vesical. No grupo A realizou-se a sutura do segmento ileal detubulizado na bexiga com fio de poliglactina 910 e no grupo B a sutura foi confeccionada com grampos de titânio. Observou-se a presença de cristais de estruvita em 11 animais e formação de grande quantidade de muco na urina em todos. Foi

possível concluir que não houve diferenças significativas entre os grupos quanto à formação de cristais urinários e urólitos após o procedimento cirúrgico, o grupo A apresentou maior tempo cirúrgico e não houve evidências de alteração na função renal em ambos os grupos.

PALAVRAS-CHAVE: cálculos vesicais; cistectomia; síntese; sutura mecânica.

INTRODUCTION

Deficiencies in bladder storage capacity have considerable clinical relevance because they significantly affect life quality and may evolve to renal failure, thus posing a serious health threat (BRANDT et al., 2004).

The bladder is exposed to a variety of injuries, even during fetal development. In addition to congenital abnormalities, other disorders such as cancer, trauma, infection, inflammation and iatrogenic injuries eventually require bladder replacement or repair (SHOKEIR, 2002).

The most frequent causes for performing bladder reconstruction are neoplasms of the lower urinary tract – mainly carcinomas – especially in humans and dogs, vesical atony, interstitial cystitis, radiotherapy, chemotherapy, multiple bladder surgeries and some congenital bladder anomalies that cause incontinence. Bladder repair surgeries in dogs are recommended in cases of severe traumas, neoplasms and recurring interstitial cystitis (GREENWELL et al., 2001; PEREIRA et al., 2002; KOUSHYAR et al., 2007). Repair procedures seek to establish a low-pressure reservoir with capacity for continence, spontaneous micturition and minimum post-micturition residue (CRANDIS et al., 1998).

Bladder reconstruction is therefore crucial to correct disorders caused by low contention capacity and high pressure. Such disorders may be corrected by bladder augmentation by cystoplasty, which replaces part of the bladder after partial cystectomy (LAMESCH & DOCIU, 1983; PIECHOTA et al., 1998).

The limited amount of urothelium available for genitourinary reconstructive surgeries has increased interest in the development of tissues for bladder replacement. The gastrointestinal tract has proved to be an effective support for bladder reconstruction and it is available in the majority of patients (MERGUERIAN, 2000).

Bladder augmentation using an ileal segment as a surgical treatment for dogs was first described by Tizzoni and Foggi in 1888; they anastomosed part of the ileum to the vesical trigone following cystectomy. The first bladder augmentation in humans was performed by von Mikulicz in 1889. Since then, several techniques have been developed to improve bladder functionality as well as to reduce morbidity and common complications (LAMESCH & DOCIU, 1983; GREENWELL et al., 2001; PEREIRA et al., 2002; TANAKA & MENDES JÚNIOR, 2007). Improvement of surgical techniques has resulted in acceptable life quality and longer life for patients (TEIXEIRA et al., 2007).

It is of crucial importance to observe calculi and crystal formation within the urinary tract related to suture material, as well as to learn about its possible causes and prevention. Persistent crystalluria may result in crystal aggregation; if not excreted, crystals may lead to urolith formation, thus causing urinary tract injuries and predisposing to inflammations, infections, severe obstructive processes, bladder rupture, renal dysfunctions and death (GRAUER, 1994; LANGSTON et al., 2008).

The use of titanium staples on sutures during ileocystoplasties has been a source of investigation to several research groups, mainly because of the controversial use of non-absorbable materials in the urinary tract. Most studies that have related non-absorbable staples within the urinary tract to greater urolith formation have analyzed staples made of stainless steel or tantalum, not titanium. However, more recent studies describing the use of titanium staples have shown that they are well tolerated by the urinary tract and that other factors may be the main cause of urolith formation, such as urinary stasis, bacteriuria and mucus production. Therefore, the use of titanium staples as a wound closure material for the urinary tract has aroused the interest of researchers of experimental surgery, human urology and veterinary medicine, standing as a possible alternative for bladder augmentation (JULIAN & RAVITCH, 1986; BOOTHE, 1998; ABREU et al., 2005).

Further research regarding possible changes and benefits of titanium staples used within the urinary tract may provide useful information for the development of surgery techniques, as well as shed light on the behavior of these staples in the urinary system. Among these benefits is the reduction of surgical times in view of the practicality of staples, especially for high-risk patients (JULIAN & RAVITCH, 1986; DALL'OGLIO et al., 2000; ABREU et al., 2005).

The purpose of this study was to determine whether there are differences in the formation of uroliths and urinary crystalloid after ileocystoplasty in dogs, conducted by means of sutures with

nonabsorbable titanium staples and suture with polyglactin 910, noting the impact of the procedure on renal function, changes in urinary constituents and the time difference between surgical groups.

MATERIAL AND METHODS

This study was assessed and approved by the Ethics Committee of Universidade Federal de Goiás (register 07/2008).

Twelve clinically healthy male dogs, of undefined breed, weighing between 10 and 20 kg, were used in the experiment. Prior to their random distribution in two groups of six (groups A and B), the animals were submitted to clinical and laboriatorial examination via general clinical exam, complete blood count, serum urea and creatinine and urinalysis. The presence of crystals in the urine exam was an exclusion factor in the selection of experimental units. All animals were acclimated for approximately 20 days prior to surgical procedure.

The animals were anesthetized and positioned in dorsal recumbency, then prepared for surgery via antisepsis of the surgical field. Access into the abdominal cavity was performed by median retro-umbilical laparotomy. After locating the bladder and the terminal ileum at aproximately 20 cm from the ileocecal valve. Intestinal content was moved away and about 10 cm of the ileum was isolated to interrupt intestinal transit. Afterwards about 5 cm of this segment was sectioned and the vascularization area of the isolated portion was preserved (Figure 1A).

Intestinal continuity was restored by termino-terminal anastomosis using simple interrupted suture with 3-0 polyglactin 910 (Poly Suture Indústria e Comércio Ltda., São Sebastião do Paraíso - MG). The mesenteric opening was closed with simple separate stitches using the same material.

In group A, ileocystoplasty was performed using 3-0 polyglactin 910 with continuous Cushing suture. After isolating the ileum portion, an incision of approximately 6 cm transected the apex of the bladder up to the lumen. The antimesenteric border of the isolated portion was sectioned, thus exposing the loop mucosa. The ileal segment was sutured to the bladder and the mucosa surface of the graft faced the bladder lumen (figure 1B).

In group B, ileocystoplasty involved the use of an Ethicon Proximate ® 55 linear cutter stapler (Ethicon Endo-Surgery, Cincinnati - Ohio) containing a reload of Proximate® titanium staples (Ethicon Endo-Surgery, Cincinnati - Ohio). Staples measured 3,0mm/3,85mm prior to stapling and 1,5mm of closed height; the staple line measured 55 mm.

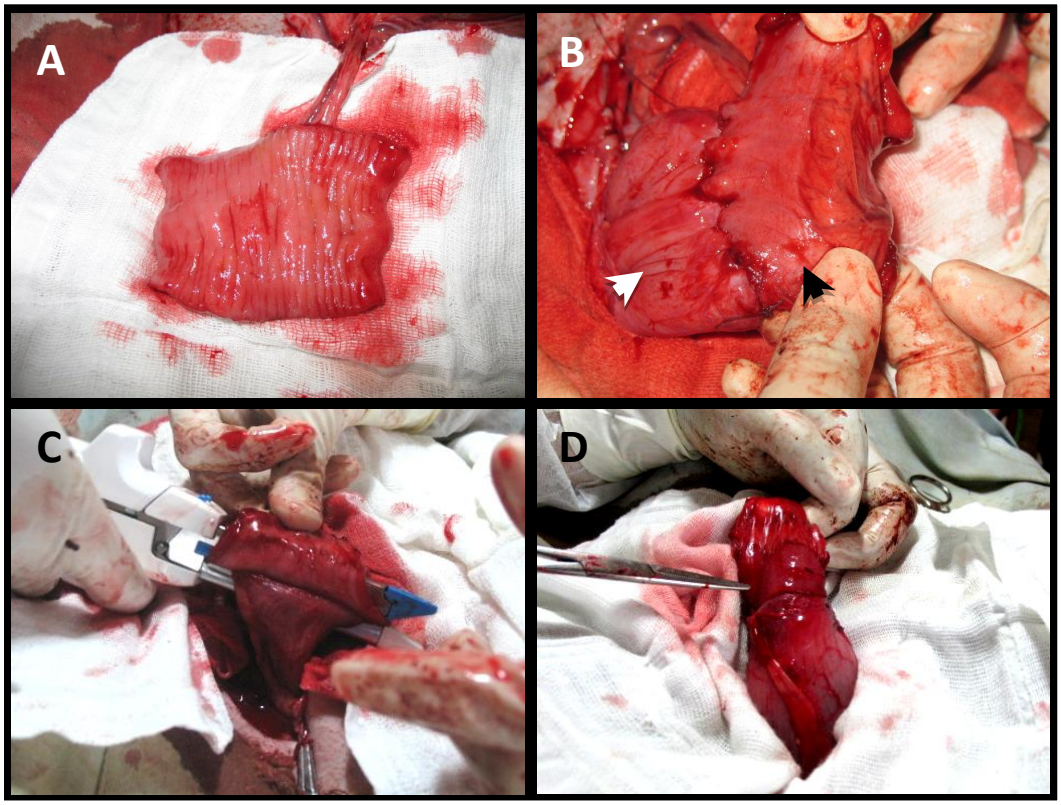

Figure 1 - Ileocistoplasty in dog. Ileal segment isolated (A), suture of ileal segment (black arrow) to the bladder (white arrow) with poliglactina 910 (B), insertion of Ethicon Proximate® in bladder and ileal segment (C), final aspect of ileocistoplasty with titanium staples (D).

After isolating the ileum terminal segment, two incisions were made on both sides of the bladder vertex up to the lumen. One of the anvils of the linear cutter stapler was inserted into the incisions and transected the apex of the bladder (Figure 1C). Another anvil crossed the lumen through the isolated ileal segment and joined it with the apex. The ileum was anastomosed to the bladder by the antimesenteric border. Care was taken not to twist or to staple the vascular pedicle of the intestinal segment. Once the stapler fired, the loop was sutured to the bladder at the ventral and dorsal portions of the apex of the bladder. Simultaneously to stapling, the area between the two staple rows was sectioned, thus exposing the mucosa from the intestinal loop segment to the bladder lumen. Regions on both sides of the apex of the bladder as well as open, unstapled areas of the loop ends were then sutured with 3-0 polyglactin 910 according to Cushing suture (Figure 1).

In both groups the abdominal musculature was sutured using a 2-0 nylon thread (Shalon Fios Cirúrgicos LTDA, Goiânia - GO) in simple separate stitches. Subcutaneous tissue approximation was performed by continuous suture with 2-0 nylon thread and skin suture was performed by continuous mattress suture with 2-0 nylon thread.

Postoperative care included antibiotic therapy consisting of enrofloxacin (Enrotec-50, FATEC AS, São Paulo - SP) administered subcutaneously (5mg/kg of live weight) twice a day for 7 days. Analgesia included subcutaneous administration of 2,5mg/kg of tramadol hydrochloride (Tramadon 50mg/ml, Cristália Produtos Químicos Ltda., Itapira - SP) twice a day, which started immediately before anesthesia and was maintained during the first three postoperative days.

At 100 days postoperatively, another surgical intervention was performed using the same laparotomic access and anesthetic procedure described previously. A macroscopic investigation sought eventual uroliths in the bladder, focusing on the visual aspect of the sutured area and on macroscopic characteristics of the intestinal segment. The entire graft area was removed. The bladder was sutured with 3-0 polyglactin 910 according to Cushing suture. Abdominal wall closure and postoperative care followed initial procedures.

Exams included total blood count, serum biochemistry, blood smear and urinalysis. Animals selected for the experiment showed crystal-free urine. Urine samples were collected via a bladder catheter. Physical testing of samples identified color, odor, aspect, density, mucus and spontaneous sediment formation. Urine was assessed in terms of chemical elements, such as nitrites, ketone bodies, urobilinogen, bilirubin, blood and hemoglobin. Albumin was the most predominant protein and its concentration was represented by crosses: one cross (+) amounted to 150mg/dl, two crosses (++) amounted to 300mg/dl and three crosses (+++) amounted to 500mg/dl, as stated by the kit manual. Urine pH was also measured on the reagent strip.

The elements found in the sediment were classified as organized and unorganized. The first group was formed by cells (erythrocytes, leukocytes, epithelial cells, bacteria, protozoa, parasite eggs, yeast, fungi and sperms) and cylinders. The second group was formed by crystals, mucus and amorphous material. The amount of elements found within the sediment, such as sperms, cylinders, squamous cells, crystals, leukocytes and erythrocytes was represented by crosses: one cross (+) corresponded to 2-4 elements per field, two crosses (++) corresponded to 4-6 elements per field and three crosses (+++) corresponded to 6 elements per field.

RESULTS AND DISCUSSION

None of the animals died during surgery or postoperative care and none revealed clinical signs of infections, digestive alterations such as vomit, diarrhea, constipation or obstipation, suture dehiscence or intestine/bladder fistulas. Animals showed quick postoperative recovery and maintained spontaneous micturition on surgery day; there was no need to eliminate urine through bladder catheterization. Urinary continence was preserved in all animals, was observed soon after anesthetic recovery and was maintained throughout the experimental period.

After 100 days of postoperative care, the intestinal segment and its vascular pedicle were macroscopically distinguished from the bladder tissue in both groups. Moreover, a few adherence areas were observed.

The ileal segment used in ileocystoplasties showed peristaltic movements in all animals from both groups, according to direct observation during the second surgical procedure. This may have helped to eliminate urine due to stimulus caused by distension of the augmented bladder.

Hematuria affected all animals during the first three postoperative days (Table 1), probably due to surgical trauma and not as a complication of ileocystoplasty. Protein was verified in all urine samples and even in urinalyses performed before ileocystoplasties, though with no evidence of

cylinders; this may suggest that the proteinuria found had a post-renal or physiological origin, especially given the fact that samples were collected by catheterization. Postrenal proteinuria may result from bleeding traumas, including those caused by catheterization, especially when many red blood cells are present. Trauma from urine collection may also be responsible for hematuria and for a possible irritation caused by urine in the flap.

Table 1 – Frequency of distribution of dogs submitted to ileocystoplasty showing red blood cells in uranalyses

Groups assessed	Red blood cells/field*	No. of animals with hematuria (preoperatory)	No. of animals with hematuria (3 days)	No. of animals with hematuria (45 days)	No. of animals with hematuria (90 days)
Group A	0	6	0	3	2
	1	0	0	0	0
	2	0	0	0	1
	3	0	6	3	1
	several	0	0	0	2
Group B	0	6	0	3	1
	1	0	0	1	2
	2	0	0	0	1
	3	0	6	0	0
	several	0	0	2	2

*Scores: 0=absent; 1=light; 2=moderate; 3=intense

Hemoglobinuria was observed in two animals from each group at 90 days postoperatively, but its reduced amount did not signal a significant change. A considerable amount of red blood cells was found in the urine of the animals tested; many red blood cells were counted per field in three samples and three were counted in the fourth sample.

All animals showed considerable amounts of mucus in the urine as from the first postoperative days. This was confirmed by the viscous aspect of urine during the first urinalysis performed 45 days postoperatively. However, none of the animals suffered from obstructive processes as a result of this change; therefore, catheterization for bladder emptying during postoperative care was not necessary.

Serum urea and creatinine exams performed prior to surgery and 45 and 90 days postoperatively did not show any significant renal changes, considering reference values of up to 1.80 mg/dl for creatinine and up to 54 mg/dl for urea.

Stapling the ileum to the bladder revealed lower mean intervals than the thread suture (Group A: mean=68.17 min, standard deviation= 17.20; Group B: mean=42.50 min; standard deviation=7.58); bladder suture time was reduced in about 25.67 minutes (Table 2). The shortest intervention period of stapling surgeries was largely due to the time reduction required for bladder sutures.

Table 2 – Mean surgical times recorded in ileocystoplasties performed on dogs using two types of suture material.

Groups assessed		Surgery time (minutes)	Bladder suturing time
Group A	Mean	146.17	68.17
	Standard deviation	26.87	17.20
Group B	Mean	107.67	42.50
	Standard deviation	18.12	7.58
Total	Mean	126.92	55.33
	Standard deviation	29.69	18.45

Urine extravasation in the sutured area was observed in animals from group A during bladder sutures, which made it necessary to reinforce the suture at several points, thus increasing the intervention period in the bladder. As for the animals from group B, urine extravasation was not reported at any point of the stapled area.

Decreased mean surgical time in group B may also be due to the reduced time to hemostasis during bladder augmentations. The stapling technique resulted in effective and immediate hemostasis after staples were fired, and there were no reports of bleeding points along the stapled area. Group A required the correction of bleeding areas at various intervals along the suture, which resulted in differences of up to 64 minutes in bladder augmentation times (Table 2).

During the second exam performed 45 days postoperatively, a small amount of crystalluria was observed in three animals; the urinalysis revealed + crystal in one animal from group A and in two animals from group B. During the third exam performed 90 days postoperatively, only one animal from group A did not have crystalluria, whereas all the others from both groups had at least + crystal, as it is shown in Table 3. As regards two animals that showed +++ crystals, crystalluria was verified by visual inspection of the sample and macroscopic visualization of crystals was possible even before urine sedimentation.

Table 3 - Distribution of frequencies of dogs submitted to ileocystoplasty according crystalluria

	Cristalluria	No. of animals with cristalluria (45 days)		No. of animals with cristalluria (90 days)	
		Frequency	Percentage	Frequency	Percentage
Group A	0	5	83,3	1	16,67
	+	1	16,7	3	50,00
	++	0	0	1	16,67
	+++	0	0	1	16,66
	Total	6	100	6	100
Group B	0	4	66,7	0	0
	+	2	33,3	1	16,7
	++	0	0	2	33,3
	+++	0	0	3	50,0
	Total	6	100	6	100

At 100 days postoperatively it was not possible to macroscopically visualize the suture material used in ileocystoplasty in group A – neither by visual inspection nor by sectioning – when the grafted segment was removed. Exposed staples were not seen in group B; however, sectioning revealed completely covered staples along the stapled area, with the exception of one animal in which a single staple was exposed to the mucosa surface or triggered a rejection process.

One of the animals from group A had a small loose bladder calculus measuring approximately 1 mm; in addition, uranalysis performed 90 days postoperatively on this animal revealed +++ crystals; these could be seen soon after urine collection, even before its sedimentation. The formation of a bladder calculus measuring approximately 4 mm was reported within the sutured area of an animal from group B. Following manipulation the calculus adhered to a staple exposed to the bladder lumen (Figure 2).

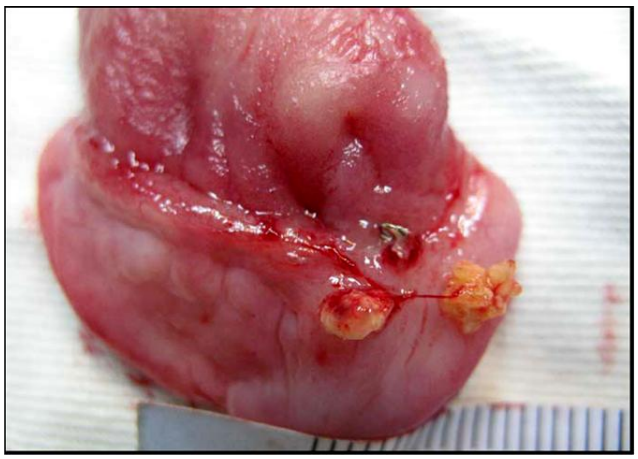

Figure 2 - Transition area of the ileal segment with bladder showing exposed titanium clip that was formed in the bladder calculus in dog.

Surgical and postoperative conditions were similar to those found in the literature. Deaths and other complications did not occur.

Peristaltic movements within the ileal segment used in bladder augmentation may help eliminate urine due to the stimulus caused by distension of the augmented bladder. According to LAMESCH & DOCIU (1983), small intestine submucosa showed contractile activity and innervation similar to those of the bladder.

During the second surgical intervention, the distensibility of the graft resembled that of the bladder tissue; this finding has also been reported in a study performed with dogs by MERGUERIAN (2000).

The ileal segment selected for ileocystoplasties, at approximately 20cm from the cecum, was easily located and mobilized, which favored its implant within the bladder. Its vascular anatomy facilitates isolation, as described by GRECA et al. (2004) and TANAKA & MENDES JÚNIOR (2007).

According to GARCIA-NAVARRO (1996), false hemoglobinuria may result from the rupture of red blood cells in the urine, leading to hematuria. Distinguishing true hemoglobinuria – originated from hemoglobinemia – is possible by checking intact red blood cells in the urinary sediment, which was observed during our experiments.

As regards the adaptation of intestinal mucosa – in terms of structure and functionality – in relation to bladder mucosa, obstructions such as mucus production and urinary retention may occur (BARROSO JÚNIOR et al., 2000; VILAR et al., 2004), leading to late bladder rupture, though they do not normally do so (KOUSHYAR et al., 2007). In association with other factors, their presence may be a major source of calculi in patients submitted to bladder augmentation using intestinal segments, as described by NURSE et al. (1996). According to GOUGH (2001) the mucus produced following cystoplasty may facilitate urinary calcium aggregation and may act as nucleus to the formation of uroliths.

Besides the fact that mucus is not easily eliminated, the absence of a mucous layer is not recommended because it may protect the intestinal epithelium from urinary carcinogenesis and other components in the urine, all of which may be incorporated by the intestinal segment (NURSE et al., 1996). Preserving the submucosa layer may be crucial to prevent fibrosis and contraction of the grafted segment, as described by MERGUERIAN (2000) and GREENWELL et al. (2001). Such findings extracted from the literature influenced our option to preserve the mucosa and submucosa layer of the intestinal segment.

Reduced surgical time in the group on which titanium staples were used may help minimize risks inherent to prolonged surgeries, especially in critical patients, as described by JULIAN & RAVITCH (1986), DALL'OGLIO et al. (2000) and ABREU et al. (2005).

Although the literature fails to report differences related to urine extravasation and to hemostasis on sutured areas, comparing the wound closure materials used in this study enabled us to observe important findings regarding surgical times.

The presence of crystals in the first urine exam was an exclusion factor in the selection of experimental units; this was the reason for the absence of crystalluria in the first exam. In both groups of animals the amount of crystals may have resulted from factors unrelated to wound closure material, because their presence was observed in almost all experimental units, regardless of the group; this fact has also been highlighted by NURSE et al. (1996) and HENSLE et al. (2004).

Triple phosphate crystals were identified in all animals with crystalluria; this is compatible with findings in the literature (NURSE et al., 1996; BARROSO JÚNIOR et al., 2000; GREENWEL et al., 2001; TANAKA & MENDES JÚNIOR, 2007). This signal a predominance of this type of crystal in patients submitted to bladder augmentation using intestinal segments. According to NURSE et al. (1996) and BARROSO JÚNIOR et al. (2000), crystal formation may be related to mucus, urinary stasis and bacteriuria, not only to the type of suture material used. Even though cultures for bacteria identification were not performed in the urine of animals, the occurrence of triple phosphate crystals in all animals with crystalluria may suggest that bacteria in the intestinal segment influenced their formation directly, despite the absence of symptoms of urinary tract infection, as described by NURSE et al. (1996), SEAMAN & BARTGES (2001) and RINKARDT & HOUSTON (2004).

The staple seen on the mucosa surface possibly acted as the nucleus for urolith formation, in addition to other factors that influenced crystal precipitation. Risk of lithiasis increased, as it is also suggested by other studies of TANAKA & MENDES JÚNIOR (2007).

Quantitative differences were not registered in bladder calculi formation in the experimental groups. However, the location of calculi formation may have suffered influence from wound closure materials, particularly from the titanium staple that was not covered properly, as described by DANGMAN & LEBOWITZ (1991). According to ABREU et al. (2007), it is possible that, had the

staple not been exposed to the bladder mucosa, calculi might not have formed on the stapled area. Calculi formation may not be solely linked to the material used, but also to factors such as excessive mucus, which was observed in all animals of this study and similar studies (SEAMAN & BARTGES, 2001; RINKARDT & HOUSTON, 2004). According to previous study (ABREU et al., 2005), titanium is well tolerated by the urinary tract because of its low toxicity, natural corrosion resistance and biocompatibility with fluids and tissues.

The entire ileal graft was removed during the second surgery to prevent future complications caused by its presence within the bladder, as the animals were put up for adoption following the experiment.

CONCLUSION

In short, our findings reveal that the use of titanium staples inileocystoplasties did not show significant differences regarding urinarycrystal and urolith formation, when compared to the use of polyglactin 910after 100 postoperative days; renal parameters assessed by clinical exam andserum urea/creatinine were in normal reference values in both groups; the stapling technique reduces suturing time in ileocystoplasties

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