Cystotomy Closure Using a Single-Layer Simple Continuous Versus Continuous Cushing Suture Patterns in Dogs

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Abstract

Two types of single-layer closure techniques were investigated on experimentally induced cystotomy in eight dogs divided equally and randomly into two groups (A and B). In animals of both groups, cystotomy was created experimentally on the ventral aspect of the urinary bladder (U. B.) wall through conventional midline ventral laparotomy. In group A, the cystotomy wound was closed by single-layer, full thickness, simple continuous (FTSC) pattern, whereas in group B, the closure was performed by single-layer continuous Cushing (CC) pattern, using polyglactin-910 (3/0) in both groups. The efficiency of cystotomy wound healing and a urine-tight seal of the reconstructed U. B. were explored at 14th and 28th post-operative (P.O.) days by general urine exam, contrast X-ray visualization by negative air media, postmortem inspection and histological interpretation.

In both groups (A and B), the general urine exam showed no precipitation of oxalate and struvit crystals. A strong urine-tight seal of the reconstructed U. B. was also evident in either group as indicated by the X-ray images. The postmortem inspection revealed optimal healing at the site of cystomy wound closure on the 14th P. O. day, however slight to moderate adhesions were observed in two dogs (one in either group). The histological examination of the U. B. biopsies showed that the morphological appearance of the healing process of the cystotomy wound was similar in both groups. Normal epithelization of the mucosal layer and normal structural appearance of the muscularis and serosal layers at the site of cystomy closure were apparent in animals of both groups on the 14th P. O. day. In conclusion, the results of the present study revealed that the efficiency of the FTSC was equal to that of the CC in all comparison parameters.

غلق بضع المثانة باستخدام طبقة واحدة من نمط الخياطة المستمرة البسيطة مقارنة مع نمط خياطة كشن المستمرة في الكلاب

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الخلاصة

قسمت ثمانية كلاب بشكل عشوائي الى مجموعتين متساويتين (أ و ب) وتم بضع الجانب ألبطني للمثانة تجريبيا في حيوانات كلتا المجموعتين من خلال إجراء عملية فتح بطن تقليدية في الجزء الأسفل من الخط الوسطي للبطن. أغلق جرح بضع المثانة في حيوانات المجموعة أ بواسطة نمط الخياطة المستمرة البسيطة لكامل ثخن الجدار فيما تم غلقه في حيوانات المجموعة ب بواسطة نمط خياطة كشن المستمرة بخيط البوليكلاكتين−910 حجم 0/3 في كلتا

المجموعتين. أجري التحري عن كفائة التئام جرح بضع المثانة وعن عدم نفوذيتها للبول في اليومين الرابع عشر والثامن والعشرين بعد اجراء العملية بواسطة فحص الادرار العام والتصوير ألشعاعي المتباين بواسطة الوسط الهوائي السلبي والتشريح المرضي و الفحص النسيجي المرضي. أظهر نتائج فحص الادرار العام عدم وجود ترسبات لاملاح الاوگسالات والستروڤيت كما بينت صور الأشعة السينية السداد المحكم للبول في المثانة البولية في كلتا المجموعتين. وأظهرت نتائج التشريح المرضي تكون إلتئام سليم في مكان غلق جرح بضع المثانة في اليوم الرابع عشر بعد اجراء العملية ولكن مع تكون التصاقات خفيفة الى متوسطة في أثنين من الكلاب (واحد في كل مجموعة). أما نتائج الفحص النسيجي لخزعات المثانة البولية فقد بينت أن المظهر الشكلي لعملية إلتئام جرح بضع المثانة كانت متشابهة في كلتا المجموعتين حيث لوحظ تكون ظهارية طبيعية في الطبقة المخاطية ولوحظ أيضا سلامة المظهر التكويني للطبقتين العضلية والمصلية في حيوانات كلتا المجموعتين في مكان غلق جرح بضع المثانة في اليوم الرابع عشر بعد اجراء العملية. دلت هذه النتائج على أن كفائة نمط الخياطة المستمرة البسيطة لكامل ثخن جدار المثانة كانت مشابهة لكفائة نمط خياطة كشن المستمرة في كافة مقاييس المقارنة التي اعتمدت في هذه الدراسة.

Introduction

Cystotomy is incision into the urinary bladder. Cystotomy may be performed for removal of cystic and urethral calculi, identification and biopsy of mass lesions, repair of ectopic ureters, or diagnosis of urinary tract infection resistant to treatment (1). Traditionally, cystotomy is performed by conventional laparotomy, which is an invasive procedure that can be associated with complications compared to laparoscopy which is minimally invasive, associated with a low morbidity and permits excellent observation of the bladder (2). The most frequent complications of cystotomy are urine leakage, calculus recurrence and adhesions (3). It is well recognized that urine leakage causes unfavorable consequences to wound healing such as delayed healing, increased inflammatory responses and stricture formation. (4). Thus, perfect suturing of cystotomy wounds is extremely important to obtain a urine-tight seal to avoid these consequences (5). The choice of suture material for closure of urethral, bladder and ureteral incisions has been studied extensively. Although results of these studies are not uniform, but several statements can be made. Prolonged intraluminal exposure of suture material may provide a nidus for mineral deposition and formation of calculi (6). Non-absorbable suture materials, such as Polypropylene and Nylon, although not required as the tissues of the urinary tract typically heal rapidly, but have been used frequently in urinary surgery and reported to produce an intense inflammatory response when used for ureteral repair (7). The absorbable synthetic sutures (polydioxanone, polyglactin-910, and polyglycolic acid) have all been used successfully (8 and 9) whereas chromic gut is associated with more severe inflammatory response and less predictable duration of tensile strength than synthetic absorbable sutures(10). Prolonged intraluminal exposure to polydioxanone has been reported following urethral repair (8). Polyglycolic acid suture retains tensile strength longer than polyglactin-910 in acid urine and the reverse is true in neutral or alkaline urine (9). Several patterns have been recommended for the closure of cystotomy incisions. Appositional closure using a single or double layer simple continuous suture pattern results in earlier and more advanced healing than the traditional double inverting suture pattern (11). The aim of the study was to evaluate cystotomy closure in dogs by single-layer continuous Cushing (CC) Vs full thickness, appositional simple continuous.

Material and Methods

Eight stray dogs, of 8.5-14 (10.4 ± 1.8) kg, weight and 8-12 (10.7 ± 3.6) months age from both sexes were used. All dogs were healthy and free of congenital or acquired diseases as indicated by their physical and clinical examination. The animals were treated for internal and external parasites, vaccinated against rabies and canine distemper and accommodated for indoor living two weeks prior to surgery. The dogs were divided randomly and equally into two groups (A and B). In group A the cystotomy wound was sutured by single-layer full thickness simple continuous (FTSC) pattern whereas, in group B, it was sutured by single-layer continuous Cushing (CC) pattern, using polyglactin-910 (size 3-0). The dogs were fasted 24 hours prior to surgery. During this period, the ventral abdominal wall was aseptically prepared for the operation. Preanesthetic medication with atropine sulphate at a dose of 0.02 mg/kg body weight was given intramuscularly. Ten to 15 minutes later, a mixture of xylazine 2% (1 mg/kg) and ketamine 5% (10 mg/kg) was given by intramuscular route. Incremental doses from the same mixture were given to the animals as needed when the plan of surgical stage of anesthesia was extended. The animals were positioned on dorsal recumbence assisted by two sand bags on either side and a third sand bag was placed under the pelvis to provide slight elevation of the lower part of the animal body. The hind limbs were pulled backward and laterally, whereas the fore limbs were pulled forward and laterally and all were fixed to the surgical table. Urine collection and evacuation of urine from the bladder were performed in male dogs by urethral catheterization with a proper-sized cuffed Foley catheter, whereas in female dogs, urine collection and bladder emptying were performed by direct aspiration of urine with a sterile 50 ml syringe from the bladder after creation of celiotomy and exploration of the abdominal cavity. Experimental dogs of both groups (A and B) were subjected to routine midline ventral laparotomy. Following abdominal exploration, the U. B. was identified, explored and isolated from the abdominal viscera with moistened sterile laparotomy towels. Two retention sutures were placed on the cranial and caudal ends of the bladder which was then completely evacuated using a 50 ml syringe supplied with a 20-gauge needle. A 3-5 cm stab incision was made by a scalpel on the ventral bladder wall. This stab incision was extended by a scissor cranially and caudally and the bladder cavity was explored for the presence of bladder lesions or calculi and flushed with warm saline before closure. The cystotomy wounds were closed by single-layer FTSC in group A (Fig. 1) and by single-layer continuous Cushing pattern in group B. In both groups, cystotomy wounds were sutured with 3/0 Polyglactin-910. Postoperative concern included monitoring of animals physical status, daily intramuscular injection of systemic antibiotic (penicillin (10.000 IU/ kg) and streptomycin (20 mg/ kg) for 3 days and daily wound care by wound dressing and application of antibiotic spray. The skin sutures were removed 8-10 days post operation.

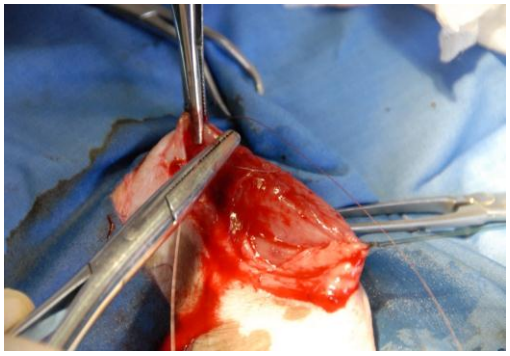

Fig. (1) Closure of the cystotomy wound by a single-layer, full thickness, simple continuous pattern in a dog from group A

Four randomly chosen dogs (two dogs from each group) were subjected to general urine exam, X-ray, postmortem inspection and biopsy collection on the 14th P.O. day and the remaining dogs were subjected to the same tests on the 28th P. O. day. Under the effect of general anesthesia, urine sample was collected from each dog for general urine exam by means of Foley catheter for male dogs and stainless steel Bitch catheters for the females. Following that, the U. B. was completely evacuated and was viewed by contrast X-ray using negative air media. The X-ray were taken on ventro-dorsal position by an X-ray machine as follow: KV 60; MAs 0.15 Sec; Distance 50-60 cm. At last, the dogs were euthanized for postmortem inspection and biopsy collection. The postmortem inspection was performed to detect the presence of any gross lesion related to cystotomy closure such as leakage, wound healing complications, and calculi formation within the U.B. Biopsies of 0.5 cm length and width were obtained from all dogs from the site of cystotomy closure and incubated in 10% neutral buffered formaline for 48 hours. Following that, they were exposed to a series of histological preparations prior to sectioning and staining with hematoxylin and eosin dyes (12).

Results

Generally, all operated dogs were depressed and showing signs of restlessness following recovery from the effect of anesthesia but none of them showed P.O. anurea. However, all dogs started to retain normal physical activity, food intake and urination 1 to 2 days post operation. At the 5th to the 7th P.O. days, all of the eight experimental dogs were completely restored their normal health and none of them died or showed clinical post-cystotomy complications. The results of general urine exam for the post-cystotomy samples of both groups (A and B) didn't showed a significant divert in the urine parameters from the pre-operative control samples. In addition, none of the urine samples at the 14th and 28th P.O. days, showed precipitation of oxalate or struvit salts. The contrast X-ray images that were taken using negative air media on the 14th and 28th P.O. days in both groups revealed that the urinary bladders were air-tight (Fig. 2, A and B), and thus, indicated retention of an adequate tensile strength on the cystotomy suture line.

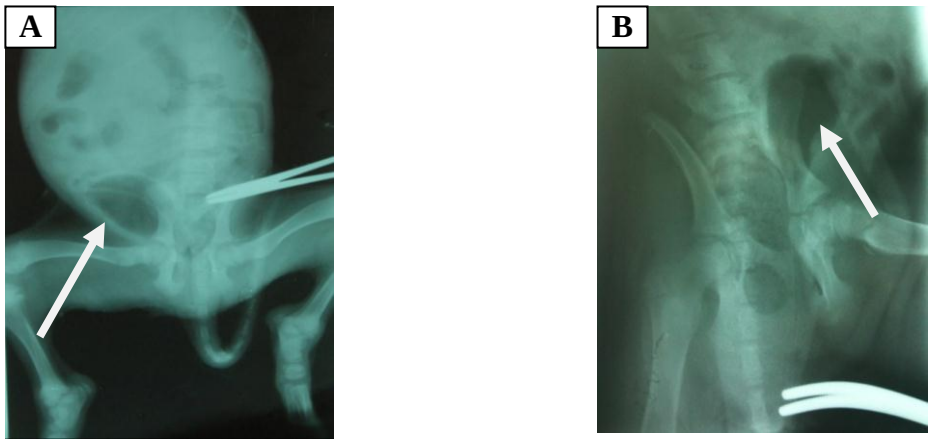

Figure (2) Ventro-dorsal, contrast X-ray images using negative air media for a male dog in group A at the 14th P.O. day and for a female dog in group B at the 28th P.O. day. The white arrows on both X-ray images show air-tight urinary bladders with no signs of leakage

The macroscopic postmortem inspection revealed no differences, regarding the efficiency of the cystotomy wound healing, between the two suture patterns used in this study. In animals of both groups (A and B), optimal healing was evident at the site of cystomy closure on the 14th and the 28th P. O. days and the polyglactin-910 stitches were still clearly visible beneath the serosal layer (Fig. 3) on the 14th P. O. day. However, slight to moderate adhesions were observed in two dogs (one in either group). The sites of adhesion were between the peritoneum and abdominal wall at the site of laparatomy incision and between the urinary bladder and the surrounding viscera (Fig. 4), nevertheless, none of these adhesions were serious to the extent that they could restrict bladder function.

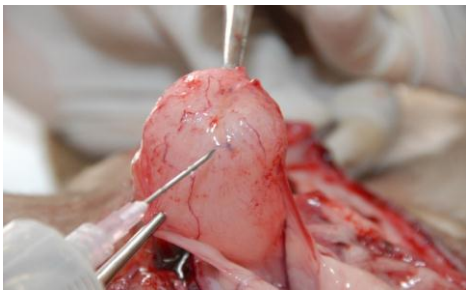

Fig. (3) Optimal healing of the cystotomy wound in one dog of group A at the 14th post-operative day. The polyglactin-910 stitches are clearly visible beneath the serosal layer

Fig. (4) Omento-bladder adhesion in one dog of group B at the 28th post-cystotomy day

Histologically, normal epithelization of the mucosal layer and normal structural appearance of the muscularis and serosal layers at the site of cystomy closure were apparent in bladder biopsies obtained from animals of both groups on the 14th P. O. day associated with insignificant pathological alterations represented by slight fibrous connective tissue proliferation, angiogenesis and slight infiltration of mononuclear inflammatory cells (macrophages, lymphocytes, and plasma cells) in the lamina propria and serosal layers (Fig. 5). At the 28th P. O. day, the inflammatory cells and the newly formed blood vessel had largely disappeared. However, marked thickening of the serosal layer associated with focal loss of the mesothelial integrity, fibrous connective tissue proliferation and slight infiltration of mononuclear inflammatory cells were evident in the bladder biopsy obtained from the dog which showed omento-bladder adhesion in group B (Fig. 6).

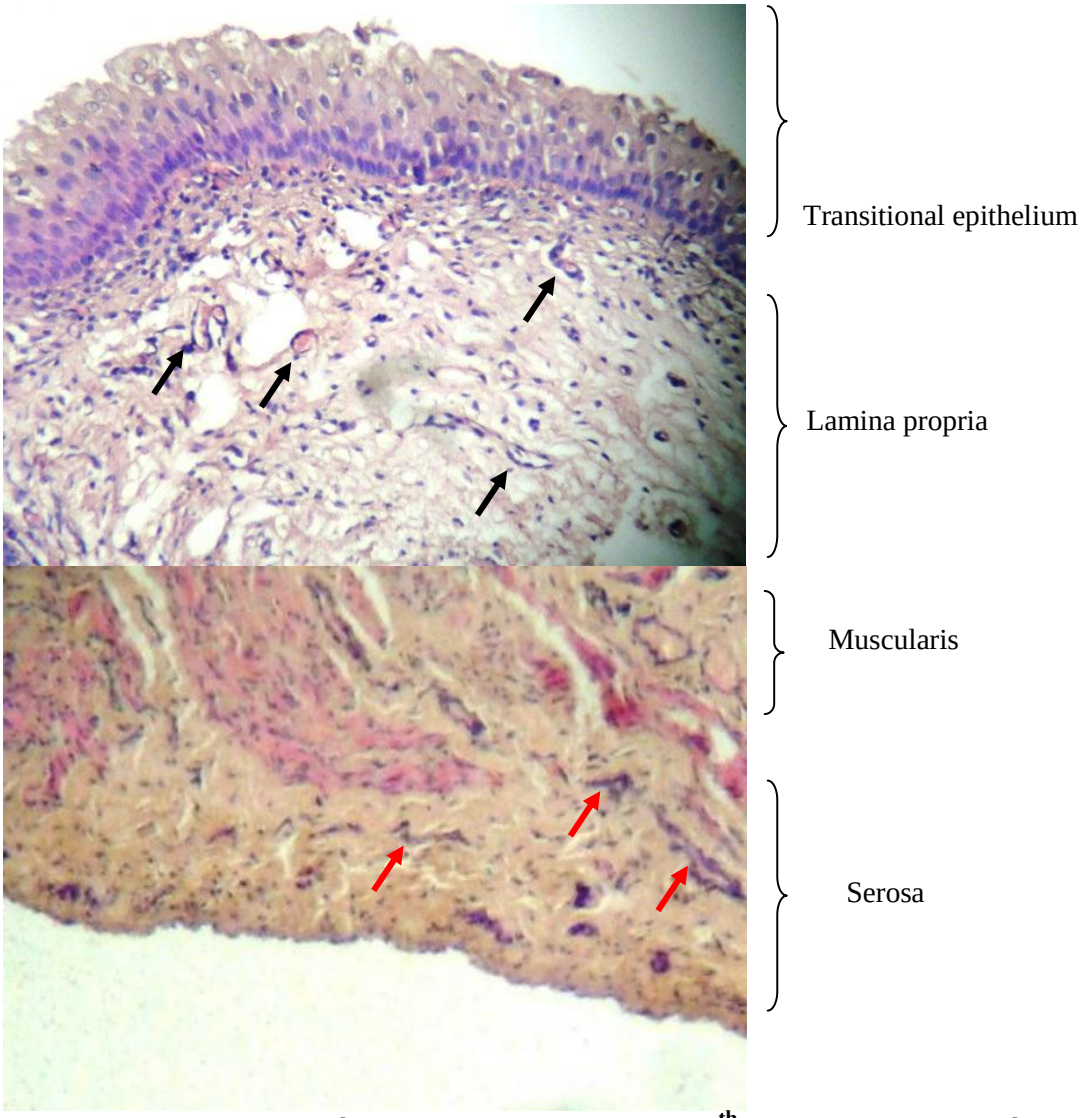

Fig. (5) A hisotomicrograph of a biopsy obtained at the 14th post-operative day from the urinary bladder of group A dogs. It shows normal epithelization of the mucosal layer associated with slight fibrous connective tissue proliferation, angiogenesis (black arrows) and slight infiltration of mononuclear inflammatory cells in the lamina propria. The deeper muscularis and serosa layers of the tissue in the lower section form the figure shows angiogenesis (red arrows) and slight infiltration of mononuclear inflammatory cells in the serosal layer, otherwise the histological structure of the muscularis and serosal layers appears normal. H and E stain, X 200.

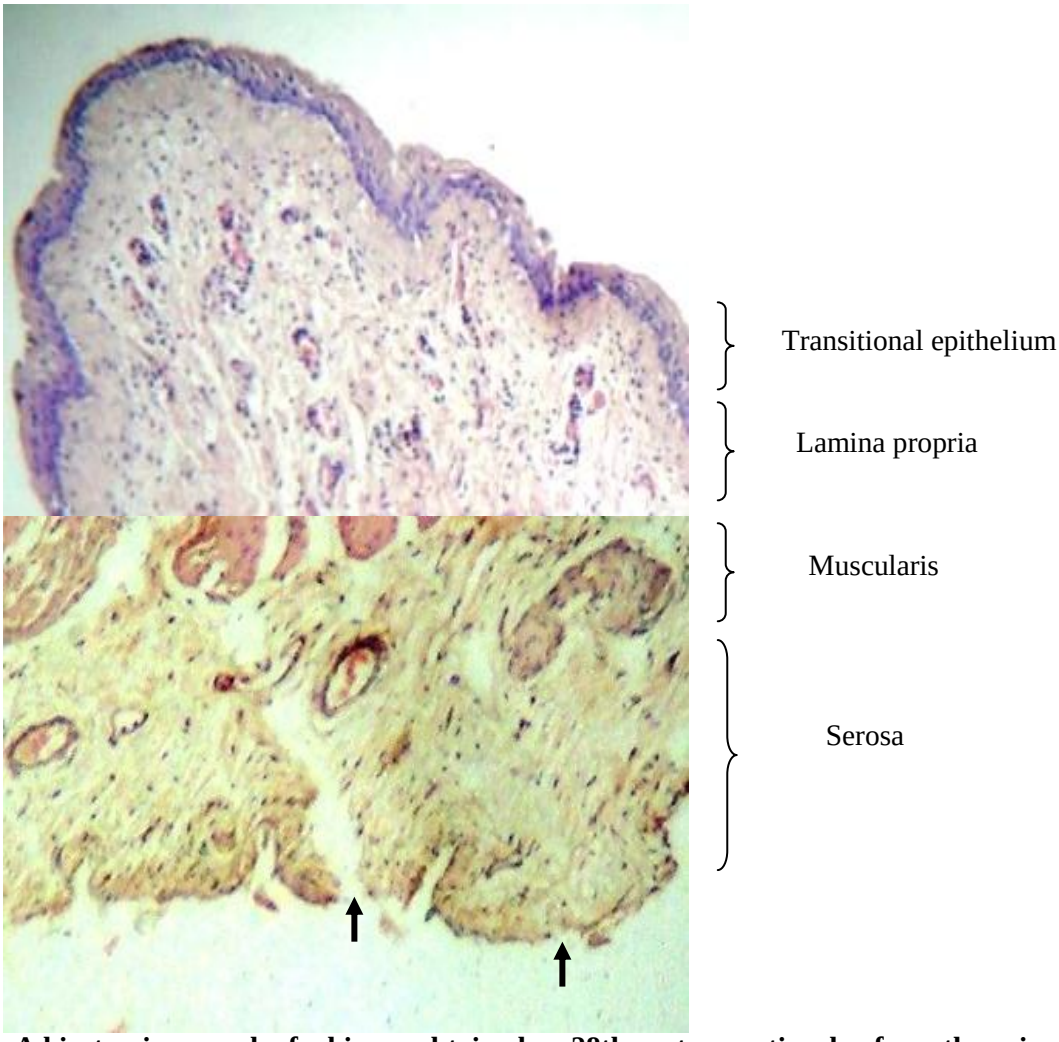

Fig. (6) A hisotomicrograph of a biopsy obtained on 28th post-operative day from the urinary bladder of one of group B dogs. It shows normal epithelization of the mucosal layer associated with slight fibrous connective tissue proliferation and slight infiltration of mononuclear inflammatory cells in the lamina propria. The muscularis and serosa layers for the tissue section at the (lower part of the figure) shows marked thickening of the serosal layer associated with focal loss of the mesothelial integrity (black arrows), slight fibrous connective tissue proliferation and slight infiltration of mononuclear inflammatory cells. H and E stain, X 200

Discussion

The principles of the surgical closure of hollow organs have evolved from a historic belief in the importance of the routinely practiced double-layer closure pattern to achieve adequate healing and a watertight seal over the single-layer appositional closure pattern to achieve anatomic reconstruction, healing, minimized reductions in luminal diameter, and watertight seal (13-16). However, the results of the present study revealed that both patterns of the single-layer suture techniques used for the closure of cystotomy wound (FTSC pattern and CC pattern) were very reliable as indicated by the air-tight X-ray images of the reconstructed urinary bladders, the lack of oxalate or struvit salts precipitation in the urine samples collected at the 14th and 28th P.O. days and the optimal healing at the site of cystomy closure which was apparent macroscopically and microscopically at the 14th and 28th P. O. days. The optimal healing at the site of cystomy closure on the 14th P.O. day is in agreement with that of another study (17) whom suggested that the major reparative

processes of the U. B. have been accomplished in 14 days. No differences were seen regarding the efficiency of the cystomy closure healing between FTSC pattern and CC pattern concerning the different parameters used in the present study including the general urine exam, X-ray, postmortem inspection and histological examination. The selection of the single-layer FTSC pattern and CC pattern rather than the double-layer pattern for closure of cystotomy wound has resulted in reducing the operative time and the use of minimal amount of suture material and knots that remain at the site of closure. Similar findings were observed in laparoscopic studies performed in human patients, suffering from bladder lacerations, by single-layer closure pattern using simple interrupted or continuous sutures through the full thickness of the bladder wall (18-20). These findings are also supported by experimental studies performed in dogs and stated that healing of cystotomy wound closure obtained by the single-layer appositional pattern is as strong as that obtained by the double-layer continuous inverting suture pattern (11 and 21). Furthermore, they are supported by the successful use of single-layer FTSC suture pattern to repair urinary bladder rupture in four postpartum mares (22). The general urine exams, performed on urine samples collected during two consecutive post-cystotomy periods (14th and 28th P. O. days) in the present study, showed no oxalate or sruvit crystals precipitate. This finding is ascribed to the type of suture mattress used (polyglactin-910) which seems not to form a nidus for bladder stone formation as it has been reported to possess a better biocompatibility with a less intense inflammatory reaction and a few areas of degenerated tissue (23). Similarly, the air-tight X-ray images, obtained during the same periods indicated the retention of an adequate tensile strength on the cystotomy suture line. This finding is once again attributed to the type of suture mattress (polyglactin-910) used in the present study (1 and 23). The histological examinations of the U. B. biopsies showed that the efficiency of the healing process of the cystotomy wounds was similar in both groups. Normal epithelization of the mucosal layer in animals of either group was apparent on the 14th P. O. day associated with slight fibrous connective tissue proliferation, angiogenesis and slight infiltration of mononuclear inflammatory cells in the lamina propria and serosal layers. Such a satisfied result can be attributed to the suture patterns used for closure of the cystotomy wounds in both groups (single-layer FTSC pattern and CC pattern) because the single-layer patterns are proved to be much better than the double-layer pattern for the surgical closure of hollow organs (15). At the 28th P. O. day, the inflammatory cells and the newly formed blood vessel had largely disappeared. This finding is ascribed to the maturation process which normally takes place at the site of surgical wound healing from the 14th to the 70th P. O. days (24 and 25). Histopathological changes represented by marked thickening of the serosal layer associated with focal loss of the mesothelial integrity, fibrous connective tissue proliferation and slight infiltration of mononuclear inflammatory cells were evident in the bladder biopsy obtained from the dog that shows omento-bladder adhesion in group B. This displeased finding is not surprising in view of the possibility of adhesion formation at the suture line of the cystotomy wound because the conventional surgical suturing often leave dead tissue within the body that may act as a focus for infection and adhesion (26). In conclusions, cystotomy wound closures by both suturing pattern used in the present study (single-layer FTSC pattern and CC pattern) were found similar. They were equal biomechanically and histologically in all comparison parameters. It was also concluded that both suturing patterns used in the present study resulted in healing of cystotomy wounds to a urine-tight level on the 14th P.O. day.

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