A Comparative Study between Inverting and Appositional Suture Patterns for Cystotomy Closure in Dog

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Summary

The present study is designed to evaluate two sutures pattern techniques (inverting and appositional) for urinary bladder closure following experimental cystotomy in dogs. Thirty two adult local breed males' dogs were enrolled for this study, aged 1-3 years and weighing 18-23 kg. Dogs were randomly allocated into two equal groups. In the first group, cystotomies were closed via double-layers of continuous inverting suture pattern (Lambert and Cushing); while, in the second group, bladders incisions were closed by single-layer appositional suture pattern (simple interrupted) which did not involve the mucosa (extra-mucosal). Synthetic absorbable suture material poly-diaxnone PDS 3/0 was used to close the bladder in all experimental animal groups. Surgery was done under the effect of general anesthesia using a combination of ketamine at a dose rate of 15mg/kg and xylazine at a dose 5mg/kg B.W. Dogs were premedicated by atropine sluphate at a dose 0.03mg/kg. All drugs administered intramuscularly. There were highly significant (P <0.05**)** differences in operative times between the two groups. In inverting group, the time was 40 ± 4.50 minutes which was higher than that recorded for appositional group 25±2.50 minutes. The animals were followed-up clinically during the studied period to record the secondary complications. Results reflected hematuria n=4, swelling of the operative site n=3 and urinary incontinence n=2. These complications were transient and disappeared in a short time. Also macroscopical and microscopical examinations were performed at 3,7,14 and 21 days post-surgery. Four dogs were used for each period. The main macroscopical finding was slight to moderate adhesions n = 3 between omentum and the wall of urinary bladder in both group. Microscopical examination of urinary bladder reflected earlier urolithium formation in appositional pattern (14 days) while inverted group (21 days). In conclusion, appositional pattern is technically easier and economic. Bladder regeneration was accomplished within 14 days in comparison with inverting pattern which reflected bladder regeneration at 21 days post-surgery.

Keyword: Cystotomy, Inverting, Appositional, Dogs.

Introduction

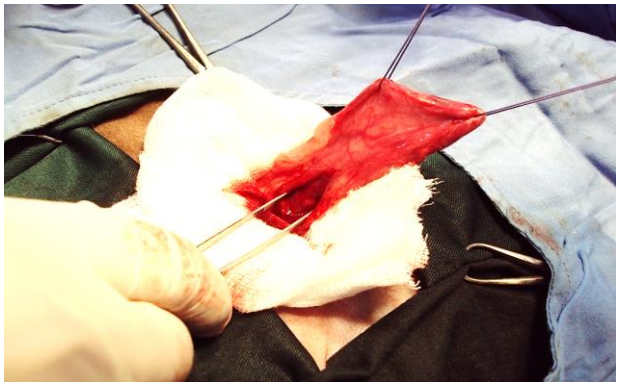
Cystotomy is a surgical incision into the urinary bladder. Cystotomy is a common surgical procedure in small animal veterinary practice (1), typically performed to remove cystic calculi and urethral calculi, identification and biopsy of masses, repair of ectopic ureters, or evaluation of urinary tract infection (UTI) resistant to medical treatment (2 and 3). The incision is made on the dorsal or ventral surface of the bladder, away from the urethra. The goal of cystotomy closure is to obtain a urine tight seal that will not promote formation of further calculi (4). This has traditionally been accomplished by using a single- or double-layer appositional or inverting suture patterns using absorbable, monofilament suture is often recommended. Complications that can develop include uroabdomen, UTI, surgical site infection, incomplete removal of uroliths, recurrence of cystic calculi, and lower urinary tract obstruction (5 and 6). The aim of the present study is to evaluate cystotomy closure in dogs by double continuous inverting (Lambert and Cushing) versus single-layer of interrupted (appositional) suture patterns.

Materials and Methods

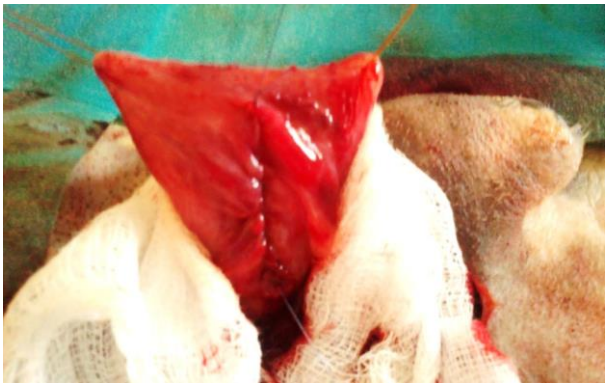
Thirty two adult local breed male dogs were enrolled for the present study, their age 1-3 years and weighing 18-23 kg. Animals were kept in Animal Resources of the College of Veterinary Medicine- Baghdad University. Dogs were randomly allocated into two equal group. The urine was evacuated by intra-urethral catheterization. Dogs were

premedicated by atropine sulphate at a dose (0.03mg/kg). After 15 minutes general anaesthesia was administered using a combination of ketamine (5%) at a dose 15mg/kg and xylazine (2%) at a dose 5mg/kg B.W. All drugs administered intramuscularly (7). Cystotomy was done according to the technique used by (8) as follows; Dog was positioned in dorsal recumbency**,** mid-line laparotomy incision was made retro-umbilical toward the pubis. The urinary bladder was located, exteriorized out of the laparotomy incision and isolated from abdominal viscera (Fig.1). Two tension stay sutures were applied at either sides of bladder wall using (2-0 chromic catgut) to help stabilize the bladder for surgical incision, moistened gauze was placed around the bladder to minimize contamination and limit urine spillage into the abdomen. Stap incision was made in the least vascular area on the dorsal aspect of the bladder (Fig.2). In order to make the incision, the bladder was reflected posteriorly and care was taken to avoid the ureters. In the first group, the bladder incision was restitched by continuous double rows of inverting suture patterns (Lambert buried by Cushing) (Fig. 3). While in the second group, the incision was closed by single-layer of appositional suture pattern (simple interrupted), which did not involve the mucosa (extra-mucosal) (Fig.4). Absorbable suture materials (Poly-dioxanone size 3/o) were used in both groups to close the bladder. The bladder and the abdomen were flushed with 0.9% normal saline. The stay sutures were removed and the urinary bladder returned into the abdominal cavity. Then the laparotomy incision was closed. Elizabethan collar was fixed on animal neck to avoid interference with the wound. A combination of penicillin (20.000 IU/kg) and streptomycin 10 mg/kg B. W. were administered for five consecutive days via IM route. The skin stitches were taken-off at 10 post-operative days after ensuring the complete healing of the operated wound. Macroscopical and microscopical examinations were performed at 3, 7, 14 and 21 days post-surgery. Sixteen dogs were used for each group, (4dogs/ period). The biopsies harvested for microscopical examination sectioned at (5-6) µm thickness and stained with Hematoxylin-Eosin (H and E) dyes and examined under light microscope (9).

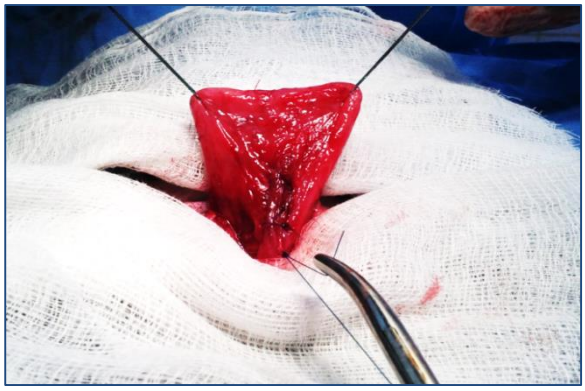
Figure, 1: Urinary bladder is exteriorized out of the laparotomy incision.



Figure, 2: Sterile gauze put around the bladder and two stay sutures are placed and the bladder is incised in its dorsal surface.



Figure, 3: In the first group, the bladder incision is closed by inverting suture (Lambert and Cushing) .



Figure, 4: In the second group, the bladder incision is closed by single-layer of (simple interrupted suture) using Polydioxanone (3/0).

Results and Discussion

In inverting group, the operative time was 40 ± 4.50 minutes which was higher than that recorded for appositional group 25± 2.50 minutes. This time is relatively similar to that recorded by (10). While (11), stated that cystotomy takes about 45 -75 minutes to perform in most cases. These differences in times for bladder surgery may be attributed to the type of bladder affections.

In the present study, the incision is made in the dorsal surface of the bladder to avoid urine leakage, adhesion and possible calculogensis. This site is preferable by (12 and 13). While (14), performed ventral cystotomy and recorded certain complications represented by formation of nidus for further calculi in addition to adhesion, urine seepage and peritonitis.

The results of bladder suturing reflected that the single layer appositional was very effective in closure of urinary bladder and the result of this study was supported by (6), who found that simple interrupted sutures do not enter the lumen give good bladder wall security. Some veterinarians do a similar closure but with a simple continuous pattern. Other author (15), indicated that inverting suture patterns of the bladder were rarely used. Especially on a bladder with a thick wall or on a small bladder. Appositional patterns have been shown to provide just as much strength and are not prone to leakage. While (16), refereed that single-layer appositional closure is always sufficient to close the bladder. During closure, mucosal penetration should be avoided as suture material into the bladder lumen promotes subsequent calculi formation.

In the present study, the bladder incision was closed by absorbable suture material (polydiaxnone 3-0). This thread has several desirable characters as mentioned by (1 and17), it provides wound support for longer periods as compared to other synthetic absorbable sutures and offers far superior tensile strength and outstanding pliability. Its monofilament structure provides good handling properties and excellent knot security.

Table, 1: The complications following cystotomy closure

Complications	Inverting group	% of affected dogs	Appositional group	% of affected dogs
Hematuria	**2**	**12.5%**	**1**	**6.25%**
Swelling	**2**	**12.5%**	**2**	**12.5%**
Urinary Incontinence	**1**	**6.25%**	**1**	**6.25%**

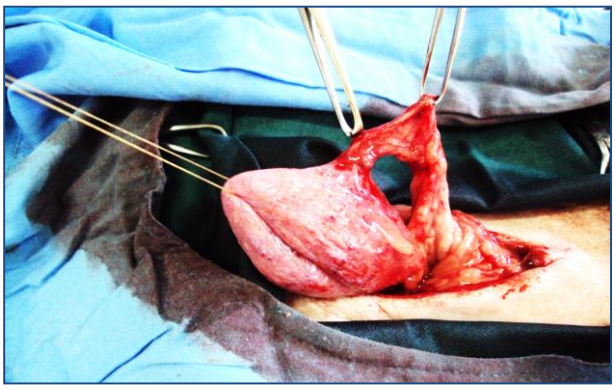
Post-cystotomy closure complications (Table, 1) were hematuria affected three animals (two from inverting group and one from appositional group).This is probably due to surgical trauma. Hematuria disappeared at the 2th day in all animal without any treatment rather than antibiotic which was used for post-operative care. In randomized trial by (18), in dogs and cats that underwent cystotomy closure by use of an inverting double-layer pattern for cystotomy closure, 50% of the animals developed minor complications such as

hematuria and dysuria which lasted for 7-10 post-surgery and resulted in death of five dogs and two cats. The differences in the number of affections between studies may be ascribed to the number of animals used in each study.

Swelling was mild, moderate and swelling noticed in four dogs (two from each group) at the operative site. Swelling was the highest at second post-operative day in both groups, this may attribute to inflammation in which swelling is one of the cardinal signs of inflammation and could be due to increase vascular permeability at the site in response to the release of vasodilators like prostaglandins, bradykinin and histamine, resulting from a post-surgical inflammatory reaction. This interpretation supported by (19). Swelling was gradually subsided in both groups at 4rd to 5th post-operative days, which could be attributed to decrease of the inflammation resulted from regular cleaning of the operative site and used of proper post-operative management in the present study. Although Urinary incontinence was observed in two dogs (one of each group). This complication was noticed soon after anesthetic recovery and lasted for the first week in inverting group, while disappeared at 4th day in dog related to appositional group. Incontinence was temporary and stop spontaneously without treatment. This may be ascribed to the irritation or inflammation of the bladder (cystitis).

This interpretation was agreed with (20). Lamb and Gregory (21) attributed incontinence to loss of the bladder control due to tumors also (22) referred that young animals may have a birth defect such as ectopic ureter(s) causing incontinence.

The macroscopic inspection revealed slight to moderate adhesions in two dogs related to inverting group (figure, 5), noticed at 3rd and 7th days and one dog related to appositional group, which developed on 3rd day post-surgery. In both groups, the sites of adhesion were between the omentum and the bladder wall. None of these adhesions were serious to the extent that they could restrict bladder function, these finding is in agreement with (23) in dog. Adhesions could be due to ischemia arising from mechanical trauma associated with sutures and suturing which play a major role in the determination of the quality of adhesion that eventually results. Kronborg *et. al.,* (24), indicated that omental adhesion to the site of bladder incision can be explained by the fact that the omentum was capable of moving to the site of inflammation.



Figure, 5: Show's the adhesion between omentum and bladder wall in a dog related to inverting

In microscopical sections of bladder related to both groups are illustrated in (Table, 2) as follows:

Table, 2: The results of histopathological sections of bladder related to both groups.

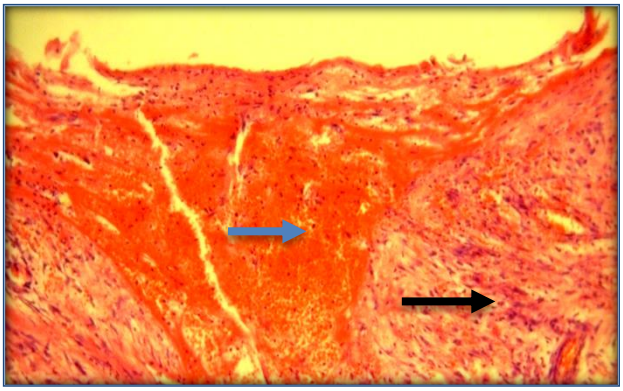
Time (day)	Inverting group	Appositional group
3	Severe hemorrhage covering the surgical region and extend deeply to the muscular layer, infiltrated with neutrophils (Fig. 6).	Severe congested blood vessels containing inflammatory cells in their lumen together with proliferation of single layer of urothelium (Fig. 10).
7	Necrosis and extensive edema surrounded by granulation tissue (Fig. 7).	Granulation tissue, in addition to fibrin deposition and neutrophils and mononuclear cells infiltration in sub-epithelial layer (Fig. 11).
14	Proliferation of highly cellular granulation tissue beneath the surface of mucosa (Fig. 8)	Mature connective tissue at the site of the insicional area covering by few epithelial cells (Fig. 12).
21	Proliferation of granulation tissue in the lamina propria of mucosa) proliferation of several layers of urolithium (Fig. 9).	The incisional site filled with mature connective tissue consisting from regular dense collagen fibers with few fibroblasts and blood vessels covered by several layers of epithelial cells (Fig. 13).

In inverting group at three days there was hemorrhage that may be due to surgical trauma and infiltration of neutrophils that may be due to acute inflammation evocated from bladder incision. Kim *et. al.*, (25), stated that inflammatory phase is started at day 0-3. Neutrophils are the first blood leucocytes to enter the wound site. Their main function appears to be phagocytosis of the bacteria.

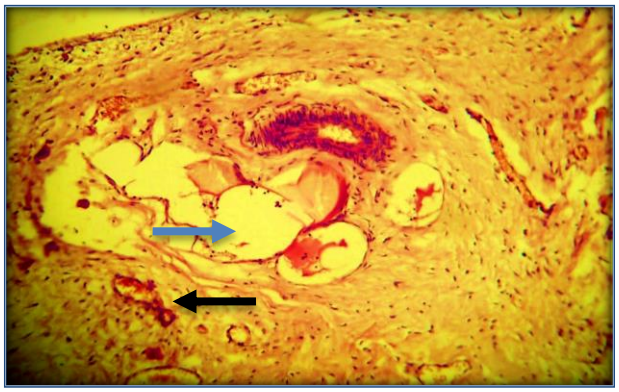
From days (7-14) there was proliferation of granulation tissue and this good sign of healing. Granulation tissue consist of inflammatory cells and new blood capillary. Other researcher (26), indicated that the next cellular, immune element to enter the wound after neutrophils are macrophages. These cells are derived from circulating monocytes. They first appear within 2-4 days post-injury and reach a peak around the 3th day post-injury Macrophages just like neutrophils phagocytize and digest pathological organisms and tissue debris. In addition growth factors and other substances which are also released are necessary for the initiation and propagation of granulation tissue formation. At 21 days there was healing of urothelium which may have originated from the free edges of the remaining urothelium. This finding agrees with (27), whom referred that re-epithelialization is complete at 14-21 days in the case of approximated incised wounds, but may take substantially longer in the case of larger wounds where there is a significant tissue defect.

In appositional group similar pictures to that were seen in inverting group in all period with few exceptions. At three days post-cystorraphy, there was proliferation of single layer of urothelium, then at (21) days there were several layers of epithelial cells. This finding is in agreement with an experimental study by (28), who reported that bladder mucosa is re-epithelialized within 25 days and also agree with (29), whom indicated that after stripping the urothelium from the whole porcine bladder, the bladder is again covered with urothelium within 20 days.

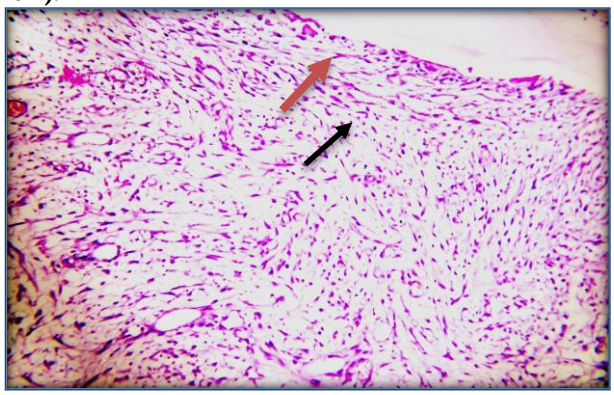
The present work revealed collagen accentuation during the first week post-wounding that arranged in regular pattern in appositional group more than inverting group. This investigation also reported mucosal proliferation within (14-21) and 7-14 days post-operation in inverting and appositional groups respectively. This result might be evacuated from inflammatory response against continuous irritation during suturing. The present histological findings agreed with those noticed by (30). Conclude that both suture patterns success in closure of bladder incision with superiority of oppositional type which enable to promote earlier healing of bladder within 14 days in comparing with inverting technique which required 21 days.



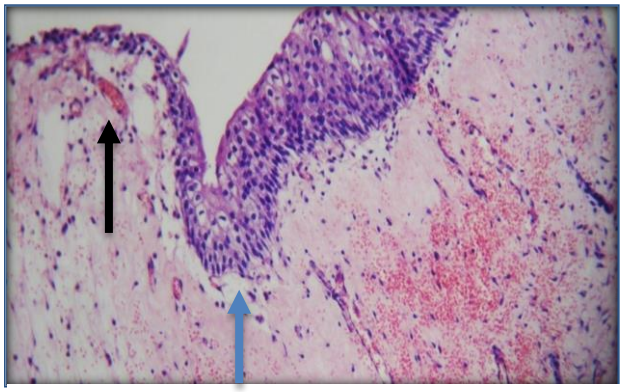
Figure, 6: Dog urinary bladder closed by inverting pattern, 3 days post-surgery show's, severe hemorrhage covering the surgical region and extend deeply to the muscular layer (black arrow), infiltrated with neutrophils (blue arrow) (H&E., 10X).



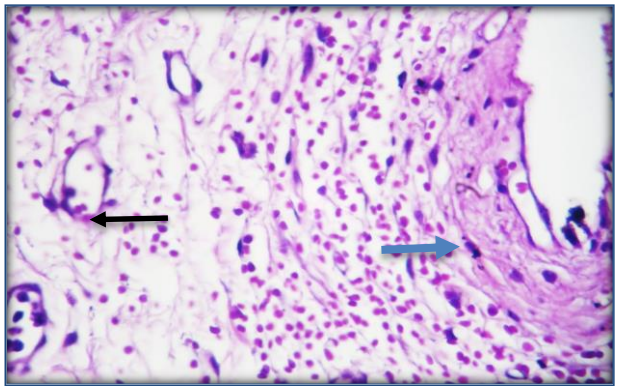
Figure, 7: Dog urinary bladder closed by inverting pattern,7 days post-operation show's, necrosis and extensive edema (blue arrow) surrounded by granulation tissue (black arrow) (H&E.,40X).



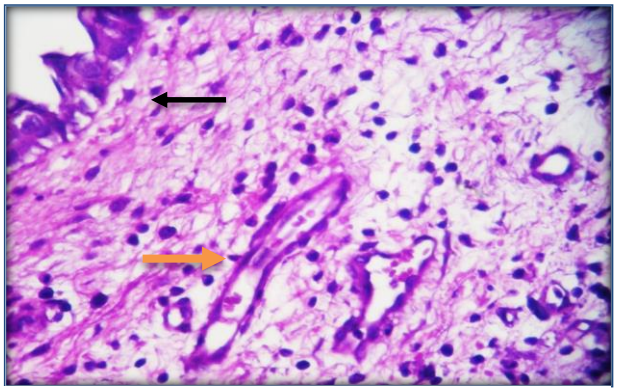
Figure, 8: Dog urinary bladder closed by inverting pattern, 14 days post-surgery, show's, proliferation of highly cellular granulation tissue (black arrow) beneath the surface of mucosa (red arrow) (H&E.,40X).



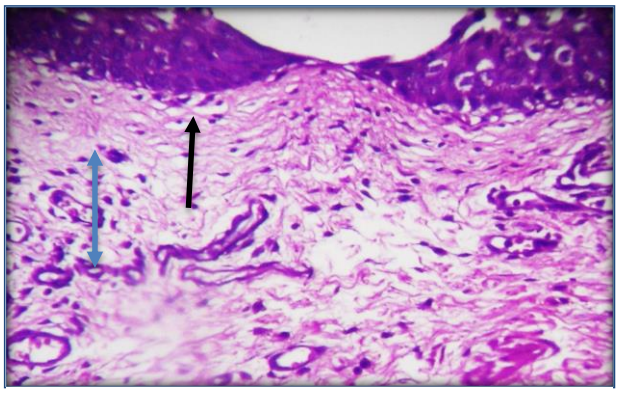
Figure, 9: Dog urinary bladder closed by inverting pattern, 21 days post-surgery show's, proliferation of granulation tissue in the lamina propria of mucosa (black arrow) and proliferation of several layers of urolithium (blue arrow) (H&E., 40X).



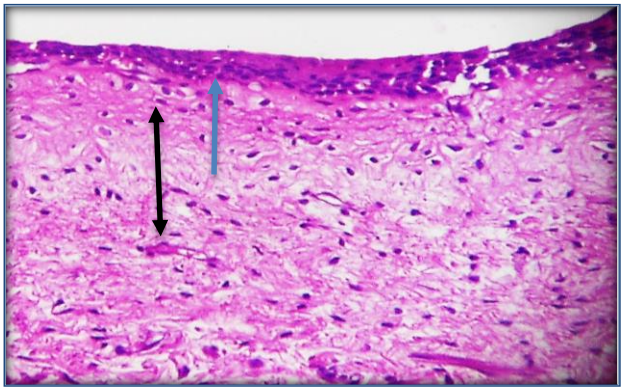
Figure, 10: Dog urinary bladder closed by appositional pattern, 3 days post-operation shows, severe congested blood vessel containing inflammatory cells in their lumen (black arrow) together with proliferation of single layer of urothelium (blue arrow) (H&E., 40X).



Figure, 11: Dog urinary bladder closed by appositional pattern, 7 days post-operation shows, granulation tissue (orang arrow) in addition to fibrin deposition, neutrophils and mononuclear cells infiltration (black arrow) in sub-epithelial layer (H&E., 40X).



Figure, 12: Dog urinary bladder closed by appositional pattern, 14 days post-operation shows, mature connective tissue at the site of the insicional area (blue arrow) covering by few epithelial cells (black arrow) (H&E., 40X).



Figure, 13: Dog urinary bladder closed by appositional pattern, 21 days post-operation shows, the incisional site is filled with mature connective tissue consisting from regular dense collagen fibers with few fibroblasts and blood vessels (black arrow) covered by several layers of epithelial cells (blue arrow) (H&E., 40X).

References

1. Appel, I. S.; Otto, S. J. and Weese, J. S. (2012). Cystotomy practices and complications among general small animal practitioners in Ontario, Canada. Can. Vet. J., 53 (3): 303-310.
2. Boland, E. D.; Coleman, B. D.; Barnes, C.; Psimpson, D. G. and Bowlin, G. L. (2005). Polydioxanone for biomedical applications. Acta Biomaterial,1(1): 115–123.
3. Chelsea, B. G. (2004). Evaluation of the tensile strengths of four monofilament absorbable suture materials after immersion in canine urine with or without bacteria. Am. J. Vet. Res., 65:847-853.
4. Sherry, L.; Appel, J. D.; Sandra, L. A.; Lefebvre, V.D. Doreen, M. and David, L. (2008). Evaluation of risk factors associated with suture-nidus cystoliths in dogs and cats: 176 cases (1999–2006). J. Am. Vet. Med. Assoc., 233(12): 1889-1895.
5. Rochat, M. C.; Lin, J.; Pope, E. R.; Carson, W. L.; Wagner- Mann, C. C. and Pace, L. W. (1996). Comparison of the degree of abdominal adhesion formation associated with chromic catgut and polypropylene suture materials. Am. J. Vet. Res., 57: 943-947.
6. Abass, B. T.; Muhammad, D. M. and Hassan, A. H. (2011). Cystotomy closure using a single-layer simple continuous versus continuous Cushing suture patterns in dogs. Al-Anbar J. Vet. Sci., 4 (2): 78- 87.
7. Al-Asadi, R.N.; Shnan, H. and Dawood, W.H. (1990). The use of ketamine-xylazine combination as a general anesthesia in dogs. Iraqi Vet. Med. J., 2 (1): 95-101.
8. William, J. M. and White, R. A. (2010). Tube cystotomy in dog and cat. J. Small Anim. Pract., 32: 598-602.
9. Prophet, E. B.; Mills, B. and Arrington, J. B. (1992). Laboratory methods in histotechnology. Washington: Armed Forces Institute of Pathology P: 275.
10. Grier, R. L. (1995). Symposium on surgical techniques in small animal practice (Cystotomy). Vet. Clin. North Am. 5: 415–420.
11. David, C.; Grant, R. S.; Tisha, A. M.; Harper, V. S. and Stephen, R. (2010). Frequency of incomplete urolith removal, complications, and diagnostic imaging following cystotomy for removal of uroliths from the lower urinary tract in dogs: 128 cases (1994–2006). J. Am. Vet. Med. Assoc., 236 (7): 763-766.
12. Gahrin, D. R. (1983). Surgical management of canine cystic and urethral calculi. In: Bojrab (ed.), Current Techniques in Small Animal Surgery. 2nd Ed Lea and Febiger Philadelphia Pp: 314-315.
13. Hellebrekers, B. W. and Kooistra, T. (2011). Pathogenesis of postoperative adhesion formation Br. J. Surgery, 98: 1503–1516.
14. Akomas, S. C. and kene, R. O. (2003). Postoperative studies following ventral and dorsal cystotomy in dogs. Nigerian Vet. J., 24(2): 52-56.
15. Karen, K. C. (2000). Cystotomy, partial cystectomy and tube cystostomy. Clin. Techn. In Small Anim. Pract., 15 (1):11-16.
16. Kosan, M.; Gonulalan, U.; Ozturk, B.; Kulacoglu, S.; Erguder, I.; Akdemir, O. and Cetinkaya, M. (2008). Tissue reactions of suture

materials (polyglactine 910, chromic catgut and polydioxanone) on dogs bladder wall and their role in bladder stone formation. Urol. Res., 36 (1): 43-49.
17. Boland, E. D.; Coleman, D.; Barnes, C. P.; Simpson, D. G. and Bowlin, G. L. (2005). Polydioxanone for biomedical applications. Acta Biomaterial, 1(1): 115–123.
18. Thieman-Mankin, K. M.; Ellison, G.W.; Jeyapaul, C. J. and Glotfelty-Ortiz, C. S. (2012). Comparison of short-term complication rates between dogs and cats undergoing appositional single-layer or inverting double-layer cystotomy closure: 144 cases (1993-2010). J. Am. Vet. Med. Assoc., 240 (1): 65-68.
19. Degner, D. A. and Walshaw, R. (1996). Healing responses of the lower urinary tract. Vet. Clin. North Am. Small Anim. Prac., 26: 197–206.
20. Westropp, J. L. (2011). Feline idiopathic cystitis. In: Bartges J and Polzin DJ (eds). Nephrology and urology of small animals. Chichester: John Wiley and Sons, Pp: 745–754.
21. Lamb, C. L. and Gregory, S.P. (1998). Ultrasonographic findings in 14 dogs with ectopic ureter. Vet. Radiol. Ultrasound, 39(3): 218–223.
22. Mc-Laughlin, J. R. and Miller, C.W. (1991). Urinary incontinence after surgical repair of ectopic ureter in dogs. Vet. Surg., 20 (2):100–103.
23. Abass, B. T.; Saeed, N. S. and Babaker, K. H. (2011). Effects of Polyethylene Glycol (SprayGelTM) on Dogs Undergoing Conventional Cystotomy. Al-Anbar J. Vet. Sci., 4: 36-42.
24. Kronborg, O.; Ostergaard, A.; Steven, K. and Gotrik, J. K. (2012). Polyglycolic acid versus chromic catgut in bladder surgery. Br. J. Urol., 50: 324–327.
25. Kim, M. H.; Liu, W.; Borjesson, D. L.; Curry, F. R.; Miller, L. S. and Cheung, A. L. (2008). Dynamics of neutrophil infiltration during wound healing and infection. J. Invest. Dermatol., 128: 1812-1820.
26. Gordon, S. and Taylor, P. R. (2005). Monocyte and macrophage heterogeneity. Nat. Rev. Immunol., 5: 953-964.
27. Munoz, A.; Gangitano, D. A.; Smith, C. P.; Boone, T. B. and Somogyi, G. T. (2010). Removal of urothelium affects bladder contractility and release of ATP in rat urinary bladder. Br. Med. Urol., 10: 10-17.
28. Liu, L.; Mansfield, K. J. and Burcher, E. (2009). Release of rabbit urinary bladder mucosa. Br. J. Pharmacol., 158: 1655–1662.
29. Ying, C.; Kylie, J. M.; Prajni, S.; Elizabeth, B. and Kate, H. M. (2013). Porcine Bladder Urothelial, Myofibroblast and Detrusor Muscle Cells. Pharmacol. 2: 27-31.
30. Ahmad, K.; Asghar, K. and Pat, L. (2007).Cellular morphological parameters of the urinary bladder. Int. J. Exp. Pathol., 88 (3): 185–190.

دراسة مقارنة بين خياطتي قلب الحافات للداخل والتقابل لغلق المثانة في الكلاب

راهي ناهي الاسدي و نذيره برهان خواف
فرع الجراحة والتوليد- كلية الطب البيطري- جامعة بغداد - العراق

الخلاصة

صممت الدراسة الحالية لتقييم نوعين من نماذج الخياطة (خياطة قلب الحافات للداخل وخياطة التقابل) لغلق المثانة بعد فتحها تجريبيا في الكلاب . استخدم للدراسة (32) من ذكور الكلاب المحلية البالغة, تراوحت اعمارها بين (1-3) سنة وباوزان (18-23) كغم قسمت الكلاب عشوائيا الى مجموعتين متساوية . في المجموعة الاولى اغلقت المثانة بخياطة قلب الحافات للداخل (لمبرت وكشن). المجموعة الثانية فقد اغلقت بخياطة البسيط المتقطع غير المخترق للطبقة المخاطية. استعمل خيط البولي داي اكسنون قياس 3\0 لغلق المثانة في كلا المجموعتين. تمت العمليات الجراحية بأستخدام التخدير العام بحقن مادة الكيتامين بجرعة 15ملغم\كلغم والزايلازين بجرعة 5 ملغم \كلغم من وزن الجسم مسبوقا بكبريتات الاتروبين بجرعة 0.03 ملغم\كغم حقنت كافة الادوية بالعظلة. اظهرت النتائج فرق معنوي $P<0.05$ في اوقات العمليات الجراحية بين المجموعتين حيث كان الوقت (40±4.50) دقيقة في مجموعة قلب الحافات للداخل بينما كان الوقت (25±2.50) دقيقة في مجموعة تقابل الحافات. تمت متابعة الحيوانات سريريا طيلة فترة الدراسة لتسجيل المضاعفات الثانوية التي شملت على البول الدموي (n=4) تورم منطقة العملية (n=3) وسلس البول (n=2). كانت المضاعفات وقتية واختفت في وقت قصير. اوضح الفحص العياني الذي اجرى خلال (3و7و14و21) يوم ظهور التصاقات (n=3) متوسطة الى خفيفة الشدة في كلا المجموعتين .كان الالتصاق بين الثرب وجدار المثانة. بين الفحص النسجي المرضي- شفاء المثانة خلال (14) يوم في مجموعة التقابل وفي يوم (21) في مجموعة قلب الحافات للداخل. تستنتج من الدراسة بأن تقنية تقابل الحافات سهلة واقتصادية واحدثت شفاء المثانة في وقت مبكر عند مقارنتها بتقنية قلب الحافات للداخل.

الكلمات المفتاحية:فتح المثانة، قلب الحافات للداخل، تقابل الحافات، الكلاب.