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A comparative study of retrieval of cystic calculi through laparoscopic assisted cystotomy and conventional cystotomy in dogs

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Sixteen male dogs of different age, body weight and breed, having urinary calculi, presented with clinical signs of anorexia, haematuria, dribbling of urine and dehydration were included in the study. Clinical, radiographic and ultrasonographic examination revealed distended urinary bladder having dispersed calculi and sludge confirming the diagnosis of obstructive urolithiasis. The animals were randomly divided into two groups of 8 animals each. Group I animals were subjected to laparoscopic assisted cystotomy; with camera port insertion near umbilicus, and secondary port insertion paramedian to prepuce to exteriorize the bladder. Stone basket and suction were used to retrieve the calculi. Group II animals were subjected to conventional cystotomy as per standard procedure. Surgical, physiological and haematological parameters were evaluated in both groups. Total surgical duration in group I was significantly longer (114.12±3.49 min) than in group II (75.12±2.35 min). Postoperatively pain in animals of group II was significantly higher than in group I. Animals of group I had haematuria (n=2) and seroma formation (n=1), and animals of group II had urinary incontinence (n=1), seroma formation (n=2) and haematuria (n=4) as postoperative complications. Results suggested that laparoscopic assisted cystotomy was more time consuming; however, it provided better visualization, lesser postoperative complications and faster wound healing as compared to the conventional cystotomy.

***Key words**: Conventional cystotomy, Dogs, Laparoscopic assisted cystotomy, Obstructive urolithiasis, Urinary Calculi*

Urolithiasis has been recognized as one of the most painful conditions in companion animals. It is reported as the third most common disease condition of the lower urinary tract. It is common in male dogs, with the signs of dysuria, dehydration, haematuria, distension of urinary bladder, dribbling of urine or urinary incontinence. Various types of uroliths such as struvite, calcium oxalate, urate, cysteine, calcium-phosphate and silicates have been reported, but struvite and calcium oxalate uroliths are more common in dogs and cats (Osborne *et al.*, 1999). Treatment protocols for obstructive urolithiasis include relief of obstruction to urine flow through retrieval of urinary calculi via different surgical approaches. Conventional cystotomy is an invasive method used for decades in almost all species of animals to remove urinary bladder calculi, veterinary surgeons gradually shifted to the newer and less invasive techniques for retrieval of cystic calculi. These techniques included lithotripsy, cystoscopic removal, and laparoscopic cystotomy (Adams and Lulich, 2006; Defarges *et al*., 2013; Pinel *et al*., 2013; Scharf *et al.*, 2022). The objective of the present study was to compare laparoscopic assisted cystotomy with conventional cystotomy for retrieval of cystic calculi in dogs.

Materials and Methods

The study was conducted on 16 male dogs of different age, body weight and breed, presented for treatment of obstructive urolithiasis. The animals were randomly divided into two groups of 8 dogs each according to the technique used for treatment, i.e. in group I, laparoscopic assisted cystotomy was performed, and in group II, conventional laparo-cystotomy was done.

In all the animals, feed and water were restricted 12 hr and 6 hr, respectively, prior to surgery. The anaesthetic protocol in animals of both groups involved premedication with atropine sulphate (0.04 mg/kg body weight) and xylazine HCl (1 mg/kg body weight) administered intramuscularly. Anaesthesia was induced using ketamine HCl (5 mg/kg body weight) administered intramuscularly, while anaesthesia was maintained using 2% isoflurane.

In group I, the dogs were placed in the Trendelenburg position. The surgical site was draped after scrubbing from xiphoid up to the pubis. The Veress needle was inserted near the umbilicus, through a nick incision using BP blade No. 20 (a hanging drop test was performed). Pneumo-peritoneum was created by attaching flexible, sterile silicon tubing to the Veress needle and using CO_2 at 8-12 mm Hg pressure with a flow rate of 2-4 L/min. The Veress needle was then replaced by a 6 mm trocar cannula (T_1). Once the cannula was inserted into the abdominal cavity, a 5 mm, 30° telescope was introduced through the T_1 cannula, and the abdominal cavity was inspected for any injuries caused by the

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Veress needle or trocar. The CO, insufflation tube was then attached to the T_1 cannula to maintain the pneumoperitoneum. Another trocar cannula (T_2) was then cork screwed into the abdominal cavity through a stab incision at paramedian to the prepuce. Then the laparoscopic Babcock forceps were inserted into the abdominal cavity through the T_2 cannula and the bladder was grasped and pulled close to the abdominal wall. After desufflation, the portion of the bladder grasped in the Babcock forceps was carefully exteriorized. A 360° cystopexy was performed with absorbable polygalactin 910 No. 2-0 (Vicryl®). An incision was made on the exteriorized portion of the bladder using a surgical cautery pencil (monopolar electrocautery) to minimize bleeding. A telescope was then introduced into the bladder to visualize and locate the calculi. The bladder was continuously irrigated with sterile normal saline solution via a urinary catheter of size 6-8 ft. for better visibility of the bladder wall and calculi. The Ryle's tube attached to the suction machine was inserted through this incision adjacent to the telescope, and suctioning was done to remove debris and smaller calculi. Larger calculi (>5 mm) were carefully retrieved using a stone retrieval basket or grasping forceps introduced at 30° to the telescope and under telescopic guidance. Retrograde hydro-propulsion was continued until the patency of the urethra was ensured and all the calculi were removed. The bladder was then evacuated of all fluid by suctioning. The telescope and Ryle's tube were withdrawn. The cystopexy suture was carefully removed, taking care to avoid any injury to the bladder. The bladder incision was then closed with a single-layer continuous suture using absorbable polyglactin 910 No. 1-0. The T1 cannula was also removed at the end of the procedure after that cystotomy incision length was measured. Abdominal muscles were sutured by simple interrupted sutures with absorbable polyglactin 910 No. 1, followed by skin closure by a standard manner using silk No.1.

In group II, the dogs were placed in dorsal recumbency, and the surgical site was prepared aseptically. A skin incision of appropriate length was made posterior to the umbilicus up to the preputial sheath, and then extended lateral to the sheath. Linea alba was exposed by reflecting the sheath. Mayo-scissors were used to extend an incision made on the linea alba. Placing sterile gauze pieces around the site of the incision, the urinary bladder was palpated and exteriorised completely. The cystotomy incision was then made on the apex of the bladder, and the cystic calculi were manually removed. The patency of the urethra was verified by flushing normal saline through the urinary catheter. The interior of the bladder was then explored with a gloved finger to verify that there were no calculi remaining after urethral catheterization and flushing. The urinary bladder incision was closed using a single-layer continuous suture with absorbable No. 1-0 polyglactin 910. Following the closure, the bladder was checked for leakage by instilling normal saline through the urinary catheter. The linea alba and associated muscles were then sutured using simple interrupted sutures with polyglactin 910 No. 1. After measuring the length of the cystotomy incision, the skin was closed in a standard manner using silk No. 1.

Postoperatively, the animals received regular wound dressing with 5% povidone-iodine, followed by the application of appropriately sized adhesive bandages (G-Dress). A broad-spectrum antibiotic (inj. Ceftriaxone-Tazobactam at 20 mg/kg body weight, i.v.) was administered twice daily for 5 days. Additionally, a non-steroidal anti-inflammatory drug (inj. Meloxicam at 0.5 mg/kg body weight, i.m.) was given once daily for 3 days. All animals were kept under observation until suture removal on the 12th postoperative day. Follow-up evaluations were conducted regularly for up to 3 months to monitor recovery and detect any recurrence of urolithiasis.

The recorded parameters included signalment and clinical, radiographic, and ultrasonographic observations. The duration of surgery, the length of cystotomy incision, intraoperative complications, postoperative pain scores, and postoperative complications were recorded. Physiological parameters (rectal temperature, respiratory rate, and heart rate), and haemato-biochemical parameters such as haemoglobin (Hb), total erythrocyte count (TEC), packed cell volume (PCV), total leukocyte count (TLC), serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), blood urea nitrogen (BUN), and creatinine were also measured both pre- and post-operatively. Chemical analysis of the retrieved calculi was also undertaken.

Basic statistical measures, including the arithmetic mean, standard deviation and standard error, were calculated for all replicative variables and were presented as mean±SE. Statistical analyses were conducted using SPSS version 20. A significance level of $P<0.05$ was considered for hypothesis testing and was indicated at appropriate places.

Results and Discussion

The age of animals in the present study ranged from 3 to 11 yr, with an overall mean age of 6.37±0.56 yr. Singh *et al.* (2016) reported mean age of 8 yr and 6 yr in animals undergoing laparoscopic and conventional cystotomy, respectively. Similarly, Amarpal *et al.* (2013) and Parmar *et al.* (2021) observed age range between 2 yr and 12 yr in their respective studies. In the present study, Pugs showed the highest breed-wise incidence of urolithiasis, followed by Labradors. Golden Retrievers and Dachshunds exhibited equal incidence rates, ranking next, while

Dobermans and Great Danes also shared equal incidence but at a lower frequency. In contrast, studies by Amarpal *et al.* (2013) and Parmar *et al.* (2021) identified Spitz as the breed with the highest incidence, with Pugs ranking second, followed by different other breeds.

The common clinical signs observed included dullness, depression, dehydration, distension of the urinary bladder, dribbling of urine or urinary incontinence and haematuria. Similar findings were reported by Ravindran *et al.* (2001), Singh *et al.* (2005) and Tion *et al.* (2015).

Radiographic examination of the abdomen revealed a distended urinary bladder with radiopaque urinary calculi (Fig. 1). In some cases, bladder distension was evident without visible calculi. Ultrasonographic evaluation showed the presence of hyperechoic calculi and sludge with distal acoustic shadowing, as well as sludge accumulation and thickening of the bladder wall (Fig. 2). Plain abdominal radiography proved to be highly sensitive for the diagnosis of obstructive urolithiasis, regardless of the anatomical location within the urinary tract in the studied animals.

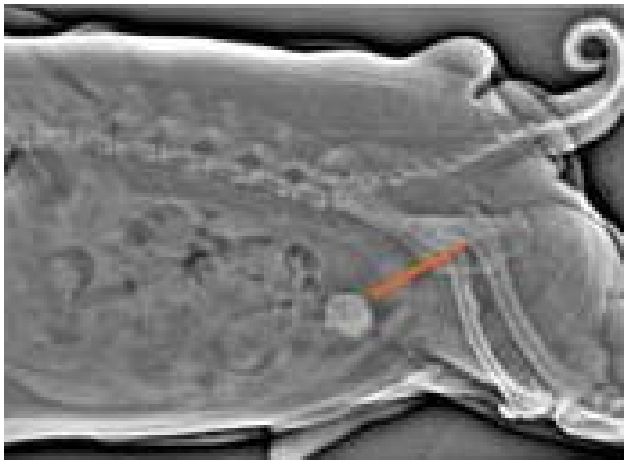

Fig. 1: Lateral abdominal radiographs: showing a single cystic calculus

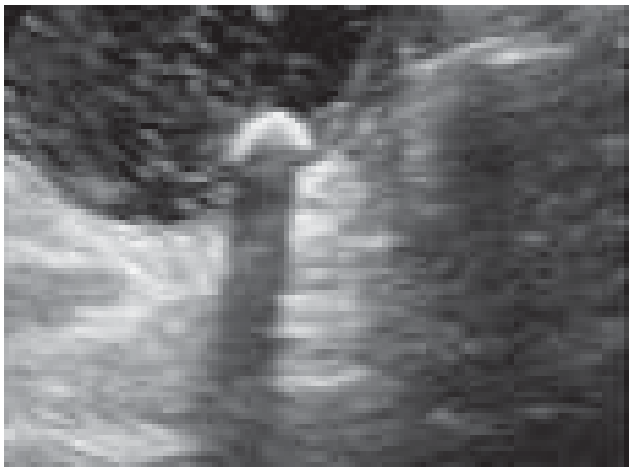

Fig. 2: Abdominal ultrasonograms: large cystic calculus and intravesical sludge with associated acoustic shadowing

Laparoscopic-assisted cystotomy was performed in group I animals (Fig. 3), while conventional laparo-cystotomy was conducted in group II animals. Group I had a longer surgical operating time compared to group II (Table 1). The duration of surgery in animals of group I exceeded the times reported by Arulpragasam *et al.* (2013), Pinel *et al.* (2013) and Lee *et al.* (2014), who have reported the mean surgical time of 80-106 min for laparoscopic-assisted cystotomy, which was significantly longer than for open cystotomy. They attributed the increased duration to the complex procedure and the associated learning curve. Similarly, Langston *et al.* (2010) observed that while laparoscopic-assisted cystotomy was less invasive than standard cystotomy, it generally required more time unless performed by a highly skilled surgeon.

Table 1: Mean surgical duration (in minutes), mean incision length for cystotomy (in cm) and mean postoperative pain score in animals of group I and II.

Sl. No.	Surgical Parameters		Group I	Group II
1.	Mean surgical duration (in minutes)		114.12±3.68	75.12±2.48
2.	Mean incision length for cystotomy (in cm)		2.05 ± 0.16	5.87 ± 0.34
3.	Mean Post-operative pain score	At 2nd postoperative hour	2.25±0.23	4.12±0.27
		At 8th postoperative hour	1.50±0.17	2.87±0.27
		At 24th postoperative hour	1.25±0.15	2.50±0.17

Intraoperative complications recorded in both groups are shown in table 2. In group I, the most common complication was difficulty in grasping the calculus with the stone retrieval basket. Other complications included leakage of urine into the abdominal cavity and intraluminal bleeding.

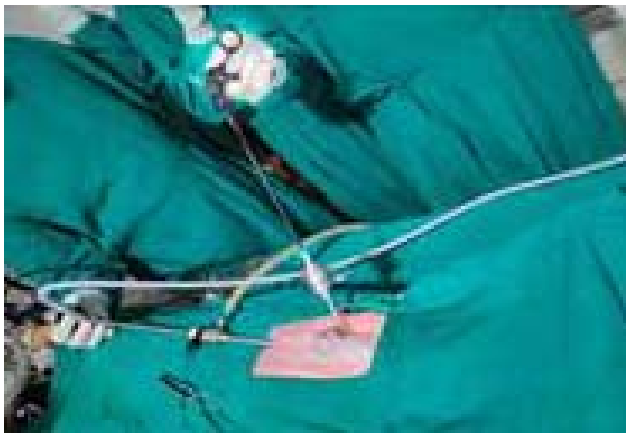

Fig. 3: Insertion of a laparoscope through the T1 port and a Babcock forceps through the T2 port (10), Grasping of the urinary bladder using Babcock forceps in a group I animal (11)

Table 2: Intraoperative complications in animals of group I and II

Sl. No.	Intraoperative complication	Group I	Group II
1	Accidental visceral organ puncture like spleen, intestine etc.	No	No
2	Urine seepage in the abdominal cavity	Yes (n =1)	Yes (n=2)
3	Intraluminal bleeding	Yes (n= 2)	No
4	Tearing of the bladder	Yes (n=1)	No
5	Difficulty in grasping calculi	Yes (n=4)	No

Milovancev and Townsend (2015) also observed haemorrhage during laparoscopic surgery. Pinel *et al.* (2013) noted that in some cases, the bladder was excessively large or friable and tore during manipulation. In group II, intraoperative complications included urine and fluid seepage in 25% of cases, particularly during retrograde hydropropulsion used to remove urethral calculi.

The mean incision length was found to be 2.05±0.16 cm in group I and 5.87±0.34 cm in group II, with a statistically significant difference observed between the two groups. The incisions in laparoscopic-assisted cystotomy were significantly smaller than those in open cystotomy. This difference is attributed to the surgical approach; in group I, only the cranioventral region of the urinary bladder was exteriorised to perform the cystotomy (Rawlings *et al.*, 2003), whereas conventional cystotomy required a larger incision. Similarly, Buote *et al.* (2022) reported longer incisions for open procedures compared to minimally invasive techniques in cats.

The mean postoperative pain score was lower in animals of group I compared to group II. That difference was attributed to the smaller incision size and reduced tissue trauma in group I. Although both groups received the same postoperative analgesia, dogs in group II exhibited higher pain scores. Kim (2012) noted that laparoscopic-assisted techniques were associated with less postoperative pain. Buote *et al.* (2022) observed that dogs undergoing open surgery had 8.3 times the odds of developing postoperative complications compared to those which underwent minimally invasive surgery, suggesting that open cystotomy is significantly more painful.

The postoperative complications observed in both groups, including haematuria and seroma formation, are depicted in table 3. Lee *et al.* (2014) reported that all dogs urinated normally, although a small amount of blood was visible upon inspection. These signs of haematuria resolved within three days. Appel *et al.* (2012) also noted complications such as persistent haematuria, recurrent urolith formation, urinary tract infections and incision site infections. Seroma formation at port sites was reported by

Table 3: Postoperative complications in animals of group I and II

Sl. No.	Postoperative complication	Group I	Group II
1	Change in general behaviour	No	No
2	Haematuria	Yes (n=2)	Yes (n=4)
3	Urinary incontinence	No	Yes (n=1)
4	Wound dehiscence	No	No
5	Seroma formation	Yes (n=1)	Yes (n=2)
6	Subcutaneous emphysema	No	No

Steffey (2016) and Milovancev and Townsend (2015), particularly when dead space was not adequately eliminated during closure. Incontinence was observed in 12.5% of cases in group II. McLoughlin (2011) described complications associated with cystotomy, including bladder atony due to extensive handling and complete exteriorisation of the bladder, denervation, urinary incontinence, and urine outflow obstruction. Pinel *et al.* (2013) reported cases of stranguria and mild urinary incontinence following laparoscopic-assisted cystotomy, attributed to urethritis and cystitis.

A slight postoperative increase in rectal temperature was noted in both groups; however, the values remained within the physiological limits (Table 4). Respiratory rates also exhibited a mild elevation following surgery in both groups, with group II showing a slightly higher mean, though all values were within normal clinical ranges. In contrast, a modest decline in heart rate was observed postoperatively in both groups, yet measurements remained within the normal physiological range. Overall, these physiological parameters did not differ significantly between the groups, indicating comparable systemic responses to the surgical intervention.

Table 4: Mean rectal temperature (F), respiratory rate (breaths/min) and heart rate (bpm) in animals of group I and Group II

Physiological parameters	Group I		Group II	
	Pre-operative	48hr post-operative	Pre-operative	48hr post-operative
Mean rectal temperature (F)	101.48 ±0.11	102.16 ±0.14	101.57 ±0.10	102.12 ±0.17
Mean respiratory rate (breaths/min)	24.75 ±1.51	26.87 ±0.89	24.12 ±1.29	28.87 ±1.73
Mean heart rate (bpm)	130.12 ±4.70	125.62 ±2.88	127.62 ±3.96	121.62 ±3.40

Postoperatively, there were reductions in haemoglobin (Hb), total erythrocyte count (TEC), and packed cell volume (PCV) in both groups (Table 5). While these changes were statistically nonsignificant in group I, a significant decline was observed in group

Table 5: Mean values of haematological and biochemical parameters in animals of group I and II.

Physiological parameters	Group I		Group II	
	Pre-operative	(48hr) post-operative	Pre-operative	(48hr) post-operative
Mean haemoglobin values (gm/dL)	13.30 ±0.68	12.83 ±0.67	12.95 ±0.51	12.02 ±0.47
Mean total erythrocyte count (millions/mm^3)	7.20 ±0.34	6.48 ±0.30	6.63 ±0.34	5.68 ±0.17
Mean packed cell volume (%)	38.23 ±1.43	34.97 ±1.41	37.76 ±1.13	36.12 ±1.01
Mean total leucocyte count (thousand/mm^3)	20.37 ±1.64	21.20 ±2.96	18.576 ±0.9	22.57 ±2.69
Mean serum aspartate transaminase (SGOT) (IU/L)	50.87 ±5.04	66.25 ±5.57	62.12 ±3.65	85.62 ±2.44
Mean alanine transaminase (SGPT) (IU/L)	42.50 ±2.88	41.00 ±2.57	50.50 ±5.96	50.87 ±4.71
Mean blood urea nitrogen (mg/dL)	19.61 ±0.92	14.75 ±0.87	20.81 ±1.42	15.36 ±1.03
Mean serum creatinine (mg/dL)	1.27 ±0.08	1.08 ±0.08	1.38 ±0.08	1.17 ±0.09

II, likely attributable to increased intraoperative blood loss resulting from extensive tissue manipulation and longer incisions associated with conventional cystotomy. The more pronounced haematuria observed in group II may have further contributed to the haematological decline.

Total leukocyte count (TLC) exhibited a postoperative increase in both groups, reaching statistical significance only in group II. This may reflect an augmented inflammatory response due to increased surgical contamination.

Serum glutamic-oxaloacetic transaminase (SGOT) levels showed an increase postoperatively in both groups, with a statistically significant elevation in group II, possibly due to muscle trauma during surgery. In contrast, serum glutamic-pyruvic transaminase (SGPT) levels remained unchanged, with no significant intra- or inter-group differences, indicating no substantial hepatic impairment.

Renal function indicators, including blood urea nitrogen (BUN) and serum creatinine, demonstrated a postoperative decline in both groups, with no statistically significant differences. These reductions were likely attributable to perioperative fluid therapy and the alleviation of urinary obstruction. Although serum creatinine levels remained slightly elevated postoperatively, they stayed within physiological limits, potentially due to residual circulating creatinine and surgical muscle trauma.

In the present study, three types of urinary calculi were identified: magnesium ammonium phosphate (struvite), mixed struvite-calcium oxalate, and calcium oxalate alone (Table 6). Osborne *et al.* (1999) also reported the presence of struvite, calcium oxalate and other types of uroliths in dogs.

The laparoscopic approach allowed magnified and illuminated views of the bladder's internal structures, enabling better visualization of both the cystic calculi and bladder wall. This is particularly beneficial in identifying all stones, including smaller or hidden ones and assessing the bladder mucosa for any associated pathology or inflammation (Hemal *et al.*, 2001).

Table 6: Types of calculi in animals of groups I and II

Case No.	Group I	Group II
1	Struvite (70%) & Calcium oxalate monohydrate (20%) + Calcium oxalate dehydrate (10%)	Struvite (70%) & Calcium oxalate monohydrate (30%)
2	Struvite	Struvite
3	Struvite	Calcium oxalate monohydrate (50%) & Calcium oxalate dihydrate (50%)
4	Struvite (80%) & Calcium oxalate monohydrate (20%)	Struvite
5	Calcium oxalate monohydrate (50%) & Calcium oxalate dihydrate (50%)	Struvite (70%) & Calcium oxalate monohydrate (20%) + Calcium oxalate dehydrate (10%)
6	Calcium oxalate monohydrate (50%) & Calcium oxalate dihydrate (50%)	Struvite
7	Struvite	Struvite
8	Struvite (80%) & Calcium oxalate monohydrate (10%)+ Calcium oxalate dehydrate (10%)	Struvite (90%) & Calcium oxalate monohydrate (10%)

To conclude, laparoscopic assisted cystotomy was more time consuming; however, it provided better visualization, lesser postoperative complications and faster wound healing as compared to the conventional cystotomy.

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