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Case Report

Surgical correction of ureter rupture due to stenosis induced secondary to accidental injury by placing nephrovesical subcutaneous ureteric bypass in a dog

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ABSTRACT

Objective: The aim of this paper is to report surgical correction of ureteric rupture due to stenosis induced secondary to accidental injury by placing nephrovesical subcutaneous ureteric bypass in a dog and postoperative long term outcomes.
Materials and methods: Imaging techniques revealed multiple bone fractures as well as left proximal ureter injury. The all bone fractures were corrected using standard techniques while left proximal ureter injury was treated as conservation medical therapy. One month later, contrast media were also found in proximal ureter and abdomen which indicated ureter rupture. This rupture was corrected surgically by nephrovesical subcutaneous ureteric bypass (SUB) under fluoroscopy guidance.
Results: First day after accidental injury, the serum BUN and CRE were 10.7 mg/dL and 0.9 mg/dL, respectively which indicated kidney injury but by conservative therapy these parameters were lowered gradually. On the 5th day after considering these parameters, the dog was judged normal. However, on the 31st day BUN and CRE were 14.3 mg/dL and 0.8 mg/Kg, respectively. The Doppler ultrasonography revealed hydroneprosis, proximal ureter stenosis and high resistive index (0.72±0.02) in the renal arcuate artery indicating renal abnormalities due to ureter obstruction. On re-examination by radiography after one month postoperatively, revealed that patency of the device and normal renal function. The dog was clinically normal with normal urination and no complications were found 6 months postoperatively.
Conclusion: In view of the above findings, it is suggested that the SUB system can be a better alternative to preserve the kidney in non-reparable traumatic ureteral damage in dogs.

KEYWORDS

Dog; Subcutaneous ureteral bypass, Ureteral rupture; Ureteral stenosis; Accidental injury

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INTRODUCTION

Ureter is tiny pipeline which transport urine from kidney to bladder (Jeong et al., 2017). So, the urine transport hampered following obstruction in the ureter passage consequently triggers several pathological conditions such as increased ureteral and intrarenal hydrostatic pressure, hydro nephrosis, decreased glomerular filtration in the ipsilateral kidney and life-threatening azotemia, especially when contralateral renal function is impaired (Berent et al., 2012). Moreover, rupture may occur which lead to peritonitis, sepsis infection, abscess formation, urinoma if remain untreated (Pampana et al., 2013). The causes of obstruction are ureterolithiasis, neoplasia, ureteral stricture or stenosis secondary to traumatic injury, iatrogenic ureteral ligation, etc. (Berent et al., 2012). However, urolithiasis, traffic accident and stenosis or strictures are the most common causes of ureter abnormalities in digs and cats (Hamilton et al., 2006; Berent et al., 2012).

Medicinal treatment with supportive care may applicable in case of partial obstruction by ureterolith until it removes. For most of the cases or when the medical treatment failed in partial obstruction, surgical correction is suggested to maintain flow patency (Berent et al., 2012). A subcutaneous ureteral bypass (SUB) device is one of the advance techniques for surgical correction of ureter obstruction. A SUB is tubing system consist of a locking loop catheter placed in the kidney and a second is cystostomy catheter, placed in the apex of the bladder and other ends of both catheters are connected commonly with a vascular access port which is located subcutaneously thereby creating an artificial ureter. The objective of this case study is to report the clinical outcome of SUB device placement in dog to correct ureter rupture due to stenosis induced secondary to accidental injury.

MATERIALS AND METHODS

Case history and diagnosis: A 18-month-old, castrated male Jack Russell Terrier dog (7.6 kg) was presented to the Royal Animal Medical Center. Physical examination findings were abdominal distension and animal was severely weak and unable to stand following street accidental injury. Imaging techniques revealed fractures of the right frontal bone fracture, bilateral sacroiliac joint luxation, ischium and pubis fracture, left femur fracture as well as pulmonary hemorrhage, left proximal ureter injury. As first aid the patient was treated against traumatic shock by pain killer and saline. The surgical team decided to first correct the right frontal bone fracture, bilateral sacroiliac joint luxation, ischium and pubis fracture, left femur fracture using standard techniques. Clinical signs were observed carefully, and pulmonary hemorrhage and left proximal ureter injury were treated as conservation medical therapy in intensive care unit (ICU). The fractured bones were healed confirmed at 31th day. In this study we focused on the surgical correction and postoperative outcome of ureter rupture due to injury induced secondary to accidental injury. Blood urea nitrogen (BUN) and creatinine (CRE) were measured as described previously (Rahman et al., 2014; Rahman, 2017; Choi et al., 2018) by Hitachi 7180 instrument (Hitachi, Tokyo, Japan). Initially in serum and ascites BUN and CRE were high which indicated kidney injury too but by conservative therapy these parameters were lowered gradually (**Table 1**). However at 31st day serum BUN and creatinine were found to increased level 14.3 mg/dL and 0.8 mg/Kg, respectively (**Table 1**). Therefore, the patient underwent for several examinations for confirmatory diagnosis. Hydro-nephrosis, extended diameter of renal pelvic, stenosis in the on left proximal ureter was further confirmed by ultrasonography using an Aplio 300 ultrasound system (Toshiba Medical Systems, Tokyo, Japan), (**Figure 1**). For the evaluation of the renal function, a resistive index (RI) of renal arcuate artery was measured using ultrasound examination which was found to be as high (**Figure 1; Table 2**). In the computed tomography using an ECLOS 16-row detector CT scanner (Hitachi, Tokyo, Japan) and radiography (Toshiba Rotanode, Toshiba Corporation, Japan) with contrast media, left proximal ureter obstruction by stenosis and rupture were diagnosed (**Figure 2**), as contrast media was visualized in proximal part of ureter and abdominal area. By considering the all techniques and parameters left proximal ureter rupture due to obstruction induced by stenosis secondary to accidental injury was diagnosed (**Figure 2**) which was finally confirmed by direct visualization after laparotomy. To release the urine from kidney to bladder SUB (the SUBTM, Norfolk Vet Products Inc., USA) was selected as surgical treatment (**Figure 3**).

Surgical procedures for the placement of nephrovesical subcutaneous ureteric bypass (SUB): General anesthesia was performed by intravenous propofol, 8 mg/Kg, *sig.*, IV (Provive® 1%, Myungmoon Pharm. Co., Ltd., Seoul, Korea) and volatile anesthetic sevoflurane inhalant (1-5%; Abbott Korea Ltd., Seoul, Korea) was used to maintain anesthesia, as described previously (Seo et al., 2017; Choi et al., 2018). Then, after shaving the expected region, aseptic preparation and

Table 1. Evaluation of kidney function in dog by serum and ascites examination

Day	Serum			Ascites		
	BUN (mg/dL)	CRE (mg/dL)	B/C ratio	BUN (mg/dL)	CRE (mg/dL)	B/C ratio
1	10.7	0.9	11.9	30.4	4.3	7.1
2	6.7	0.5	13.4	37.6	4.7	8
3	3.5	0.5	7	31.4	8.8	3.6
4	8.6	0.6	14.3	23.1	3.4	6.8
5	7.7	0.4	19.3	12.2	0.8	15.3
7	5	0.4	12.5			
11	6	0.4	15			
25	14.2	0.6	23.7			
31	14.3	0.8	17.9			
35	6.7	0.6	11.2			
62	5.4	0.4	13.4			

BUN, blood urea nitrogen; CRE, creatinine; B/C ratio, Ratio of BUN and CRE. In the ascites, BUN and creatinine concentration increased most in 1st day. Ascites was observed till 5th day. From the 5th day, the tendencies of the decrease were observed in blood BUN and Creatine till 11th day. On the 25th, the BUN concentration of the patient has increased within reference range (5-30 mg/dL).

Table 2. Evaluation of kidney function in dog from ultrasonography by measurement of resistive index, peak systolic velocity and end diastolic velocity in the renal arcuate artery from three parts

	RI	Vmax (cm/s)	Ved (cm/s)
1	0.71	52.4	15.3
2	0.74	48.5	12.4
3	0.71	32.2	9.4
AVG±STD	0.72±0.02	44.37±10.7	12.37±3.0

RI, resistive index; Vmax, peak systolic velocity and Ved, end diastolic velocity.

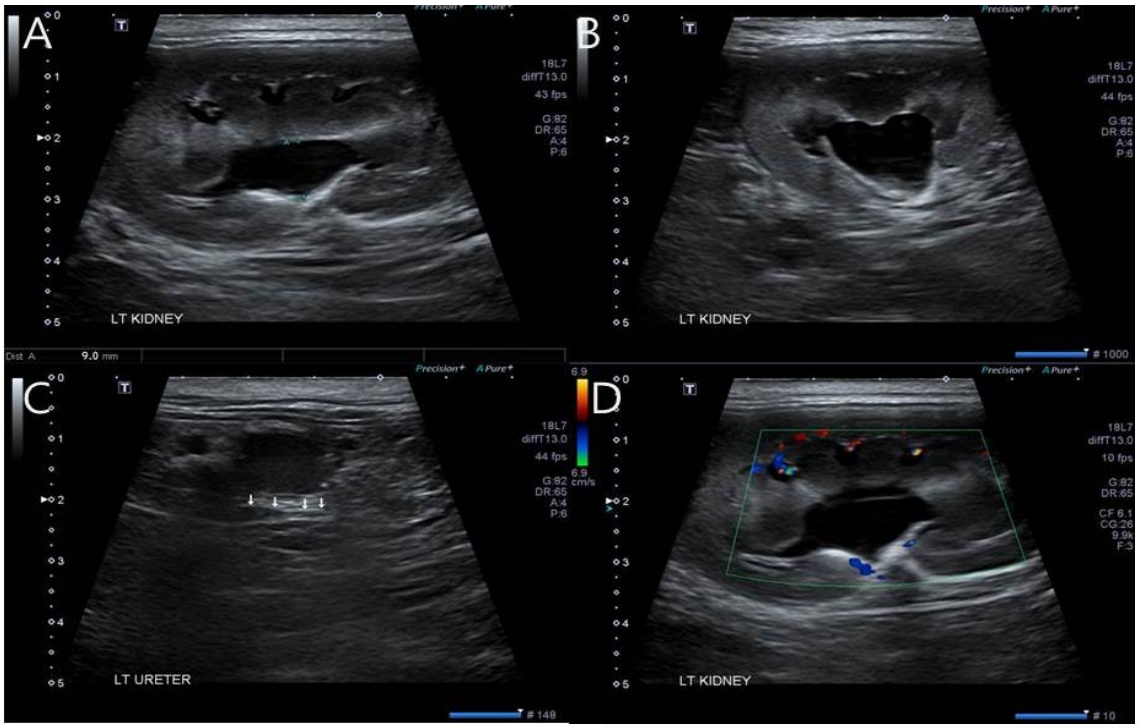

Figure 1. Ultrasonography images of affected left kidney. (A-B) The diameter of left renal pelvic was extended 9 - 13 mm. (C) The site of stenosis in the proximal urethra was identified. (D) For the evaluation of the renal function, a RI value was measured in the arcuate artery, which was found to be as high as 0.72 (D).

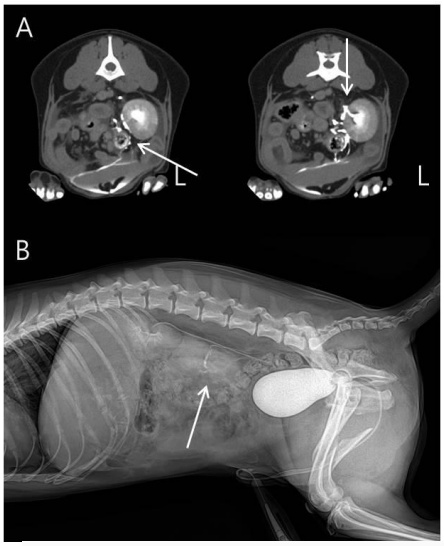

Figure 2. Computed tomography (A) of transverse views and radiography (B) of lateral view showing proximal left ureteral rupture and urinary leakage into the left ventral abdominal cavity retroperitoneal space.

Figure 3. Parts of nephrovesical subcutaneous ureteric bypass tubing system. It consists of four parts; (A) 0.035 "J"-tipped guide wire; (B) Pig tail (red arrow) nephrostomy catheter and a fixed Dacron cuff (yellow arrow); (C) 7 Fr cystotomy catheter with fenestrations, this catheter consist of hollow cannula, sharp stylet and Dacron cuff (green arrow); (D) Subcutaneous port and its two Herber needle (white arrows).

draping were performed, and the animal was positioned in dorsal recumbency. A median incision was made, and the subcutaneous tissue was, muscle dissected and the left kidney, ureter, bladder were exposed. Direct visual observation confirmed left ureteral rupture due obstruction induced by stenosis. The ruptured ureter was dissected and ligated proximally at the ureterovescicular junction. Before surgery saline water flushing was performed for tube patency and to wet of inner surface of tube. Placement of nephrovesical SUB was shown in **Figure 4-5**. Briefly, left kidney was exposed and fixed. An 18-gaze over-the-needle catheter was inserted to renal pelvis from caudodorsal of the left kidney. A needle was removed leaving catheter sheath. Through IV catheter sheath "J"-tipped guide wire was inserted into the renal pelvis and a locking-loop nephrostomy catheter was installed on the pelvis, along with the guide wire. After a silicon sleeve of locking-loop nephrostomy catheter was pushed to renal pelvis using a modified Seldinger technique through the caudal renal pole, silicon/Dacron cuff attached to renal capsule using sterile tissue glue (GS glustitch®, GluStitch Inc., Delta, British Columbia, Canada). Neprostomy catheter was placed under fluoroscopy guidance (OEC® 9800 Plus, GE OEC Medical System, Inc.,Salt Lake City, UT, USA) (**Figure. 5**). On abdominal ventral wall stab incision was taken with a hemostat forceps. Through stab incision site the nephrostomy catheter was pulled, and it connected with caudal end of port. Purse string suture (4–0 polypropylene, Prolene, Ethicon) was performed on bladder apex. Using no 11 blade stab incised at the middle of purse string suture. Cystotomy catheter inserted to stab incision site and hollow trocar and sharp stylet was intra-bladder. Silicone/Dacron cuff was sutured on bladder surface and was attached also with sterile tissue glue. In the same manner of neprostomy catheter, the cystostomy catheter pulled out through another second stab incision of abdominal wall, and connected with cranial end of the port. Routine closing of the abdomen was performed. Pre and intraoperative intravenous (IV) fluid therapy with 0.9% normal saline at 10 mL/Kg/h (CJ HealthCare, Eumseong-gun, Chungcheongbuk-do, South Korea) was performed and it was continued for 4 days postoperatively at a maintenance rate (45-54 mL/Kg/day), as described previously (Choi et al., 2018).

Medication and ethical statement: The postoperative medications were systemic antibiotics IV (cephradine, 30 mg/Kg, intravenously twice daily for 7 days and orally 7 days more; enrofloxacin at 10 mg/Kg sig. intramuscularly for 3 days); a pain killer (tramadol at 3 mg/Kg, intravenously 2-4 times for 5 days); and cimetidine at 10 mg/Kg bwt IV bid for 7 days orally for 7 days were administered (Rahman et al., 2017; Seo et al., 2017; Jeong et al., 2017). One dose of antibiotic and pain killer was given preoperatively. These clinical case was diagnosed and surgical treatment were decided by the expert veterinary surgeon by the team meeting at Royal Animal Medical Center and committee on the care of animal resources was approved all protocols employed

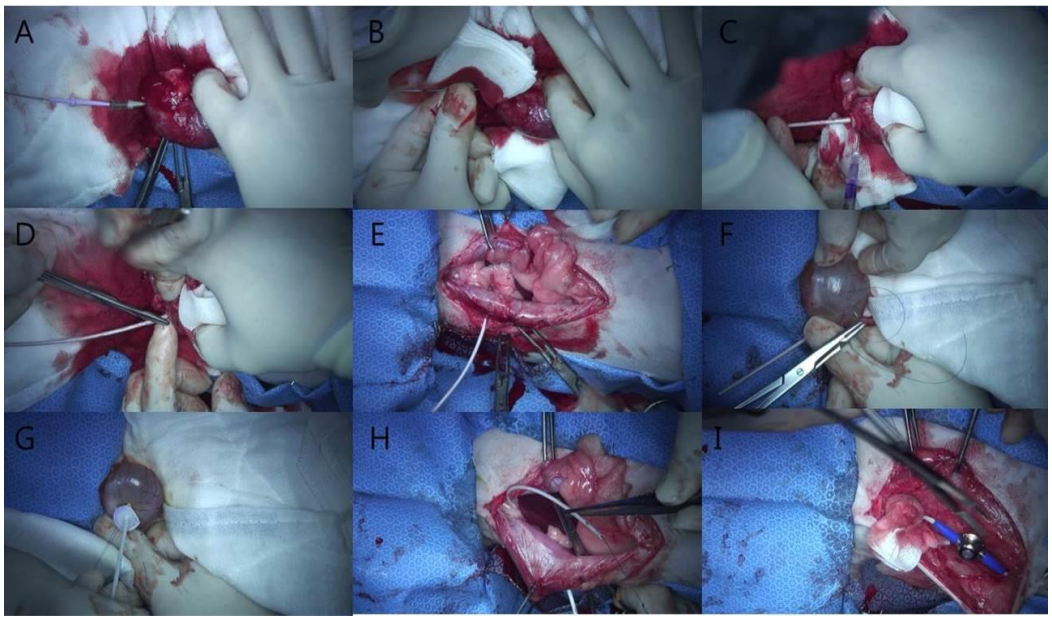

Figure 4. Intraoperative images during placement of the nephrovesical subcutaneous ureteric bypass catheter. (A) Inserting 18-gaze needle catheter to the renal pelvis from caudodorsal of the exposed left kidney. (B) The needle was removed leaving catheter sheath. (C) Inserting "J"-tipped guide wire into the renal pelvis through IV catheter sheath and a locking-loop nephrostomy catheter was fixed subsequently. (D-E) On abdominal ventral wall stab incision was taken with a hemostat forcep. Through stab incision site the nephrostomy catheter was pulled, and it connected with caudal port. (F) Purse string suturing on bladder apex (G) Fixation of cystomy catheter. (H) Cystostomy catheter pulled out to connect with cranial part of port. (I) Placement of connected port with the nephrostomy and cystostomy catheter under the skin of left abdominal wall.

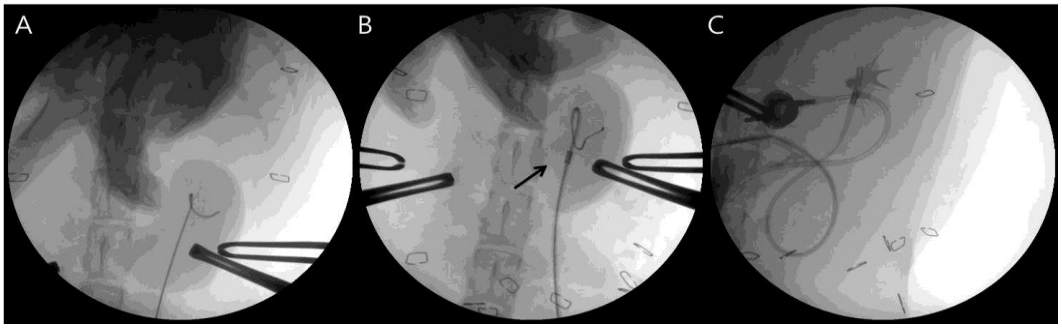

Figure 5. Fluoroscopic guided placement of nephrostomy catheter. (A-C) Proper placement of nephrostomy pig tail catheter was confirmed.

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RESUTS AND DISCUSSION

The elevated level of BUN and CRE values revealed high levels of waste products, which indicate kidney disease (Eubig et al., 2005; Go et al., 2015; Rahman et al., 2015; Rahman, 2017). First day after accidental injury, the serum BUN, CRE and B/C ratio were 10.7 mg/dL, 0.9 mg/dL and 11.9 respectively which indicated kidney injury but by conservative therapy these parameters were lowered gradually (**Table 1**). In ascites, similarities (higher level) in BUN, CRE and B/C ratio (30.4 mg/dL, 4.3 mg/dL and 7.1 respectively) were also found on the first day, which also gradually improved by conservative medicinal treatment. On the 5th day after considering these parameters, the dog was judged normal. However, on the 25th day serum BUN, CRE and B/C ratio found to increased level 14.2, 0.6 and 23.7. On the 31st day 14.3 mg/dL, 0.8 mg/Kg and 17.9, respectively (**Table 1**), indicating the renal abnormalities.

For more confirmation, we have evaluated Doppler ultrasonography, contrast radiography and CT-scan examination. The Doppler ultrasonography gives accurate anatomic and dynamic vascular flow information such as arterial systolic and diastolic pressure (Novellas et al., 2007; Andrew et al., 2018; Rovella et al., 2018). In this study we also found that renal arcuate artery systolic and diastolic velocities of the left kidney were decreased 44.37±10.71 cm/s and 12.37±3.0 cm/s, respectively (**Table 2**). These results indicating the lowering of renal

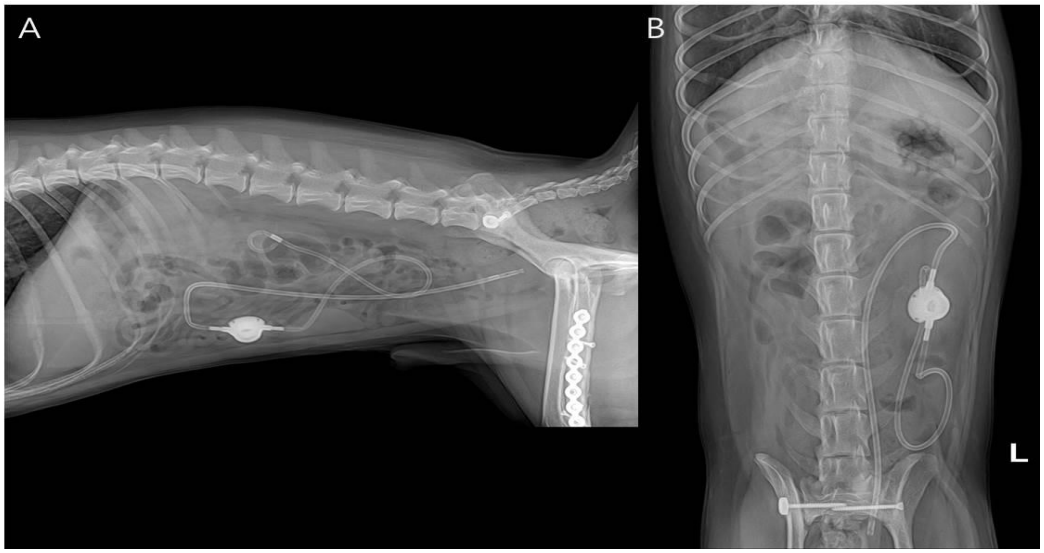

Figure 6. Radiographic images of postoperative (after one month) follow up of nephrovesical subcutaneous ureteric bypass placement. (A) Lateral view and (B) Vento-dorsal view. The images showing that proper settings of locking loop nephrostomy catheter and the cystostomy catheter with the subcutaneous port.

blood flow might be for ureteral obstruction. Because of following ureteral obstruction renal blood flow decrease and hydro nephrosis develop (Berent et al., 2012).

It is wise to mention here that hydro nephrosis as well as renal pelvis diameter abnormalities also confirmed by ultrasonography (**Figure 1A-B**). The Doppler-derived renal RI has been used recently to evaluate changes in vascular resistance due to urinary obstruction, variety of renal clinical abnormalities such as the detection and management of renal artery stenosis, diuretic effects, differential diagnosis in acute and chronic obstructive renal disease, and congenital dysplasia, evaluation of progression risk in chronic kidney disease, and more recently as a predictor of renal and global prognostic factor in the critical patient with renal diseases (Novellas et al., 2007; Viazzi F et al., 2014; Andrew et al., 2018). In this study kidney function in dog was also measured from ultrasonography by resistive index measurement in the renal arcuate artery 0.72±0.02 which is too high and it was presumed that it might renal abnormalities due to ureter obstruction. In addition ureter stenosis also confirmed by ultrasonography (**Figure 1C-D**). By evaluating CT scan and radiographic images with contrast media, ureter obstruction and rupture was diagnosed as contrast media was found in the proximal ureter part and abdomen (**Figure 2**). After laparotomy, by direct visualization ureter obstruction and rupture were finally confirmed. Our surgical team decided to correct ureter rupture due to stenosis which induced secondary accidental injury.

Ureter obstruction and rupture can be corrected by several surgical technics such as ureteral ureteral reconstruction by anastomosis, neoureterocystostomy and ureteronephrectomy, depending on the severity and location of the lesion (Weisse et al., 2002). However, in this case, ureteral reconstruction, anastomosis or neoureterocystostomy was not possible due to the complex lacerated end of ureter and that's why it was dissected and ligated proximally. In veterinary practice, ureteral reconstruction is considered challenging for the small size of the ureters and the consequent complications in small dogs and cats. Ureteral reconstruction is related with high rate of morbidity and mortality (18~30%) and high rate of complications (<30%) such as strictures or stenosis formation due to the size of the ureter (Weisse et al., 2002; Berent, 2011; Stafford and Bartges, 2013). Ureteronephrectomy is considered as a last option when the ureter and the kidney are severely damaged or when complications occur following surgical reconstruction. The prognosis of unilateral ureteronephrectomy is appears good in patient without preexisting renal disease (Weisse et al., 2002; Stafford and Bartges, 2013). Following unilateral nephrectomy or lack of function the glomerular filtration rate, blood flow increased in the contralateral kidney as consequences it physiologically hypertrophied if there is renal reserve for a compensatory hypertrophic mechanism for the response of functional demand (Berent et al., 2012). However, this physiological process may be failed if preexisting diseases are present. In this study, kidneys were injured but not severely damaged and

it was recovered by conservative medicinal therapy. So, we were worried because kidneys were slightly injured. Therefore, our surgical team was decided for to correct by nephrovesical subcutaneous ureteric bypass in a dog. Following surgical correction the animal condition was improved including serum BUN and CRE. After one month radiographic images also confirmed proper settings of nephrovesical SUB along with good normal urination and health condition without any complications.

There were few cases were reported describing the use of an SUB for the management of bilateral ureteral rupture following ureteral stenting failure and reported a normal urination without complications one year postoperatively in a cat (Kulendra et al., 2014). Another case also confirmed the good outcome nine weeks postoperatively in cat (Rossanese and Murgia, 2015). However, complications such as dislodgement occur in some cases due to intraoperative errors during catheter fixation (Berent et al., 2012).

We were conscious about this matter and both catheters and SUB were placed under fluoroscopic guidance (**Figure 5**). Moreover, post-operative radiographs confirmed the appropriate positioning of the SUB. In addition, on re-examination by radiography one month (**Figure 6**) post-operatively, revealed that patency of the device and normal renal function. The dog was clinically normal with normal urination and no complications were found 6 months postoperatively. To the best of author's knowledge this is the first report of placement of nephrovescical SUB in unilateral ureter rupture due to stenosis induced secondary to accidental injury in a dog along with postoperative follow-up study.

CONCLUSION

Finally based on the above results and discussion as there were no complications along with normal urination and good health condition were found in dog, it is suggested that the SUB system can be a better alternative to preserve the kidney in non-reparable traumatic ureteral damage in dogs.

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CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTION

All authors contributed equally.

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