A Surgical Guide
provided by Drs. Allyson Berent and Chick Weisse

A New Therapeutic Option for Dogs & Cats to Bypass Ureteral Obstructions
designed and developed in collaboration with veterinarians.

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Lateral radiograph of the SUB™ System
PATENT PENDING
Figure 1: The Subcutaneous Ureteral Bypass (SUB™) device.

A) Lateral fluoroscopic image of a cat patient after SUB™ placement showing the nephrostomy catheter, cystostomy catheter, and shunting subcutaneous injection port.

B) The SUB™ device put together outside of the patient.

EQUIPMENT NEEDED

- An 18-gauge over-the-needle catheter - NOT INCLUDED in the SUB kit
- Sterile cyanoacrylate tissue glue - NOT INCLUDED in the SUB kit - Optional Extra & must be ordered separately - Cat.No. GLU
- 22-gauge Huber needle with a T-connector and 3-way stop-cock (not in picture).
- A 0.035” "J"-tipped guide wire (4b)- included in the SUB kit.
- Shunting port (small port for small cats and small dogs; large port for larger cats and dogs). This should be flushed with a Huber needle to ensure patency of both ends prior to implantation.
- Blue cuffs (“boots”).
- 7 French bladder catheter with fenestrations, 1 cm markings and a fixed Dacron cuff. The catheter is fitted with a hollow cannula and sharp stylet.
- 6.5 French locking-loop nephrostomy catheter with Dacron cuff and silicone sleeve. The hollow cannula should be within the lumen of the catheter to keep it straight, the string should be pulled snug to keep it flush.

Additional equipment you will need that is not included in the SUB kit

1. An 18-gauge over-the-needle catheter
2. Sterile cyanoacrylate tissue glue - GLUTURE - AN OPTIONAL EXTRA

SUB™ KIT CONTENTS

- SUB1001K - for use in cats and small dogs
  - Small Shunting Port
  - 6.5 French locking loop & hollow cannula
  - 7 French bladder catheter & insertion stylet
  - 0.035” "J"-tipped guide wire
  - 2 x 22 gauge Huber needles
  - 1 x 22 gauge Huber infusion set
  - Surgical Instructions

- SUB2001K - for in larger dogs
  - Large Shunting Port
  - 6.5 French locking loop & hollow cannula
  - 7 French bladder catheter & insertion stylet
  - 0.035” "J"-tipped guide wire
  - 2 x 22 gauge Huber needles
  - 1 x 22 gauge Huber infusion set
  - Surgical Instructions
GUIDELINES WHEN USING THE SUBCUTANEOUS URETERAL BYPASS (SUB™)
provided by Allyson Berent, DVM, DACVIM and Chick Weisse, VMD, DACVS

The placement of nephrostomy catheters in veterinary medicine was recently reported, and has been met with excellent success when the appropriate device is used. The biggest limitation is the externalized drainage, requiring careful management and hospitalization to prevent infection and dislodgement. The development of an indwelling SUB device (Figure 1) using a combination locking-loop nephrostomy catheter attached via a dual-armed shunting port to a multi-fenestrated cystostomy catheter allows a nephrostomy tube to remain indwelling long-term. A similar bypass device in humans has been used with extensive urinary tract malignancies, ureteral strictures secondary to renal transplantation, when ureteral stenting is ineffective, or when traditional surgery fails or is contraindicated. It has been shown to reduce complications associated with externalized nephrostomy tubes and improve quality of life. The SUB™ device is designed for veterinary patients and contains a locking-loop design to prevent migration of the nephrostomy catheter, and a shunting port in the subcutaneous space that is used for flushing and sampling of urine as needed; a design unique to this system to help maintain long-term patency.

The use of the SUB™ device has recently been described in cats and dogs. These devices have been successfully in place for the last 4 years. The shunting port that is secured to the ventral abdominal wall connects the nephrostomy and cystostomy catheters, allowing sampling and flushing of the device. If there is concern of patency, or need for renal pelvic culture, this can be easily obtained through this subcutaneous port using a non-coring Huber needle. This avoids the need for high risk interventions or diagnostics. It is important for the operator to have appropriate training with this device prior to considering its use on a clinical patient. Please contact us prior to use (Allyson.Berent@gmail.com or Chick.Weisse@gmail.com).

Complications encountered with this device are uncommon and can often be avoided with proper placement. This data is from the >100 cases to date in the authors’ practice. These include 1) leakage at the nephrostomy/cystostomy tube or shunting port. This issue has been resolved with the addition of the Dacron cuff design and careful locking of the string at the port (<5%) (see detail how to avoid this below), 2) hemorrhage during nephrostomy tube placement (<1%), 3) system occlusion with blood clots, purulent debris, or stones (5%) (with the new recommendation of flushing the system through the shunting port routinely [every 3-6 months], occlusion of the catheter rarely occurs), 4) kinking of the catheter during placement, and 5) UTIs (seen 35% pre-op and 15% post-op). Most of these complications can be avoided with careful placement and thorough leak testing upon completion of the procedure (see below).

The use of a SUB for feline and canine patients with a ureteral obstruction can be considered a functional option when other traditional therapies have failed or are contraindicated. At this time, in the authors’ practice, this device is considered to have less short- and long-term complications in cats than many other alternatives when appropriate training is obtained. Care should be taken, as the longest device is only in place for 4.0 years so outcomes beyond this point cannot be ascertained.
PREPARATION
Before proceeding with the surgery each part of the system should be prepared by flushing the catheters, wires and port to ensure patency and make sure each piece is moist.

THE LAPAROTOMY
A ventral midline laparotomy is performed in order to expose the bladder and affected kidney. The peri-renal fat is gently and bluntly dissected off the caudal pole of the kidney exposing a 1-2 cm region of renal capsule (Figure 2a).

PLACING THE LOCKING LOOP NEPHROSTOMY CATHETER
The nephrostomy catheter should be prepared: The hollow cannula is placed inside the pre-flushed 6.5 French locking-loop catheter (pre-loaded with the Dacron cuff and silicone sleeve). The system should be flushed.

With the aid of fluoroscopy, the nephrostomy catheter is placed using the modified-Seldinger technique (Figure 2b, 3). An 18-ga over-the-needle catheter is used to puncture the renal pelvis from the caudal pole and a urine sample is obtained for culture (Figure 2b, 3a). A 50% diluted sterile iodinated contrast (iohexol) is injected to perform antegrade pyelography (Figure 3a). A 0.035” “J”-tipped guide wire is advanced through the 18-ga catheter and coiled inside the renal pelvis being careful to avoid perforation (Figure 2c-d; 3b-d). This wire can be straightened out using digital retraction of the wire, or using the introducer. Once the entire “J”-tip is within the renal pelvis (Figure 3b) the catheter is removed while the wire is carefully secured with a hemostat at the renal capsule to avoid losing wire access. The 6.5 Fr. catheter with the hollow cannula is advanced over the guide wire into the renal parenchyma (Figure 2e, 3d). Once it enters the renal pelvis the hollow trocar is pulled back as the catheter is advanced over the guide wire. This can be very tight so be sure to pin the wire and catheter as the trocar is withdrawn in a twisting motion (Figure 3d-e). Gentle twisting of the cannula within the catheter will help facilitate sliding along one another. The locking string is pulled gently to prevent catheter dislodgement while avoiding it being too tight which can kink the pigtail within the pelvis (Figure 3e-f) and the string is then clamped with a hemostat at the junction of the string and catheter to maintain tension (Figure 5b).

Be sure not to clamp the catheter itself, but just the string at the junction of the catheter and the string.

The radiopaque marker should be seen during the contrast study to ensure it is within the renal pelvis as that marks the last whole of the multi-fenestrated loop of the nephrostomy catheter. (Figure 3).

The Dacron cuff is then gently advanced down the nephrostomy catheter to the renal capsule to keep the catheter snug in the renal pelvis (Figure 2f). Sterile cyanoacrylate glue is applied between the Dacron and the renal capsule to provide security and prevent leakage (Figure 2f).
Figure 2: Nephrostomy access into the kidney.

A) The peri-renal fat is bluntly dissected off the caudal pole of the kidney to expose the renal capsule.

B) An 18-ga. IV catheter is gently inserted into the dilated renal pelvis until a flash of urine is seen. Then under fluoroscopy a pyelogram is performed.

C) A 0.035” angled hydrophilic guidewire is advanced into the renal pelvis through the IV catheter under fluoroscopic guidance looping around the renal pelvis.

D) The 18-ga. catheter is then removed and the wire is secured with a hemostat.

E) The locking loop nephrostomy catheter is passed over the guidewire and advanced into the renal pelvis. Once the catheter is seen under fluoroscopy inside the renal pelvis the hollow trocar is withdrawn and the locking string is pulled to tighten.

F) The silicone/Dacron cuff and silicone sleeve is advanced to the renal capsule and sterile tissue glue is used to adhere the Dacron to the capsule.
A) 18 ga IV catheter (white arrow) being placed into the caudal pole of the renal pelvis and a pyelogram being performed.

B-C) A 0.035” “J”-tipped guide wire (red arrow) advanced through the catheter and coiled inside the dilated renal pelvis.

D) The locking loop nephrostomy catheter (black arrow) is advanced over the guide wire and hollow cannula inside the renal pelvis allowing a curl to form over the wire (red arrow) within the renal pelvis. The white arrow is the radiopaque marker which marks the last hole of the multi-fenestrated loop, ensuring the entire loop is within the renal pelvis.

E) Once the radiopaque mark is within the renal pelvis (white arrow), the wire and hollow trocar are removed, the string is locked.

F) A pyelogram is performed to confirm no leakage and appropriate catheter placement. Notice the pigtail catheter loop is tight and locked with the mark (white arrow) within the large dilated pelvis.

Figure 3: The Modified-Seldinger technique being used for locking loop nephrostomy access.
Figure 3: The Modified-Seldinger technique being used for locking loop nephrostomy access continued.

G) The renal pelvis is then drained to confirm all of the contrast can be easily removed.

H) The device once within the patient. The head is to the top of the image. The nephrostomy catheter (black arrows) is connected to the caudal male adaptor of the port (white arrow) and the bladder catheter (yellow arrows) is connected to the cranial male adaptor of the port.

I) Contrast study being performed using a Huber needle through the port to confirm bladder and kidney patency and no leakage.

J) Lateral fluoroscopic image similar to image (H) with the kidney catheter attached caudally (black arrows) and the bladder catheter attached cranially (yellow arrows) to the shunting port (white arrow).

**PLACING THE URINARY BLADDER CATHETER**

The urinary bladder catheter is now placed (Figure 4). First, using 3-0 monocryl suture a purse string suture pattern is made at the apex of the bladder (Figure 4a). In the center of this purse string a #11 blade is used to puncture a small hole into the bladder lumen (Figure 4b) making sure to pierce the bladder mucosa. Next, the loaded cystostomy catheter, with the hollow cannula and the sharp stylet, is advanced through the incision and into the urinary bladder lumen (Figure 4c,d) to the level of the Dacron cuff. The sharp trocar is discarded, the catheter is advanced until the Dacron cuff is against the serosal surface of the bladder, and the purse-string suture is secured and tied. Using 3-0 monocryl suture the Dacron cuff is sutured to the bladder wall (full thickness) using 3 or 4 sutures (Figure 4e). Notice how the suture is passed through both the superficial silicone ring and the deeper Dacron disc (Figure 4e). Sterile cyanoacrylate glue is used to further secure the Dacron to the serosal surface of the urinary bladder (Figure 4f). There is a radiopaque marker on the bladder catheter identifying the last hole to ensure that the entire catheter is within the bladder lumen. Care should be taken to ensure that this catheter is not too far into the bladder to the level of the trigone as this could be very irritating. If the bladder is small and the tip of the catheter is too far within the bladder lumen the tip should be cut. The tip of the bladder catheter should not be more than 50% into the bladder lumen to the level of the bladder body. Once secure, saline is infused through the hollow trocar and the seal is leak tested. Once satisfied with no leak the hollow trocar is removed.
Figure 4: Placing the cystoscopy catheter.

A) A purse string suture is made at the apex of the bladder.

B) A #11 blade is used to make a stab incision in the center of the purse string.

C-D) The bladder catheter is advanced through the stab incision with the hollow trocar and sharp stylet in place. Then the purse string is secured around the catheter and tied.

E) The silicone/Dacron cuff is sutured in 1 or 2 spots.

F) Tissue glue is applied to the Dacron cuff adhering to the serosal surface of the bladder and an additional 2 sutures are placed to secure the catheter to the bladder wall.
PLACING THE CATHETERS THROUGH THE BODY WALL

Finally, the skin and subcutaneous tissues immediately lateral to the ventral abdominal incision on the ipsilateral side of the nephrostomy tube is dissected down to the abdominal musculature (Figure 5a). Both catheters are passed gently through the body wall. Typically the nephrostomy catheter is attached to the caudal barb and the cystostomy catheter is attached to the cranial barb, which maintain a gentle bend to the port and prevent kinks (Figure 3h-j,5). Using blunt dissection with a mosquito hemostat a puncture is made through the body wall and into the abdomen (Figure 5b). The ends of the hemostat carefully clamp the locking string at the end of the nephrostomy catheter and the string and catheter are pulled through the body wall in unison (Figure 5b,c). Do Not Clamp The Catheter Itself. Once the kidney catheter is through the body wall, the string is kept locked and the blue cuff is placed over the end of the catheter (tapered end first), (Figure 5c) while holding the string tight manually to maintain the lock. Then the barb of the shunting port is advanced onto the catheter (Figure 5d, 6).

A) The ventral abdominal fat is gently dissected off the body wall from the incision laterally on the ipsilateral side of the obstructed kidney.

B) Using small hemostats a stab incision is bluntly made through the body wall and into the abdomen where the kidney catheter will be placed. This is typically done caudal to the port. Once through the body wall the string at the junction of the catheter end is engaged (white arrow) and the other hemostat is removed so the catheter can be pulled through the body wall.

C) The string and catheter are pulled through the rectus muscle maintaining the locking string and the blue cuff is placed over the string (tapered end first) and onto the nephrostomy catheter.

D) The string is wedged between the first rung of the barb on the shunting port and the catheter to maintain the lock (white arrow). The string is cut distally toward the port (See figure 6), and no excessive string should be present. The catheter is advanced onto the other barbs and the blue boot is pulled up over the junction. Again no string should be seen exiting the nephrostomy tube at the junction.

Figure 5: Placing the catheters through the body wall.

A) The ventral abdominal fat is gently dissected off the body wall from the incision laterally on the ipsilateral side of the obstructed kidney.

B) Using small hemostats a stab incision is bluntly made through the body wall and into the abdomen where the kidney catheter will be placed. This is typically done caudal to the port. Once through the body wall the string at the junction of the catheter end is engaged (white arrow) and the other hemostat is removed so the catheter can be pulled through the body wall.

C) The string and catheter are pulled through the rectus muscle maintaining the locking string and the blue cuff is placed over the string (tapered end first) and onto the nephrostomy catheter.

D) The string is wedged between the first rung of the barb on the shunting port and the catheter to maintain the lock (white arrow). The string is cut distally toward the port (See figure 6), and no excessive string should be present. The catheter is advanced onto the other barbs and the blue boot is pulled up over the junction. Again no string should be seen exiting the nephrostomy tube at the junction.
Figure 5: Placing the catheters through the body wall continued.

E) The same is done on the bladder catheter side and this is pulled to the cranial aspect of the incision and port. This is pulled through the body wall by grasping the catheter directly with the hemostat. The blue boot is pre-placed. Once through the body wall the end of the catheter is cleanly cut with a scissors prior to attaching to the port. The blue boot is placed on this catheter.

F) The bladder side is attached to the shunting port as with the kidney side the blue boot is pulled up to the junction.

G) The port is sutured to the body wall using permanent suture through all 4 eyelets.

H) The Huber needle inserted through the silicone diaphragm of the port for leak and patency testing.

Once the first rung of the barb is within the catheter the string will be wedged between the barb and the catheter, locking the string. A #11 blade is then used to cut the string flush with the catheter end, against the metal barb (Figure 6), being careful to not have any excessive string out of the catheter as this can be a site of leakage. Then the catheter is advanced over all of the barbs so that it is snug (Figure 6c,d).

The string should NOT be hanging out of the end of the catheter once it is advanced onto the port. This makes an incomplete seal and the site that can leak (Figure 6c,d).

The pre-loaded blue cuff is advanced over the catheter to the port (Figure 5e). The same is done on the bladder catheter side (Figure 5e), only there is no string to cut.
Figure 6: Detailed steps on cutting the string of the kidney catheter.

A) String (black arrow) wedged between the kidney catheter and the male adaptor of the shunting port (white arrow).
B) A #11 blade cutting the string away from the catheter when on the first rung of the male adaptor barb.
C) Advancing the catheter over the barbs to lock the string and secure the catheter.
D) The catheter on the port prior to advancing the blue boot.

To pull this catheter through the body wall the tip is clamped with a hemostat. Since the end of the catheter could get damaged the tip of the catheter is cut with a scissors and the end is discarded (Figure 5e). The blue cuff is advanced over the catheter, ensuring the tapered end goes down the catheter and the thicker blunt end is towards the shunting port. Finally the shunting port is attached to the bladder catheter.

Care should be taken to ensure there is enough space made for the shunting port with both arms and the blue cuffs. Leaving approximately 1 cm of catheter between the end of the blue boot and the entry to the abdomen encourages a gentle bend into the abdomen so the catheter does not kink.

As mentioned above, the bladder catheter is secured to the cranial barb of the shunting port and the kidney catheter to the caudal barb (Figure 3,5).

This too prevents kinking by making a nice gentle loop within the abdomen prior to passing through the body wall. The excess catheter should remain in the abdomen.
Figure 7: Ventrodorsal (A) and lateral (B) fluoroscopic images after SUB placement showing the kidney catheter attached to the caudal part of the port and the bladder catheter on the cranial part of the port. Note the radiopaque marker (black arrow) is well with the renal pelvis and the Dacron cuff (white arrow) is seen along the caudal border of the kidney.

Once this system is closed one suture is placed (non-absorbable synthetic 3-0) through the ventral rectus sheath to the eyelet of the port to secure it in place. Using a 22-gauge Huber needle, saline is initially used to flush the system while both sides of the tubing are digitally compressed in the abdomen to test the port for any leaking. Care should be taken to ensure the tubing is compressed without damaging it. Once no leak is confirmed at the port a 50% mixture of contrast and saline is used to flush the entire system under fluoroscopic guidance. This should be done using digital subtraction to better visualize any leak. Care should be taken to monitor that the renal pelvis and bladder fill and drain easily.

The catheters need to be examined carefully at the renal capsule entry point, apex of the bladder entry point and both sides of the shunting port for any leakage. In addition all catheters should be examined for any kinks (Figure 9d,e).

The port is then secured to the abdominal wall using permanent suture material (2-0 or 3-0 synthetic non-absorbable) (Figure 5f,g). The subcutaneous tunnel is closed routinely and any dead space addressed. Typically, topical bupivacaine is placed in the SQ pocket around the port to provide additional analgesia.

Once complete, a fluoroscopy image is taken in both VD and lateral to ensure no kinks are seen and the catheter is well situated in the renal pelvis and urinary bladder (Figure 7). The radiopaque marker on the nephrostomy catheter should always be within the renal pelvis and the Dacron cuff can be seen at the margin of the caudal pole of the kidney. An abdominal wrap is placed for the first 24 hours post-operatively.

**FLUSHING PROCEDURE**

Flushing of the SUB (Figure 8) should be done every 3-6 months to ensure no encrustation and full patency. This can be done using a 22-ga Huber needle. This can be done more frequently if patency or leakage is of any concern. We typically perform this under ultrasound guidance, but it can also be done using fluoroscopy (Figure 8, 9a-c). The skin over the port is clipped of fur and aseptically prepared. An extension set with a 3-way stop-cock is used with one empty syringe (10 mL) for urine sampling and one syringe filled with sterile saline (ultrasound-guidance) or a 1:1 dilution of iohexol and saline (fluoroscopic-guided flush). The shunting port is palpated under the skin and the flat silicone insertion site is isolated (Figure 8). Using sterile technique the Huber needle is advanced through the skin, into the silicone diaphragm until metal is reached. This must be done in a perpendicular manner (Figure 8). Once the needle is inside the shunting port a urine sample is obtained (Figure 8b). If no urine is withdrawn than the needle is either not deep enough into the access port, at the wrong angle, or the system is occluded. Once urine is obtained (and submitted for urine culture and urinalysis) the syringe with saline (+/- contrast) is used to inject the system. The volume of fluid
injected should never be greater than that which was removed. The renal pelvis should always be monitored during this procedure with either ultrasound or fluoroscopy to ensure it is not being over-distended. Typically the author will remove 5-10 mL of urine for analysis and culture and then serially infuse 1-2 mL of saline monitoring the renal pelvis with ultrasound for distension, bubbles or turbulence. If this is seen, and it gets larger than the fluid can be withdrawn and the nephrostomy catheter is deemed patent. Then the same is done while monitoring the bladder side, looking for a “bubble study” (Figure 8). Once this is seen the cystostomy catheter is considered patent. Finally the renal pelvis is emptied (monitoring with ultrasound or fluoroscopy), and then 1 mL of saline is injected to clear the device of any debris that could have been sucked into the system.

**Ultrasound-guided technique:** The sterile saline is carefully injected into the port while the renal pelvis is being monitored with ultrasound guidance (Figure 8d). The renal pelvis should be measured prior to injection and then seen to enlarge as the pelvis is flushed. Once saline is seen to enter the renal pelvis, usually small air bubbles are seen, the fluid is withdrawn to avoid over distension. Next the ultrasound probe should be placed over the bladder apex and the port should be flushed again to see fluid enter the urinary bladder through the SUB cystostomy tube (Figure 8 e,f). Again, bubbles are usually seen (Figure 8f). Care must be taken NOT to overfill the renal pelvis during monitoring of the urinary bladder.
**Fluoroscopic Guidance Technique:** If the flush is being done under fluoroscopic guidance then a solution of iohexol:sterile saline is made in a 1:1 dilution in a 10 mL syringe. Ultrasound is not needed for the flush but should be used prior to the flush to get an accurate renal pelvis size measurement to ensure proper function of the SUB device. The patient is placed under the fluoroscopic unit in dorsal recumbency and the port area is clipped and scrubbed aseptically, as described above. The fluoroscopy image should be aligned with the patient so that the kidney, port and bladder are seen in the image. After the urine sample is obtained (5-10 mL), to ensure proper needle placement and for urinalysis and culture, the contrast solution is injected into the port. Careful monitoring of the contrast should be seen using fluoroscopy traveling from the port, up the catheter, to the kidney while the renal pelvis fills (Figure 9b,c). This is ideally done using digital subtraction radiography (DSA), as long as the patient is not moving (Figure 9c). If the patient is not sedated than DSA is more difficult and regular fluoroscopy is appropriate. The pelvis should not be over-distended and the injection should be done slowly (2-3 mL is all that is needed typically). At the same time the urinary bladder should be filling with contrast. Then all of the contrast should be easily withdrawn from the bladder and renal pelvis. If contrast is used for the flushing, the author then injects 2-3 mL of sterile saline to wash the catheter of contrast material and any debris that could have been suctioned into the system.

**COMPLICATIONS AND PROGNOSIS (Figure 9)**

The SUB device is not meant to replace traditional surgery for ureteral obstructions, but rather is an alternative when traditional surgery either fails, is contraindicated, or has a high risk of re-obstruction.

Considering that over 85% of cats have concurrent nephroliths and the median number of stones per ureter was 4 in a recent study, a majority of cases seem to benefit from this approach in the authors’ practice.

The device should only be placed by those experienced with the technique and those that are appropriately trained, as these cases are technically challenging and can become very complicated.

The authors’ prefer all new users to contact them via the email(s) above in order to go through the procedure details prior to placing the first SUB on a live animal. The authors’ also recommend first practicing on a cadaver.

The acute decompression success rates are high (>98%), but training is mandatory. In the authors’ experience, patency of the device was evident long-term (~92%), followed for a median of 18 months (range: 30-1460 days), with improvement in the creatinine concentrations in 98% of patients after placement. SUB™ catheter occlusion with stone debris was seen in 5% of cases, kinking in 2%, and blood clots in 1%. Since starting the practice of routine prophylactic flushing, obstruction with debris has not been a major issue.

Complications are more common during, and immediately after, placement, and this too is rare (~5%). These are very rare but have included immediate leakage at the nephrostomy tube site (resolved with the new Dacron cuff design); leakage at the junction of the port and the catheter (resolved since cutting the string after the first rung and not allowing it to exit the catheter at the end of the shunting port); hemorrhage during nephrostomy tube placement, and obstruction with a blood clot requiring infusion of tissue plasminogen activator; and kinking of the catheter as it enters the body wall (resolved by placing the nephrostomy catheter to the caudal barb and the cystostomy catheter to the cranial barb of the shunting port, as well as leaving 1 cm of catheter past the blue boot prior to the catheter entering the body wall).
Overall, the use of a SUB for feline and canine patients with a ureteral obstruction can be considered a functional option when other traditional therapies have failed or are contraindicated. Again, operators should be well versed in interventional techniques and devices, the possible complications, and appropriately trained in the use of this device before trying this in a clinical patient.

Figure 9: Fluoroscopic images showing some complications that can be seen with the SUB device.

A) Lateral image of a cat with a SUB device. During fluoroscopic flushing at the end of the procedure the cystostomy catheter (black arrows) is seen to fill with contrast but the nephrostomy tube (white arrows) is not filling. This was due to a severe pyonephrosis and with serial flushing the catheter eventually cleared and started flowing.

B) If this occurs drain the entire system completely and then flush again, as it can be that the renal pelvis is too full to allow more flush.

C) A digital subtraction image of a cat with transitional cell carcinoma after ureteral and urethral diversion. There is a ureteral stent on one side and an internalized ureteral bypass on the other side (white arrow). During cystography contrast is seen advancing up the ureteral stent and bypass and leaking out of the kidney (yellow arrow) at the previous catheter access point.

D-E) A kinked (red arrow) SUB device in a cat.

F) After manipulation of the kink digitally it straightened out. This was done under anesthesia immediately post-operatively.

Please email allyson.berent@gmail.com or chick.weisse@gmail.com if you have any questions or need additional information on the surgical implantation procedure of the SUB™ device.
MISCELLANEOUS

In the traditional SUB™ device kit, there are 2 port sizes (small and large). The smaller port is ideal for small thin cats and small dogs, but the larger port is used in overweight cats and medium/larger dogs. Additionally, there are 2 connectors that can be used: 1) a 3-way shunting port called The PantsPort™, and 2) an internalized metallic male-to-male barbed adaptor (Figure 10).

1) The **3-way PantsPort™** allows you to connect both kidneys to a single bladder catheter for bilateral ureteral obstructions. The authors’ prefer each kidney to have its own port when possible as flushing each side individually is ideal, but the PantsPort saves a fair amount of anesthesia time in compromised patients. This is typically used in cancer-induced ureteral obstructions.

2) The **internalized male-to-male barbed adaptor** (Figure 9d) is used when the patient is not tolerating general anesthesia and the time it takes to secure the catheters subcutaneously is not possible (15-30 minutes additionally). This allows a fast connection to be made, with the same premise to lock the string and advance the blue cuffs, but there is no need to secure these connections to the body wall. It is left free within the abdomen. This does not allow flushing and sampling in the long-term.

![Figure 10: Miscellaneous equipment that can be used during ureteral bypass placement.](image)

**Figure 10**: Miscellaneous equipment that can be used during ureteral bypass placement.

A) This is a 3 way “PantsPort™” that can be used for bilateral ureteral obstructions where there are 2 kidney catheters and one bladder catheter that are all connected to one port.

B) This is a male-male barbed adaptor that will connect the kidney to bladder catheter and remain internalized. This provides bypass without an access port so it is not subcutaneous. This allows for faster placement but does not allow the device to be serially flushed in the future.

REFERENCES


