Imaging-Guided Suprapubic Bladder Tube Insertion: Experience in the Care of 549 Patients

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OBJECTIVE. Symptomatic bladder outlet obstruction and neurogenic bladder are common conditions that frequently necessitate suprapubic insertion of a bladder tube. The purpose of this study was to describe an experience with minimally invasive imaging-guided percutaneous suprapubic bladder tube placement and the clinical and technical success and complications encountered.

MATERIALS AND METHODS. A total of 585 primary suprapubic bladder tube insertions and 439 exchanges of suprapubic bladder tubes were performed on 549 patients (469 men, 80 women; mean age, 66 years; range, 15–106 years). The details of percutaneous tube placement (indication, tube type, size at insertion and change, and method of insertion) were retrospectively recorded.

RESULTS. The technical success rate for primary suprapubic bladder tube insertion was 99.6% (547/549) and for exchanges was 92.3% (405/439). The clinical success rate for primary insertion was 98.1% (572/583), and symptoms were unresolved in 1.9% (11/583). Minor complications occurred in 7.2% (42/583) of cases at tube insertion and in 4.8% (21/439) at exchange. There was one major complication (a patient needed surgery because the small bowel was traversed by a catheter), and there was no procedure-related mortality.

CONCLUSION. Radiologic imaging-guided percutaneous suprapubic bladder tube placement is a safe and effective procedure.

Keywords: bladder outlet obstruction, neurogenic bladder, suprapubic tube

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Symptomatic bladder outlet obstruction and neurogenic bladder dysfunction are common conditions, frequently requiring long-term use of indwelling bladder catheters for adequate bladder emptying, prevention of complications of long-term bladder outlet obstruction, patient comfort, and optimal quality of life. A number of studies have found in favor of the suprapubic over the transurethral route for long-term bladder catheter drainage [1–5]. Two Cochrane review analyses of the advantages and disadvantages of alternative approaches to catheterization showed that use of a suprapubic bladder tube was associated with less bacteriuria, need for recatheterization, and discomfort than use of a transurethral catheter [1, 2]. Bergman et al. [3] found that suprapubic bladder tubes were associated with fewer urinary tract infections. Other studies [4, 5] have shown that patients with transurethral catheters have significantly more visits to the hospital because of pain than do patients with suprapubic bladder tubes with no difference in follow-up findings on blood loss, postoperative morbidity, and length of hospital stay [4]. Sugimura et al. [6] found that patients with spinal cord injury associated better quality of life with use of suprapubic bladder tubes. After surgery, the controlled return of normal voiding with a suprapubic bladder tube is comparable to that of transurethral catheterization with fewer bladder and urethral symptoms [7–9].

Interventional radiologists are skilled in percutaneous catheter drainage techniques, but despite this familiarity, there are few descriptions in the radiology literature of suprapubic bladder tube insertion performed by interventional radiologists [10, 11]. The purpose of this study was to describe our experience with minimally invasive imaging-guided percutaneous suprapubic bladder tube placement and tube exchanges and the clinical and technical success and complications encountered.

Materials and Methods

Approval for this retrospective study was obtained from the hospital ethics committee on human studies. The study was HIPAA compliant, and patient informed consent was waived.

Medical Record Review

We searched the interventional radiology database at our institution for records of all patients in whom a percutaneous suprapubic bladder catheter had been placed from July 1999 through January 2009. A total of 585 primary suprapubic bladder tube insertions and 439 suprapubic bladder tube exchanges were performed on 549 patients (469 men, 80 women; mean age, 66 years; range, 15–106 years).

Two of the authors retrospectively reviewed and abstracted data from institutional medical records; relevant diagnostic and procedure-related imaging reports; and surgical, pathologic, and other laboratory reports. The following data were abstracted: sex, age, indication, insertion technique (trocar or Seldinger), catheter diameter, type of catheter (Foley or pigtail), technique of radiologic guidance (ultrasound with fluoroscopy, CT), whether the procedure was a primary insertion or catheter exchange, complications encountered (hemorrhage, pain, urinary tract infection, bowel injury, urine leak), and whether the symptoms for which the tube was inserted resolved.

Drainage Procedure

A team consisting of one of 19 attending staff interventional radiologists and an interventional radiology fellow performed the procedures over the period studied. The experience of the staff radiologists ranged from 3 to 25 years at the time of placement.

Drainage procedures were performed with ultrasound–fluoroscopic or CT guidance and with IV conscious sedation. Sedation when needed was achieved with IV administration of midazolam hydrochloride (Versed, Roche) or fentanyl citrate (Sublimaze, Taylor) ($n = 974$) or general anesthesia ($n = 14$). The conscious sedation medications were administered in keeping with institutional guidelines, and continuous monitoring was performed. Heart rate, blood pressure, and oxygen saturation were recorded every 5 minutes. IV sedatives were titrated to achieve adequate pain control for the procedure. All patients were given IV antibiotics (1 g ampicillin sodium and 80 mg gentamicin sulfate; 500 mg levofloxacin was substituted for gentamicin if the patient was allergic to the latter) immediately before the procedure.

Catheters

Pigtail catheters were self-retaining locking pigtail catheters with distal hydrophilic tips ranging in size from 8 to 14 French. The diameter of the Foley catheter (Bard) ranged from 12 to 14 French. The choice of catheter type (Foley or pigtail) and size for each procedure was made by the attending radiologist performing the procedure. In patients with mature catheter tracks, after placement by a radiologist, the suprapubic bladder tubes were followed up and exchanged as needed in the urologist's office. For patients without mature tracks (tube present < 6 weeks), all exchanges and increases in tube size were performed in the interventional radiology suite until the track matured or was deemed too complex for office suprapubic bladder tube change.

Technique

Catheters were placed by either Seldinger or trocar technique. Catheter exchanges were performed with a modified Seldinger technique. After granting informed consent, the patient was placed in the supine position on the procedure table.

Trocar technique—An existing urethral Foley catheter was used for retrograde instillation of iothalamate meglumine (17.2% weight/volume Cys-

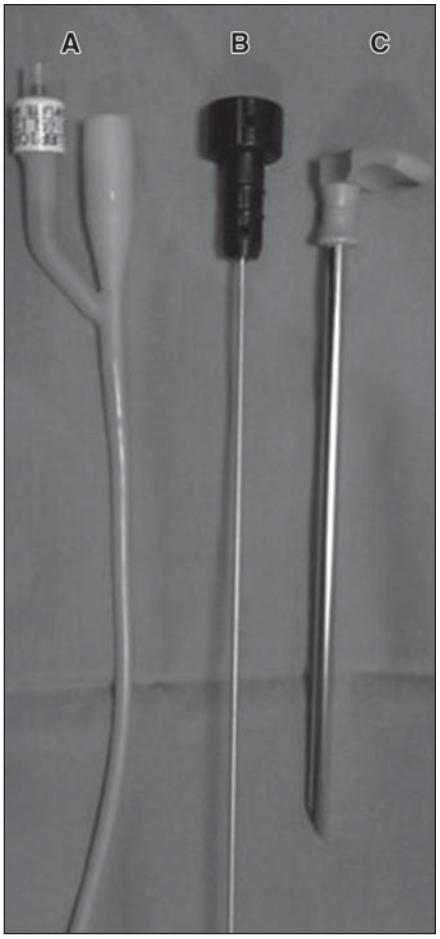

Fig. 1—Photographs show unassembled external trocar device set consisting of three parts.
A, Foley catheter.
B, Inner stylet or stiffener for Foley catheter.
C, External trocar, which has sharp cutting edge.

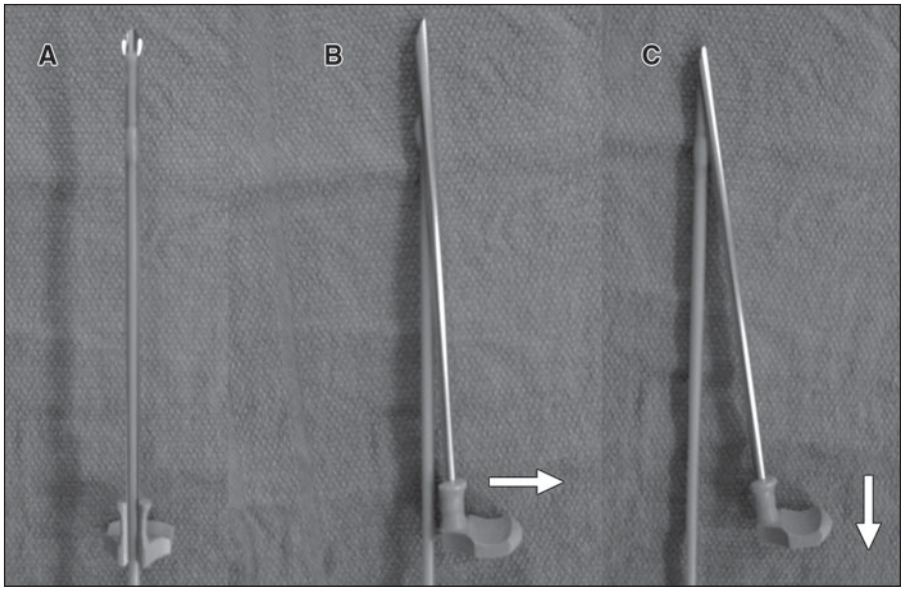

Fig. 2—Photographs show assembly of external trocar device.
A, Inner stylet straightens Foley catheter, which is loaded onto external trocar.
B and **C,** Proximal plastic perpendicular plate of external trocar is used to pull external trocar away from Foley catheter (*arrow,* **B**) and out of patient (*arrow,* **C**) once device is correctly placed into bladder while Foley catheter and inner stiffener are held in place. Foley catheter is then fed off inner stiffener, which is withdrawn, leaving Foley catheter in bladder. Foley catheter balloon is then inflated to hold catheter in place.

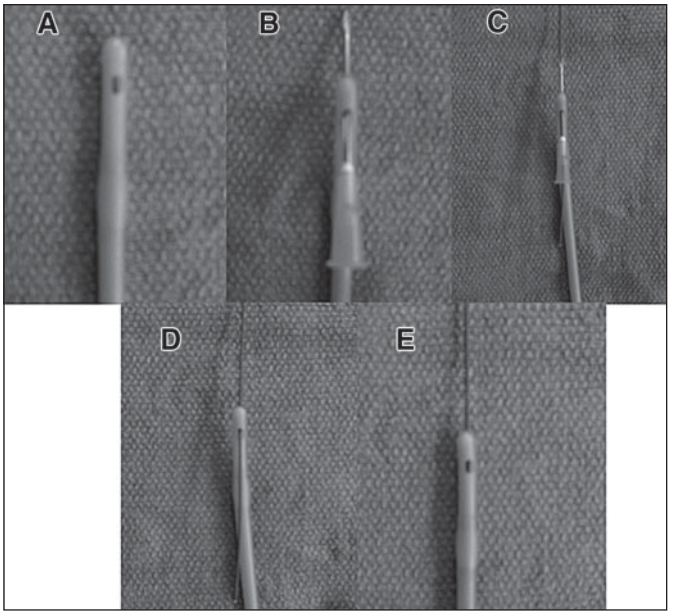

Fig. 3—Photographs show appearance of device for loading Foley catheter onto distal end of wire when wire lies within catheter track at suprapubic bladder tube exchange.
A, Foley catheter.
B, Needle (16-gauge) is inserted through side hole to pierce distal tip of Foley catheter.
C, Distal end of wire is carefully inserted into distal (sharp) end of 16-gauge needle and passed through needle.
D, Needle is removed, leaving wire to enter distal tip of Foley and exit side hole.
E, Wire is carefully pulled back until it flops into inner lumen of catheter through side hole and is advanced down Foley catheter. Foley catheter can then be advanced over wire and into bladder, where it is deployed and balloon inflated to secure it in position.

to-Conray, Mallinckrodt) into the bladder to distend it. This step decreased the distance from the anterior abdominal wall to the anterior bladder wall and displaced the small-bowel loops superiorly away from the course of the tube. Ultrasound with color-flow Doppler technique was performed to evaluate the bladder and assess the position of vascular structures and intervening bowel.

After assessment for the most direct route of access to the bladder and fluoroscopic confirmation of the route, the patient was prepared and draped in a sterile manner. The puncture site was lateral to the midline above the pubis. After the bladder was distended with contrast material, the skin and soft tissues overlying the bladder were anesthetized with 1% lidocaine. Under direct ultrasound visualization, Foley catheters were placed with an external trocar (Figs. 1 and 2), and pigtail catheters were placed with an internal trocar. Urine was withdrawn to confirm position, and the balloon was inflated or the pigtail locked. The bladder was drained, and contrast material (61% weight/volume iopamidol, Isovue, Bracco) was injected through the suprapubic bladder tube for fluoroscopic confirmation of position. Although real-time sonography may be sufficient for catheter placement, we instill contrast material to use additional fluoroscopic guidance during the procedure if needed. We also perform a contrast injection at the end of the procedure to verify the position of the catheter within the bladder.

Seldinger technique—In a manner similar to the trocar technique, for the Seldinger technique the bladder was filled with contrast material through a transurethral catheter. A 15-cm Ring needle (Fig. 3) was advanced into the bladder under ultrasound and fluoroscopic guidance. The needle was withdrawn, and an Amplatz guidewire was advanced into the bladder through the Ring sheath. Serial dilations of the track were performed under fluoroscopic guidance. A catheter was then inserted over the Amplatz wire. Figure 4 shows how a Foley catheter is loaded on the back end of an Amplatz wire so that it can be advanced over the wire into the bladder. Contrast injection confirmed intraluminal placement of the catheter.

For both the Seldinger and the trocar techniques, when transurethral Foley catheter placement was not possible owing to underlying urethral strictures, a 20-gauge Chiba or 18-gauge Ring needle was advanced into the bladder under imaging guidance for bladder distention. Once the bladder was distended, a catheter was inserted into the urinary bladder through a separate puncture site in a tandem trocar or Seldinger technique.

Of the 583 primary suprapubic bladder tubes placed, 558 (95.7%) were placed with a combination of ultrasound and fluoroscopy, and 25 (4.3%) were placed under CT guidance. CT guidance was indicated because of complex anatomy due to con-

TABLE 1: Patient Demographics

Characteristic	Primary Tube Insertion	Tube Exchange
Sex (no.)		
Men	467	167
Women	80	42
Age (y)		
Average	66	67
Range	15–106	18–96
Tube type (no.)		
Foley	325	321
Pigtail	258	106
Tube size (French)		
Mean	12	14
Range	8–16	8–26
Mode of insertion		
Trocar	408	
Seldinger	175	404
Technical success rate (%)	99.6 (583/585)	92.3 (405/439)
Clinical success rate (%)	98.1 (572/583)	

Note—Values in parentheses are raw numbers.

genital disorders or previous pelvic surgery, small contracted bladder, habitus, or infiltrative pelvic cancer. Seventy percent (408/583) of suprapubic bladder tubes were placed by trocar and 30% (175/583) by Seldinger technique. All suprapubic bladder tube exchanges were performed with fluoroscopy and 99.7% (404/405) with a modified Seldinger technique (Table 1).

Suprapubic tube exchange and track rescue technique—Routine catheter exchange was performed by over-the-wire exchange of the existing catheter. For urgent replacement of catheters that had become dislodged or were no longer terminating in the bladder, a 0.038-inch J-wire was advanced with an 8-French pediatric feeding tube or 5-French Kumpe catheter through the suprapubic catheter track into the bladder under fluoroscopic guidance. The track was initially identified by placement of the catheter in the superficial track and performance of a contrast injection to delineate the track, through which the wire and catheter system was negotiated. The pediatric feeding tube was exchanged over the wire for a 5-French Kumpe catheter. The wire was removed, and approximately 60 mL of iopamidol diluted 50% with 0.9% normal saline solution was injected to confirm the position in the bladder. An Amplatz guidewire was advanced into the bladder, and the Kumpe catheter was exchanged for a Foley catheter. Track dilation was performed if needed. Final position within the bladder was confirmed with contrast injection under fluoroscopic guidance. Our experience with track rescue is with combinations of Kumpe catheters and pediatric feeding tubes, but the catheter with which an operator is most comfortable and has most success is recommended.

Technical Success

Technical success was defined as placement of the suprapubic bladder tube in the bladder as planned.

Clinical Success

Clinical success was defined as resolution of symptoms associated with urinary retention and bladder outlet obstruction after catheter placement.

Data Analysis

Data were analyzed by chi-square analysis and Fisher's exact test. Logistic regression analysis (SAS 9.0, SAS Institute) was used to evaluate whether method of insertion, catheter type, and catheter size were independent predictors of complications and whether catheter type and size were independent predictors of catheter blockage. A value of $p < 0.05$ was considered significant.

Complications

Complications were categorized according to the Society of Interventional Radiology reporting guidelines. Major complications were those requiring treatment with another procedure, transfusion, or ICU admission. Major bleeding was defined as a decrease in hematocrit requiring transfusion. Minor complications were defined as those requiring minimal treatment exclusive of additional procedures, transfusion, or ICU admission [12]. Pain was defined as pain related to the suprapubic tube experienced by the patient from day 1 after the procedure.

Results

Technical Success

A total of 585 primary suprapubic bladder tube insertions and 439 exchanges were performed on 549 patients. One primary insertion was performed on 511 patients and two primary insertions on 36 patients, yielding a total of 583 successful primary insertions (the second insertion was performed for tube or track malfunction, discussed later). Two of the scheduled 585 primary insertions on 549 patients were unsuccessful, resulting in 583 (99.7%) successful primary insertions on 547 patients. On a per-patient basis the technical success rate was 99.6% (547/549). One technical failure was due to inability to place a catheter with the internal trocar technique under ultrasound guidance because the trocar did not traverse the thick-walled bladder. The second failure occurred because the thick-walled bladder (seen at previous CT) could not be accessed percutaneously because of the presence of overlying bowel and a ventral hernia at the CT-guided procedure. The technical success rate for suprapubic bladder tube exchange was 92.3% (405/439), 34 failed exchanges or rescues necessitating new primary suprapubic tube reinsertion.

Clinical Success

The clinical success rate for primary insertion was 98.1% (572/583); symptoms were unresolved in 1.9% (11/583) of cases (Table 1).

Complications

Minor complications occurred in 7.2% (42/583) of primary suprapubic tube insertions and at 4.8% (21/439) of exchanges ($p = 0.17$) (Table 2). There was one major complication, which became apparent at postprocedure CT. The suprapubic tube traversed the small bowel, which was adhesed anterior to the bladder as a result of previous laparoto-

Fig. 4—Photograph shows unassembled Ring needle.

TABLE 2: Procedure-Related Complications

Type of Complication	Primary Tube Insertion	Tube Exchange	*p*
Major complication rate (%)	0.17 (1/583)	0 (0/439)	0.38
Minor complication rate (%)	7.2 (42/583)	4.8 (21/439)	0.17
Hemorrhage	19	8	
Pain	5	3	
Urinary tract infection	5	5	
Urine leak (around the tube)	11	5	
Tube malposition	2	0	

Note—Values in parentheses are raw numbers.

TABLE 3: Catheter Malfunction

Variable	Dislodgment	Blockage
Total	96/1,010 (9.5)	48/1,010 (4.8)
Rescued successfully	72/96 (75)	38/48 (79)
Tube type		
Foley	43/646 (6.7)	35/646 (5.4)
Pigtail	53/364 (14.5)	13/364 (3.6)
p	0.0003[a]	0.27

Note—Values are number of cases with percentage in parentheses.
[a]Statistically significant.

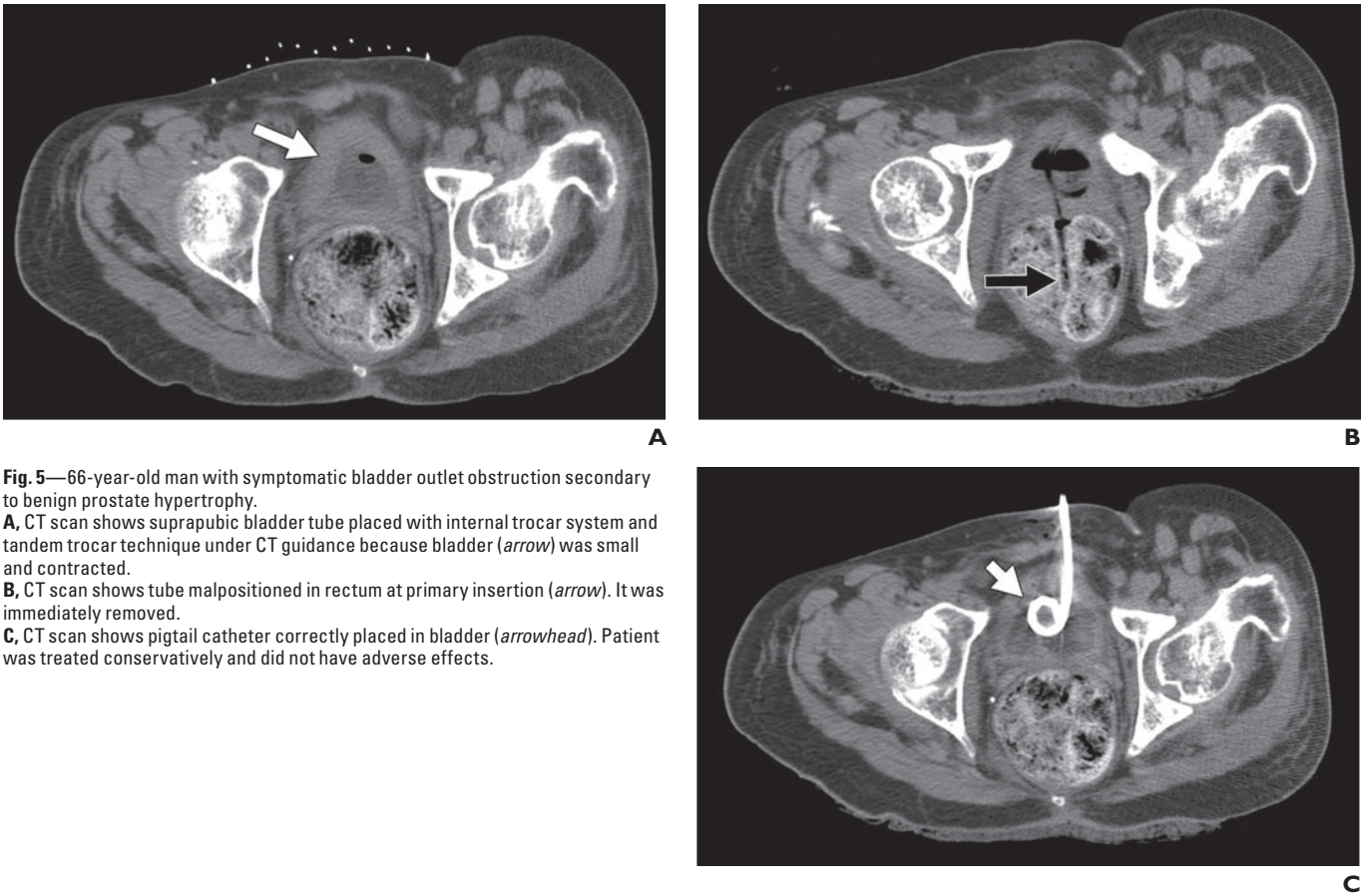

Fig. 5—66-year-old man with symptomatic bladder outlet obstruction secondary to benign prostate hypertrophy.
A, CT scan shows suprapubic bladder tube placed with internal trocar system and tandem trocar technique under CT guidance because bladder (*arrow*) was small and contracted.
B, CT scan shows tube malpositioned in rectum at primary insertion (*arrow*). It was immediately removed.
C, CT scan shows pigtail catheter correctly placed in bladder (*arrowhead*). Patient was treated conservatively and did not have adverse effects.

my. After multidisciplinary team discussion (radiology, urology, general surgery), the patient was brought to the operating room, and the bowel loop traversed by the catheter was resected and reanastomosed to conserve the suprapubic catheter. This surgical option was chosen because the patient needed a suprapubic bladder tube to drain the bladder as a result of complete urethral obstruction, the complex postsurgical anatomy, and CT findings showing that the presence of bowel precluded an alternative site for safe percutaneous catheter placement. This patient did not experience further complications and was without problems at follow-up catheter exchanges. There was no procedure-related mortality.

Although more minor complications were associated with the Seldinger (21/175) than with the trocar technique (21/408) for suprapubic tube insertion, multiple logistic regression analysis showed that mode of catheter insertion (Seldinger versus trocar [p = 0.06]), catheter type (Foley versus pigtail), and catheter size were not independent predictors of complications. Complications of primary insertion occurred in 19 of 325 Foley procedures and 23 of 258 pigtail procedures (p = 0.85). Complications of catheter exchange occurred in 15 of 329 Foley procedures and six of 110 pigtail procedures (p = 0.9). The bowel perforation rate was 0.3% (2/583). The suprapubic tube was malpositioned into the rectum in one case and into the small bowel in the previously described case (Figs. 5 and 6). In the former case, the malpositioned catheter was immediately removed from the rectum. The patient was treated conservatively and did not have adverse effects. This case was considered a mi-

TABLE 4: Number of Visits to the Interventional Radiology Suite for Primary Suprapubic Tube Insertion or Exchange

No. of Patients	No. of Visits	Percentage of Patients (n = 547)
134	1	24.4
38	2	6.9
16	3	2.9
5	4	0.9
5	5	0.9
3	6	0.5
4	8	0.7
1	10	0.18
1	12	0.18
1	15	0.18
2	16	0.36
1	17	0.18
211	99	38.6

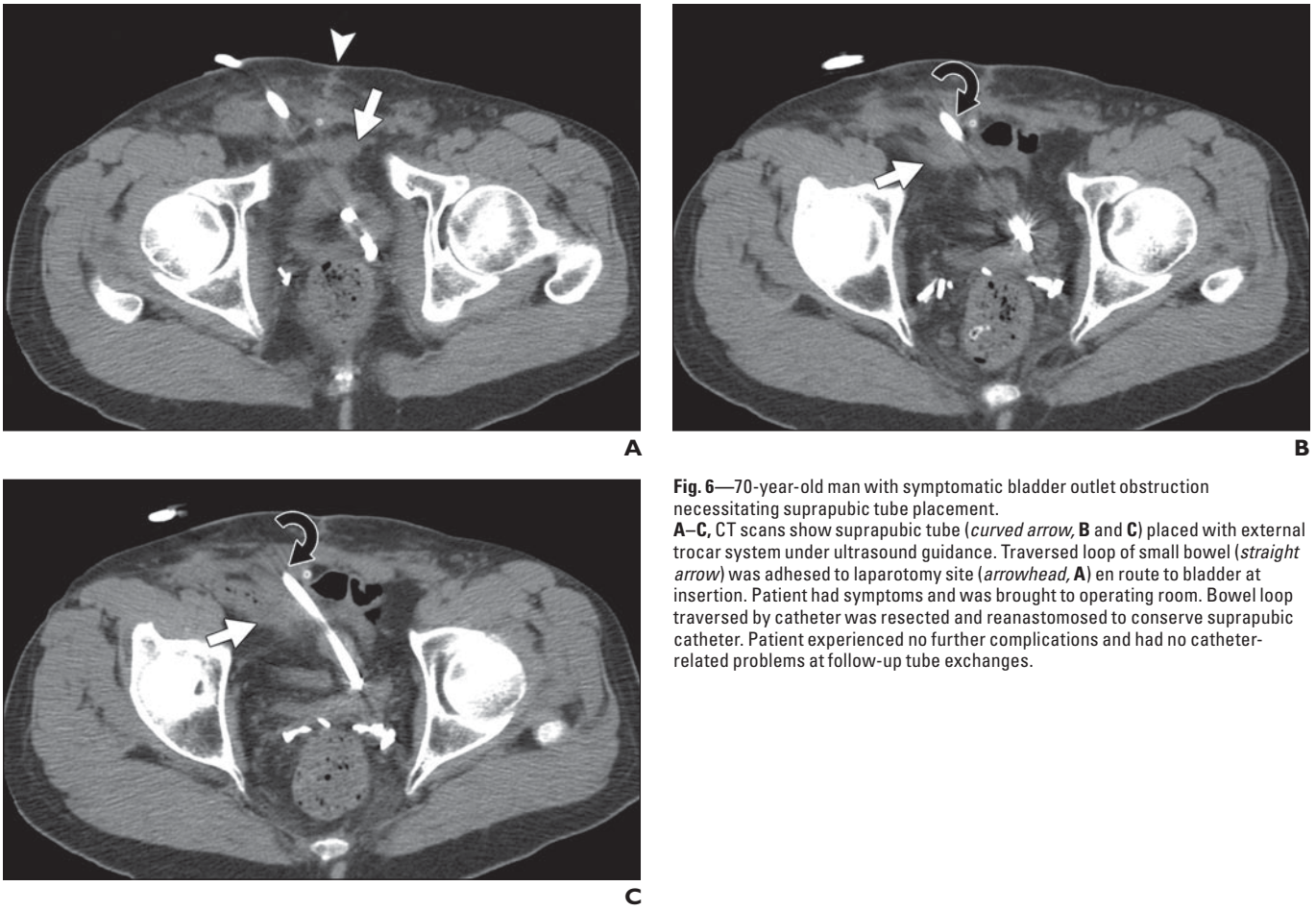

Fig. 6—70-year-old man with symptomatic bladder outlet obstruction necessitating suprapubic tube placement.
A–C, CT scans show suprapubic tube (*curved arrow,* **B** and **C**) placed with external trocar system under ultrasound guidance. Traversed loop of small bowel (*straight arrow*) was adhesed to laparotomy site (*arrowhead,* **A**) en route to bladder at insertion. Patient had symptoms and was brought to operating room. Bowel loop traversed by catheter was resected and reanastomosed to conserve suprapubic catheter. Patient experienced no further complications and had no catheter-related problems at follow-up tube exchanges.

nor complication for analysis because surgery was not required.

Indications for suprapubic catheter placement were neuropathic bladder (n = 175), bladder outflow obstruction (n = 342), and miscellaneous reasons, such as bladder injury, urethral disruption, bladder or penile fistula, scrotal or penile infection or abscess, penile or perineal ulceration, and vulvar vestibulitis (n = 30). Complication rates did not differ significantly with respect to whether the catheter was placed for bladder outlet obstruction or neurogenic bladder (p = 0.4). Complications occurred in 9.7% (17/175) of cases of neuropathic bladder, 7.0% (24/342) of cases of bladder outflow obstruction, and 3.3% (1/30) of cases of miscellaneous indications.

Catheter Blockage or Dislodgment

Tube malfunction was described as premature dislodgment or blockage of a catheter (Table 3). Pigtail catheters were statistically more likely to fall out (p = 0.0003). Multiple logistic regression analysis performed to assess whether catheter size and type were associated with blockage showed that catheter size was statistically associated with catheter blockage (p = 0.025). However, neither Foley nor pigtail catheters were more likely to become blocked (p = 0.27), even when matched for catheter size (12-French Foley with 12-French pigtail) ($p > 0.05$).

Of the 547 patients, 336 (61.4%) underwent single primary insertion with subsequent exchanges performed in a urologist's office or nursing home or by the patient; 211 (38.6%) patients returned to the interventional radiology department for catheter exchanges. Table 4 shows the number of visits each of these 211 patients made to the interventional radiology department for exchange before returning to the referring service. Only 2.4% (13/547) of patients needed six or more visits for exchanges until a mature catheter track was optimized and no further complications were encountered.

Discussion

Bladder outlet obstruction is a common condition. The estimated prevalence is 20–35% among elderly men, and 5–15% of residents of long-term care facilities need urinary catheters for extended periods [13]. Although many patients are initially successfully treated with a combination of medical and surgical management, these options can fail, necessitating permanent treatment, such as bladder catheterization. Although urologists and surgeons are familiar with suprapubic tube insertion technique, the radiology literature contains few descriptions of the procedure performed by interventional radiologists. Those reports [10, 11] describe the feasibility of performing suprapubic cystostomy by the Seldinger technique in small patient cohorts. Other articles [14, 15] describe placement of a suprapubic tube in the operating room under cystoscopic guidance and general anesthesia in a large number of cases.

We describe our institutional experience performing suprapubic tube insertion in the interventional radiology suite as an outpatient procedure with a short procedure time and high clinical and technical success rates. The procedure is performed with moderate sedation,

allowing rapid recovery and allowing patients at high anesthetic risk and declining medical status to benefit from this approach. Exchanges of suprapubic tubes are performed in the radiology suite as needed until the track is enlarged and matured. Suprapubic bladder tubes are then exchanged without a guidewire or instrumentation other than the catheter itself. The catheter can be placed down the mature track in the urologist's office by a nurse [16] or by patients themselves. Radiology services can be reserved for unforeseen tube rescue and track closure.

Previously described complications of the use of suprapubic bladder tubes are minor in most patients. They include infection, hemorrhage, blockage, encrustation, and bowel injury. Serious complications usually are isolated and more commonly occur at tube insertion. Small-bowel injury has been infrequently described. Thirteen cases of small-bowel injury at insertion have been reported [14, 15, 17, 18], and 10 cases of these procedures were performed with cystoscopic guidance [14, 15]. In two described cases of bowel injury at catheter exchange [19, 20], primary insertion had been performed months before exchange without incident. Two cases of colonic injury and sigmoid and cecal injury also have been reported [21, 22]. As of this writing, the largest series of suprapubic bladder tube placement by urologists using cystoscopic guidance had bowel perforation rates of 2.4% (five cases) [14] and 2.7% (also five cases) [15]. Our bowel perforation rate is lower than in those series, 0.4% (2/547).

The complications in the two urology series [14, 15] were similar to those in our series. The complication rate in both of those series was 10%, whereas in our series, the rate of minor complications was 7.2% (42/583) at tube insertion and 4.8% (21/439) at tube exchange. We found no statistical difference in complication rates by catheter type, catheter size, mode of insertion (Seldinger versus trocar), primary insertion or exchange, or indication (bladder outlet obstruction versus neurogenic bladder) ($p > 0.05$).

We used two types of suprapubic bladder tube: Foley and pigtail catheters. Pigtail catheters have larger interior lumens than other catheters of the same size and should allow more efficient urine drainage with less catheter blockage. In our series, 4.8% (48/1,010) of tubes became blocked. Using logistic regression analysis, we found that catheter size was statistically associated with increased risk of blockage, which makes sense because the smaller a lumen, the more likely it is that a catheter will become blocked. We found less blockage with pigtail catheters than with Foley catheters (pigtail, 3.6%, 13/364; Foley, 5.4%, 35/646), but this finding was not statistically significant ($p = 0.27$). Pigtail catheters were statistically significantly more likely to become dislodged and complicate patient course (pigtail, 14.6%, 53/364; Foley, 5.4%, 35/646) ($p = 0.0003$). The dislodgment may occur because the hydrophilic external coating on the pigtail catheter may promote catheter movement.

In terms of procedure-related mortality, previous series had mortality rates of 1.8% (4/219) [12] and of 0.6% (1/157) [13]. In our large series of 583 insertions and 427 exchanges in 547 patients, no procedure-related mortality was encountered. We conclude that imaging-guided percutaneous suprapubic bladder tube placement is a successful and safe procedure that has high technical and clinical success rates.

References

1. Niël-Weise BS, van den Broek PJ. Antibiotic policies for short-term catheter bladder drainage in adults. *Cochrane Database Syst Rev* 2005; Jul 20:CD005428
2. Niël-Weise BS, van den Broek PJ. Urinary catheter policies for short-term bladder drainage in adults. *Cochrane Database Syst Rev* 2005; Jul 20:CD004203
3. Bergman A, Matthews L, Ballard CA, Roy S. Suprapubic versus transurethral bladder drainage after surgery for stress urinary incontinence. *Obstet Gynecol* 1987; 69:546–549
4. Dunn TS, Figge J, Wolf D. A comparison of outcomes of transurethral versus suprapubic catheterization after Burch cystourethropexy. *Int Urogynecol J Pelvic Floor Dysfunct* 2005; 16:60–62
5. McPhail MJ, Abu-Hilal M, Johnson CD. A meta-analysis comparing suprapubic and transurethral catheterization for bladder drainage after abdominal surgery. *Br J Surg* 2006; 93:1038–1044
6. Sugimura T, Arnold E, English S, Moore J. Chronic suprapubic catheterization in the management of patients with spinal cord injuries: analysis of upper and lower urinary tract complications. *BJU Int* 2008; 101:1396–1400
7. Ratnaval CD, Renwick P, Farouk R, Monson JR, Lee PW. Suprapubic versus transurethral catheterisation of males undergoing pelvic colorectal surgery. *Int J Colorectal Dis* 1996; 11:177–179
8. Wells TH, Steed H, Capstick V, Schepanksy A, Hiltz M, Faught W. Suprapubic or urethral catheter: what is the optimal method of bladder drainage after radical hysterectomy? *J Obstet Gynaecol Can* 2008; 30:1034–1038
9. Myers JB, McAninch JW. Management of posterior urethral disruption injuries. *Nat Clin Pract Urol* 2009; 6:154–163
10. Lee MJ, Papanicolaou N, Nocks BN, Valdez JA, Yoder IC. Fluoroscopically guided percutaneous suprapubic cystostomy for long-term bladder drainage: an alternative to surgical cystostomy. *Radiology* 1993; 188:787–789
11. Papanicolaou N, Pfister RC, Nocks BN. Percutaneous, large-bore, suprapubic cystostomy: technique and results. *AJR* 1989; 152:303–306
12. Gervais DA, Levis DA, Hahn PF, Uppot RN, Arellano RS, Mueller PR. Adjunctive intrapleural tissue plasminogen activator administered via chest tubes placed with imaging guidance: effectiveness and risk for hemorrhage. *Radiology* 2008; 246:956–963
13. Gammack JK. Use and management of chronic urinary catheters in long-term care: much controversy, little consensus. *J Am Med Dir Assoc* 2002; 3:162–168
14. Ahluwalia RS, Johal N, Kouriefs C, Kooiman G, Montgomery BS, Plail RO. The surgical risk of suprapubic catheter insertion and long-term sequelae. *Ann R Coll Surg Engl* 2006; 88:210–213
15. Sheriff MK, Foley S, McFarlane J, Nauth-Misir R, Craggs M, Shah PJ. Long-term suprapubic catheterisation: clinical outcome and satisfaction survey. *Spinal Cord* 1998; 36:171–176
16. Evans A, Feneley R. A study of current nursing management of long-term suprapubic catheters. *Br J Community Nurs* 2000; 5:240–245
17. Noller KL, Pratt JH, Symmonds RE. Bowel perforation with suprapubic cystostomy: report of two cases. *Obstet Gynecol* 1976; 48[suppl]:67S–69S
18. Cundiff G, Bent AE. Suprapubic catheterization complicated by bowel perforation. *Int Urogynecol J* 1995; 6:110–113
19. Wu CC, Su CT, Lin AC. Terminal ileum perforation from a misplaced percutaneous suprapubic cystostomy. *Eur J Emerg Med* 2007; 14:92–93
20. Mongiu AK, Helfand BT, Kielb SJ. Small bowel perforation during suprapubic tube exchange. *Can J Urol* 2009; 16:4519–4521
21. Witham MD, Martindale AD. Occult transfixation of the sigmoid colon by suprapubic catheter. *Age Ageing* 2002; 31:407–408
22. Liau SS, Shabeer UA. Laparoscopic management of cecal injury from a misplaced percutaneous suprapubic cystostomy. *Surg Laparosc Endosc Percutan Tech* 2005; 15:378–379