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Percutaneous Imaging-Guided Access for the Treatment of Calculi in Continent Urinary Reservoirs

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Abstract

Purpose: To describe our long-term experience with percutaneous access to continent urinary reservoirs for calculus removal.
Patients and Methods: A retrospective study of 13 procedures in 10 patients was performed. In 2 of the 13 procedures, access and calculus removal was performed in a single session. In the other 11 procedures, initial access was obtained using ultrasonography, fluoroscopy, and/or computed tomography. The patients then returned at a later date for a second step where the access was dilated and the calculi were removed.
Results: Access was achieved successfully in all cases with no complications. At mean follow-up time of 13.6 months (range 1–94 months) one patient had died of complications unrelated to her continent urinary reservoir. Another patient had been placed on suppressive antibiotics for recurrent calculi. The remaining patients were stone free and without late complication.
Conclusions: Percutaneous removal of reservoir calculi can be performed safely, avoiding potential injury to the continence valve mechanism by a direct cystoscopic approach. We propose a two-stage procedure using CT guidance for initial access as the preferred technique.

Key words: Calculi—Bladder, surgery—Bladder, interventional procedure

Patients with continent urinary reservoirs created due to bladder carcinoma, neurogenic bladder, or myelomeningocele can develop calculi within the reservoir [1, 2]. The potential complications from urinary reservoir calculi include obstruction of the ureters, obstruction of the continence mechanism of the reservoir, and predisposition to infection. In the past, removal of bladder calculi was accomplished with either an open surgical technique [3] or performed endoscopically via the continence mechanism [4, 5]. These methods have some disadvantages; chief among them are the potential for damage to the continence mechanism [6–9] and the creation of adhesions [7]. The potential for complications from trans-stomal therapy is related to the type of continence mechanism employed [9]. Percutaneous access into the continent urinary reservoir using imaging guidance followed by endoscopic stone removal has the potential to avoid many of these complications and has been previously reported in small series and a single case report [7, 10]. We have previously reported a single patient in whom percutaneous removal of reservoir calculi was performed [2]. We now present our long-term experience with use of imaging guidance for percutaneous access to continent urinary reservoirs for calculus removal.

Patients and Methods

Thirteen percutaneous procedures were performed in 10 patients (4 male, 6 female) between 1990 and 2000. The patients had a variety of continent urinary reservoirs, as summarized in Table 1. One patient (patient 1) was reported previously [2]. Patient ages at the time of their procedure ranged from 15 to 66 years (mean = 31.2 years). Patients were only included in the series if the access was obtained with a percutaneous approach and were excluded from this series if access to the reservoir was gained through the ureters via a conventional nephrostomy tract. The indication for the procedure was removal of reservoir calculi in all procedures. For the access procedure, conscious sedation (n = 7), general anesthesia (n = 3),

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Table 1. Type of reservoir and the imaging guidance used

	Indication for CUR	Type of CUR	Imaging		
			Ultrasonography	Fluoroscopy	CT guidance
One stage procedure					
Patient 2	Pelvic exteneration due to cervical cancer	Kock	–	×	–
Patient 5 (first procedure)	Neurogenic bladder (Insensate below chest)	Bladder augmentation w/ ileocolonic cystoplasty	×	×	–
Total for one stage procedure			1	2	0
Two-stage procedures					
Patient 1 (first procedure)					
First step	Bladder exstrophy	Indiana pouch	–	×	×
Second step			–	×	–
Patient 3					
First step	Cystoprostatectomy due to bladder cancer	Indiana pouch	–	–	×
Second step			–	×	–
Patient 4					
First step	Myelomeningocele, neurogenic bladder (insensate below T12)	Indiana pouch	×	×	–
Second step			–	×	–
Patient 6					
First step	Myelodysplasia	Indiana pouch	–	×	×
Second step			–	×	–
Patient 7					
First step	Neurogenic bladder	Indiana pouch	–	×	×
Second step			–	×	–
Patient 1 (second procedure)					
First step	Bladder exstrophy	Indiana pouch	–	×	–
Second step			–	×	–
Patient 5 (second procedure)					
First step	Neurogenic bladder (insensate below chest)	Bladder augmentation w/ ileocolonic cystoplasty	–	–	×
Second step			–	×	–
Patient 5 (third procedure)					
First step	Neurogenic bladder (insensate below chest)	Bladder augmentation w/ ileocolonic cystoplasty	–	–	×
Second step			–	×	–
Patient 8					
First step	Bladder exstrophy	Colon reservoir	–	–	×
Second step			–	×	–
Patient 9					
First step	Bladder exstrophy	CUR using sigmoid colon	–	–	×
Second step			–	×	–
Patient 10					
First step	Neurogenic Bladder	Ileocolonic bladder	–	–	×
Second step			–	×	–
Total for two-stage procedure			1	16	9
Total for series			2	18	9

CUR: Continent urinary reservoir

or local anesthesia ($n = 3$) was used based primarily on patient age. Conscious sedation consisted of midazolam (usually 1–2 mg iv) and fentanyl citrate (usually 50–100 mcg iv). Intravenous antibiotics were used in all 13 procedures. Ampicillin and ceftriaxone were our preferred regimen ($n = 8$). Levofloxacin ($n = 2$) and cefazolin ($n = 3$) were used in the remaining procedures. In our series, we used two approaches for percutaneous access and calculus removal. In one approach, we performed percutaneous access and calculus removal in one stage. In the second approach, calculus removal was deferred after obtaining percutaneous access as a two-stage procedure.

We used the first approach in 2 of the 13 procedures. The patients were taken to the operating suite and, using either intraoperative ultrasound (US) or fluoroscopy as guidance, access into the continent urinary reservoir was obtained with an 18G trocar needle (Cook, Inc., Bloomington, IN). Next, the tract was dilated to 30F using a balloon/sheath system (Tractmaster, Meditech, Matick, MA) over a stiff wire (Superstiff, Meditech). Immediate stone removal followed the placement of a 30F sheath.

In the other 11 procedures, the treatment was a two-stage procedure. The first stage was to obtain initial access into the reservoir and to allow the percutaneous tract to mature. CT ($n = 9$), US ($n = 1$), or fluoroscopy alone ($n = 1$) were used for guidance. Fluoroscopy alone was used in a patient who had had a prior identical procedure and the scar from that procedure was used as the puncture site. From 2–6 weeks later, the percutaneous access was dilated further for removal of the reservoir calculi, and only fluoroscopy was used during the second stage (Table 1).

A two-stage procedure with CT guidance was the preferred technique in our series. Primary access of the reservoir was performed entirely in the CT suite in six cases (Fig. 1). To assist in defining the anatomy better, contrast was added to the reservoir during one CT scan. The margins of the reservoir were then clearly visualized in comparison with the non-opacified bowel loops adja-

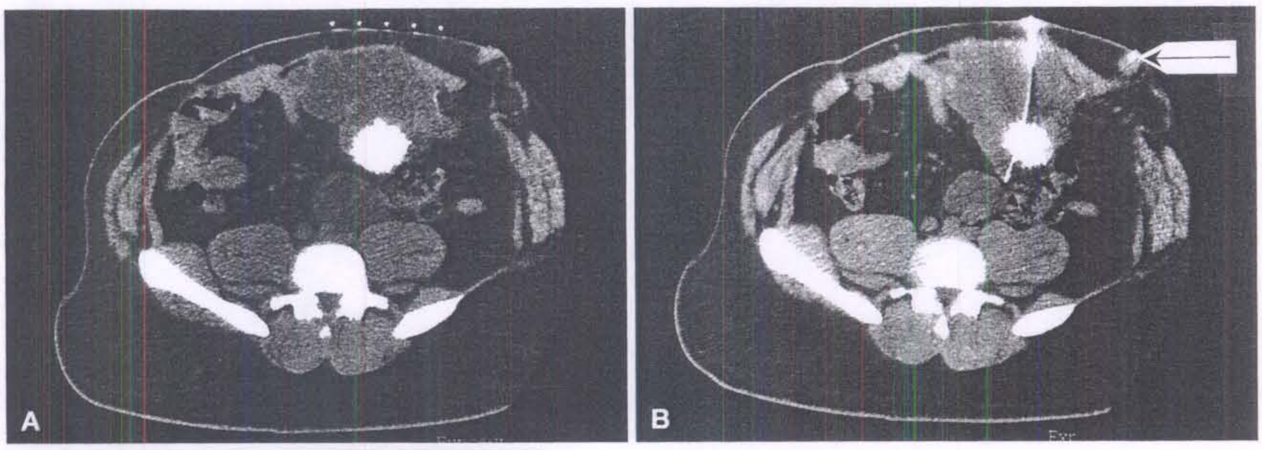

Fig. 1. Stage one of two-stage procedure: access to continent reservoir. (**A**) CT image demonstrating localization for initial puncture. Note the large calculus in the posterior aspect of the reservoir. (**B**) CT image following catheter placement. Dilator and guide wire are seen. Continence mechanism is indicated by arrow. (**C**) Abdominal radiograph after catheter placement.

cent to the reservoir. The site was marked and the patient was taken to the fluoroscopy suite to gain access. Air alone or in addition to contrast (Hypaque, Sanofi Winthrop, Morrisville, PA) was added to the reservoir just prior to puncture. The reservoir then appeared as a gas-containing structure adjacent to the abdominal wall.

Procedures

In the two-stage procedure, an 8F locking pigtail drainage catheter (Cook or Medi-Tech, Natick, MA) was placed in the reservoir. In the second stage, tract dilation and stone removal were identical to the second part of the one-stage procedure. At the end of each procedure, a 20–24F Malecot drainage catheter (C.R. Bard Inc, Murray Hill, NJ) was left in place for approximately 2 weeks and then removed.

Results

Thirteen calculus-removal procedures were performed. Access was obtained in all cases. No complications were encountered. One patient developed moderate abdominal pain after the initial access. The pain was effectively treated with a single dose of morphine. At mean follow-up time of 13.6 months (range 1–94 months), one patient had died of complications unrelated to her urinary reservoir. Another patient was placed on suppressive antibiotics because of three recurrences of calculi. One patient was lost to follow-up due to relocation. All other patients were stone free and without late complications.

Discussion

Continent urinary diversion can be accomplished using a variety of continent urinary reservoirs. All continent urinary diversions require a reservoir, a catheterizable stoma that does not leak, and an antireflux mechanism for the ureters [11]. The Kock pouch and Indiana pouch are two of a wide variety of continent urinary reservoirs. The Kock pouch is an ileal reservoir that achieves a large capacity with low pressure. The Indiana pouch is an ileocecal reservoir that can use the ileocecal valve or the appendix as the catheterizable stoma (the Mitrofanoff technique).

Urinary reservoir calculi are a recognized long-term complication of continent urinary reservoirs such as the Kock and Indiana pouches [1, 2]. Removal of these calculi is imperative because of the damage they may do to the continence mechanism or from obstruction of the ureters. Reservoir calculi may also predispose to infection.

The goal of treatment of the reservoir calculi is to remove the calculi without damage to the continence mechanism, ureters, or surrounding structures. Percutaneous access can accomplish these goals using the appropriate imaging techniques. Elder [7] presented his initial experiences with percutaneous access for calculus removal in four patients. We present 13 procedures on 10 patients performed without complication and our view of the optimal mode of imaging for access.

Computed tomography offers several advantages over the other imaging modalities that make it useful for this type of procedure. CT includes information regarding vascular structures, surrounding bowel, the ureters, and the continence mechanism, as well as the variable location of the reservoir itself. Typically, the reservoirs are located adjacent to the anterior abdominal wall although not necessarily adherent to it. One can see the reservoir in cross-section in relation to the adjacent structures before the initial access is attempted. The continence mechanism and ureters can be definitively located so that they are not damaged in the initial access (Fig. 1B). These images can be obtained without IV contrast administration, therefore contrast nephropathy is not a concern. CT imaging is not operator-dependent, providing information that is more reproducible than ultrasonography. In the uncommon situation in which the reservoir is located further away from the anterior abdominal wall, CT can delineate which access route, if any, is available. If no safe access can be obtained, the patient would be converted to open surgery or endoscopic surgery.

Ultrasonography and fluoroscopy offer a safer approach than blind access; however, each has its limitations. Fluoroscopy can delineate the outline of the continent urinary reservoir only after the instillation of contrast either through the continence mechanism or after IV contrast. Fluoroscopy is limited by its inability to show the surrounding bowel in relation to the reservoir, a concern in light of the surgically altered abdomen in these patients. Unrecognized puncture of the bowel with subsequent dilatation could lead to serious complications including peritonitis, hemorrhage, or death.

Ultrasonography can also show the reservoir in relation to the abdominal wall, but the overlying bowel may obscure the reservoir and potential approach paths. Because of these limitations, we now believe that ultrasonography has little role in guiding access to continent reservoirs, and that the role of fluoroscopy should be limited to guiding tract dilation after initial CT-guided access.

Our access method and imaging preference evolved over the course of the series. In the early cases, access was obtained using either one or two steps. The two-step method was adopted out of concern for peritonitis but also for logistical reasons allowing access to be performed on outpatients and no need to coordinate the radiological and the surgical part of the procedure.

The actual incidence of complications from percutaneous access into continent urinary reservoirs is unknown because of the small number of cases performed. In our series, we did not experience serious complications such as bleeding, infection, inadvertent puncture of bowel, or the catheter dislodgement.

In conclusion, this series showed that percutaneous removal of reservoir calculi can be performed safely and effectively. The percutaneous access avoids potentially damaging instrumentation of the continence mechanism. CT guidance is optimal for percutaneous access by best demonstrating the continent urinary reservoir in relation to the abdominal wall and other structures.

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