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A Practical Approach to Difficult Urinary Catheterizations

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Abstract Routine placement of transurethral catheters can be challenging in some situations, such as urethral strictures, severe phimosis and false passages. Intravaginal retraction of the urethral meatus can complicate Foley placement in postmenopausal females. In men, blind urethral procedures with mechanical or metal sounds without visual guidance or guidewire assistance are now discouraged due to the increased risk of urethral trauma and false passages. Newer techniques of urethral catheterization including guidewires, directed hydrophilic mechanical dilators, urethral balloon dilation, and direct vision endoscopic catheter systems are discussed, along with the new standardized protocol for difficult transurethral catheter insertions. Suprapubic catheter placement techniques, including percutaneous trocars and the use of the curved Lowsley tractor for initial suprapubic catheter insertion, are reviewed. Prevention and management of common catheter-related problems such as encrustation, leakage, Foley malposition, balloon cuffing and frequent blockages are discussed.

Keywords Foley · Urethral stricture · Catheterization · Suprapubic · Cystostomy · Phimosis · False passage · Cystoscopy · Lowsley

Introduction

One of the most commonly performed procedures in hospitals, ERs, nursing homes and clinics is urinary catheterization. While this is usually a simple and routine procedure, it can rapidly turn into a major problem which is often complicated by the lack of a standardized protocol for difficult catheterizations. Several serious potential complications of difficult urinary catheterizations can significantly affect patient morbidity including rectal perforation, penile erosions, urethral rupture, ischemic penile necrosis, life-threatening bleeding, urinary tract infections, urosepsis and Fournier's gangrene [1•, 2–4]. New techniques involving guide wires, inflatable balloon dilators, improved hydrophilic mechanical dilators and flexible direct vision technologies are changing the way we deal with this problem. A practical review of the strategies and techniques for difficult urinary indwelling urethral and suprapubic catheterization is presented, as well as a trouble-shooting guide to catheter care.

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General Preparations

First, make sure the catheter is absolutely necessary. After all, if you eliminate the need for the catheter, you've solved the problem! Studies have indicated that from 20–50 % of all indwelling catheterizations in hospitals were unnecessary and inappropriate [5–10]. For example, there is no reason to catheterize a continent, cooperative, non-critically ill patient just for urinary output monitoring [10]. Review the patient's history for any previous urological problems and procedures such as prostatectomies. Were there any problems with prior catheterizations?

Next, gather all the supplies you will likely require. Call for the "Urology Cart" which typically has all the necessary urological supplies and can be easily transported to the bedside. Administer appropriate pain medication in advance to minimize patient discomfort during the forthcoming procedures and have a flexible cystoscope available in case simpler techniques fail.

Elevate the bed to a comfortable level and ask the patient to move closer to your side of the bed so you don't have to lean over. Wear a gown for protection and make sure you

have sufficient light. Ask for a portable surgical spotlight or at least a flashlight if no other lighting is available. Place the patient in optimal position and have at least one nurse available to assist you.

Transurethral Catheters

Protocol for Female Patients

Difficult urethral catheterizations in females are most often due to patient characteristics such as morbid obesity, atrophic vaginitis, intravaginal retraction of the urethral meatus, previous pelvic operative procedures, anatomical variations of the pelvic organs, pelvic or perineal trauma, prolapse, edema, radiation and urethral strictures [11, 12••]. (The standard protocol for normal female urethral catheterization is summarized in Table 1 [13].)

Morbidly obese female patients may require multiple assistants to optimize visualization and access to the introitus and urethral meatus. Putting the patient in the Trendelenburg position will allow easier retraction of the panniculus and better exposure. If Trendelenburg is not possible, use pads, towels, blankets, or even a bed pan underneath the patient to elevate the pelvis.

If the urethral meatus is still difficult to visualize, better exposure may help. This can be achieved by use of a vaginal speculum and optimized lighting such as from a portable surgical spotlight. Place a finger into the vagina about 2 or 3 centimeters below the clitoris and then push slightly in and upwards. This will often help expose the urethral meatus and places the tissue on some tension which helps stabilize it. Just wiping the area with a betadine swab will often provoke a twitch or "wink" of the meatus which can help localize the lumen as will asking the patient to cough or Valsalva.

If the catheter inadvertently enters the vagina instead of the urethra, leave it there to serve as a guide; then use a new sterile Foley to catheterize the patient.

A lubricated cotton swab or a short female 12 French catheter can be used to gently probe the area of the expected urethral meatus. It may be hidden under tissue folds or in a small vaginal dimple. Every possible hiding place, fold and dimple along the anterior vaginal wall may need to be gently probed to find the true urethral meatus.

If all possible visible sites have been eliminated, then the urethral meatus may have retracted intravaginally, especially in older postmenopausal women. In these cases, the opening can often be found by touch with a single finger gently introduced into the vagina and directed along the anterior vaginal surface. The urethral meatus will feel much like a buttonhole on a typical lab coat. Once the meatus has been located, a finger can be used to help direct a coudé catheter into the urethra and bladder. A catheter guide can help stiffen the end of the catheter and facilitate introduction.

If the urethral meatus still cannot be identified, a coudé catheter can be gently advanced with the tip facing upwards, into the vagina along the anterior midline in the 12 o'clock position where it will often naturally tend to enter the urethral meatus.

Protocol for Male Patients

Problems that can interfere with male catheterization include urethral strictures, prostate cancer, penile edema, phimosis, buried penis, prostatectomy, false passages from previous catheterization attempts and hematuria. This is often compounded by the lack of a standard protocol for difficult catheterizations, suboptimal technique, insufficient knowledge of urological anatomy and inadequate skill level of those performing the procedure. If resistance is met when advancing a catheter, inexperienced personnel are often tempted to apply additional pressure which may cause urethral trauma, bleeding, false passages and future stricture formation [14•, 15].

Transurethral catheterization is absolutely contraindicated if a urethral injury is suspected such as after major pelvic trauma. Signs such as meatal blood, a high-riding prostate and urinary retention commonly suggest a urethral injury, although their absence should not completely exclude the diagnosis [14•, 16]. Retrograde urethrography is the preferred diagnostic technique in these situations and is necessary to investigate possible urethral injuries following

Table 1 Standard urethral catheterization technique of female patients (modified from SUNA Clinical Practice Guidelines [13])

- Initial hand washing and personal protective equipment, including wearing of cap and mask, are recommended.
- Place patient in the supine lithotomy position with legs apart and knees flexed.
- Identify the external urethral meatus, which will be below the clitoris and above the vaginal orifice. Use an expanding circular motion to clean the vulvar outlet and labia with betadine or chlorhexidine and place appropriate sterile fenestrated drapes.
- Wearing sterile gloves, use the left hand, exposing the urethral meatus by separating the labia with the thumb and index fingers.
- Identify the external urethral meatus and lubricate the distal end of the catheter with the sterile jelly. Carefully insert lubricated catheter (double-lumen, straight-tipped), gently advancing into the bladder. If a catheter inadvertently ends up in the vagina, leave it there to act as a landmark and get a new, sterile catheter for the bladder.
- Once the catheter is well-placed inside the bladder and the urine is seen coming out, continue to advance the catheter to ensure complete insertion of the balloon into the bladder; then inflate with 10 mL of sterile water.

major pelvic trauma prior to any transurethral catheterization attempts or instrumentation [16–18].

Standard Catheterization Technique

Standard practice is to advance the catheter completely to the Y-hub bifurcation, as significant complications develop when the catheter balloon is inflated or pulled into the prostate or urethra. (The standard protocol for normal male urethral catheterization is summarized in Table 2 [19].) If the catheter is trying to expel itself after initial placement to the Y-hub, it is probably not properly positioned. **Just because the Foley is draining urine does not necessarily mean the catheter balloon is completely within the bladder**. Any pain on balloon inflation indicates possible catheter malposition. Inflation should be immediately halted, the balloon deflated and the catheter repositioned. The final location of the Foley can be easily verified by bedside ultrasound which is recommended if there is any doubt about the catheter's final position. Injecting a few milliliters of diluted radiological contrast into the Foley balloon and through the catheter's main drainage lumen will also clearly demonstrate any malposition, but requires X-ray assistance [20]. CT scans can also be used, but we usually prefer ultrasound for catheter location imaging due to its low cost, convenience, availability and lack of ionizing radiation.

Complications from inadvertent Foley balloon inflations in the urethra as well as traumatic or multiple unsuccessful catheterization attempts, significantly increase patient morbidity. They also increase healthcare costs by lengthening hospital stays and requiring additional urological treatment [12••, 14•, 21, 22].

When expecting difficulty during catheterizations, it is helpful to prep not only the penis, but the adjacent areas of the scrotum, upper thighs and suprapubic region with antiseptic as preparation if more invasive procedures are needed [12••].

Table 2 Standard catheterization technique for male patients (modified from SUNA Clinical Practice Guidelines [19])

- Assemble all of the necessary equipment before beginning the procedure.
- Initial hand washing and personal protective equipment, including wearing of cap and mask, are recommended. Washing the penis and male genitalia is recommended.
- Prepare and drape the penis and surrounding area under sterile technique.
- Cleanse the urethral meatus with the antiseptic solution of choice (e.g., povidone–iodine, chlorhexidine).
- Maintain aseptic technique during the cleansing of the meatus.
- Before grabbing the penis, have all required supplies opened and immediately available for access by the remaining sterile hand.
- If available, retrograde injection of 10–20 mL of a water-soluble lubricant or water-soluble 2 % lidocaine hydrochloride jelly can be helpful.
- The catheter should be well-lubricated before advancement occurs.
- Gently hold the penis upwards and place the catheter in the urethral meatus by grasping the catheter an inch or two from the tip.
- As you advance the catheter, begin to gently stretch the penis downwards toward the feet to minimize the angulation between the bulbous urethra and the prostate.
- As you reach the membranous urethra, you may encounter some mild resistance to further advancement of the catheter. Ask the patient to take a deep breath to help relax the sphincter or ask him to try and void. This will often allow easier catheter passage.
- If resistance is met, do not attempt forceful catheter insertion; instead, apply slow, gentle pressure and slightly twist the catheter from right to left and back for 30–60 seconds to allow for relaxation of the external sphincter muscle.
- Once the catheter is well-placed inside the bladder and urine is seen coming out, continue to advance the catheter all the way to the Y-Hub bifurcation to ensure complete insertion of the balloon well into the bladder. Then inflate the balloon with 10 mL of sterile water. Do not use normal saline to inflate the balloon.
- Replace the foreskin over the head of the penis to avoid paraphimosis in uncircumcised males.

Use of Urethral Lubrication

Several studies have compared the instillation of 2 % lidocaine jelly to plain lubricant. In a meta-analysis, the efficacy of 2 % lidocaine was questioned and demonstrated no difference in pain scores for males undergoing urinary catheterization [12••, 23]. However, Chan and associates, in a recent double-blinded randomized trial, reported that 2 % lignocaine gel significantly reduced the procedural pain of urethral catheterization in females [24]. Several other investigators have also found a benefit to urethral lidocaine gel instillation prior to instrumentation [25–28]. If using lidocaine gel, better results were obtained using an instilled gel volume of at least 20 mL with a urethral exposure time of at least 10 minutes [26]. A penile clamp is recommended to maintain optimal contact between the anesthetic gel and the urethral surface. We have found the Hyams clamp to be the most comfortable and effective for this purpose. If the anesthetic gel and penile clamp are utilized early in the procedure, such as during setup, there should be adequate time to achieve reasonable urethral analgesia.

We prefer using a mixture of 10 ml plain lubricating jelly with 10 ml of 2 % lidocaine gel placed in a Toomey syringe and injected together into the urethra. Adding lubricating jelly makes the mixture more lubricious and longer-lasting than lidocaine gel alone which tends to dry out relatively quickly. In some institutions, lidocaine gel is classified as a drug and must therefore be obtained laboriously through the pharmacy making it much more difficult and time-consuming to acquire. For these reasons, in emergency or urgent situations, our preference is to just use plain lubricating jelly.

Inability to Access the Urethral Meatus

Access to the meatus and distal urethra can be a problem in patients with significant penile edema, buried penis, severe phimosis or fossa navicularis strictures.

Penile edema can be minimized with an elastic compression dressing such as an Ace wrap or Coban dressing to continuously compress the penis reducing the swelling. A gauze pad or cling should be placed around the penis first, before applying the compression dressing. Substantial reductions in penile edema are usually evident after only about 20 minutes of compression. Additional options which will also work in buried penis include introducing an anoscope, rigid cystoscope or small vaginal speculum through the swollen foreskin sufficient to allow visualization of the urethral meatus which can then be catheterized [29–32].

A buried penis can be expressed or exposed in many cases by pressing down firmly around the base of the penis. This should be done by an assistant, leaving the urologist free to actually place the catheter. In morbidly obese patients, another technique is to insert a flexible cystoscope into the passage leading to the penis to visualize the glans and urethral meatus [33]. Once this is seen, a guide wire can be passed into the urethra through the cystoscope or a catheter can be placed over a straightened catheter guide and passed alongside the cystoscope. This can then be directed under vision into the meatus and then advanced into the bladder.

Phimosis can make it difficult or impossible to visualize the meatus. One technique is to pull the foreskin directly outward which will telescope the skin and usually help open the passage enough to allow visualization. If this is not successful, it may be necessary to pass the catheter exclusively by touch. A coudé catheter should be used with or without a catheter guide. If only a small catheter will pass through the narrowed foreskin, try a 12 French silicone catheter. A guidewire can be passed through the catheter lumen to provide additional rigidity if necessary [34]. The meatus can typically be found in the middle of the glans, slightly inferior to the horizontal midline. If unsuccessful, a dorsal slit procedure may be required.

Meatal stenosis and fossa navicularis strictures are often best managed with solid metal dilating sounds.

Initial Approach and Catheter Selection

Review the patient's history and physical exam, paying special attention to previous urinary status and any prior urological procedures, diseases and treatments. Clinical observations from those involved in attempted catheterizations will assist in identifying the location and severity of the problem [12••, 14•, 35]. Detailed knowledge of failed procedures will help avoid duplicating previously unsuccessful maneuvers.

The main types of indwelling urinary catheters used in common practice include the latex or silicone Foley (self-retaining balloon), irrigating or three-way (used for severe or active bleeding) and coudé or curved tip catheters. Coudé catheters allow for improved directional control so false passages are more easily bypassed, enabling the tip to find the true urethral lumen. In most cases, the tip should be directed anteriorly or upwards, as this is the most likely orientation of the true lumen. Catheter size is measured using the French scale (circumference in mm), in which 1 French equals approximately 1/3 mm in diameter [35]. In general, do not use catheters with intrinsic temperature probes in difficult or complicated catheterizations as the lumen size of the drainage port is compromised.

The initial use of a plain 16 or 18 French Foley catheter is reasonable for most men [14•, 35, 36]. During catheter advancement, the penis should be gently pulled downwards towards the feet to help straighten the natural curve of the bulbous and prostatic urethra. The patient should be asked to take long, slow deep breaths to help relax the membranous urethra as the catheter approaches this area.

For difficult urinary catheterizations, the next step should be a 16 or 18 French coudé Foley. This one step alone was successful in 41–54 % of patients where urology was consulted for a difficult catheterization [12••]. If unsuccessful, this should be followed by a 12 French silicone Foley catheter [12••, 14•]. The 12 French silicone Foley catheters are recommended due to their small outside diameter, coiling resistance, rigidity and their relatively large internal lumens.

A useful trick to facilitate passage of the 12 French silicone Foley is to fold the tip of the catheter 180 degrees backwards about 2 cm from the tip or about midway in the balloon area. After lubrication, the folded catheter tip can be advanced into the urethra while the fold is maintained with a finger. When the catheter reaches the bladder, the tip flips back into its usual position. This technique makes the new forward tip of the advancing catheter more rounded and firm. Also, if a large space is encountered such as in a previously resected prostatic fossa, the tip will naturally point upwards towards the usual position of the bladder neck lumen [37].

The Liss maneuver can be used to stiffen the shaft of a Foley catheter to facilitate placement and advancement. It is particularly effective and useful in smaller catheters (12 and 14 French) that often lack rigidity and are too small for catheter guides [34]. The floppy end of a guide wire is introduced into the moistened catheter lumen until it reaches the tip. The guide wire is then clamped securely at the distal end of the catheter. This allows the wire to add substantial stiffness to the catheter shaft while leaving the tip unaffected. Tests have shows that this increases the average resistance to

bending (stiffness) of the catheter shaft up to about 360 %, which improves the ability of the Foley to navigate tortuous urethras before resorting to more aggressive techniques [34]. If unsuccessful, the same guide wire can still be used independently as outlined below.

Use of Guidewires and Flexible Cystoscopy

There is little harm in initially attempting to place a standard guide wire blindly [38]. Avoiding initial cystoscopy decreases the overall cost and allows the cystoscope to be available elsewhere. A 0.035-inch, 150-cm-long standard-stiffness wet hydrophilic guide wire should be advanced gently into the urethra until it reaches the bladder. If advancement is blocked, the guide wire usually returns back through the urethral meatus. We have found that a guide wire can be successfully placed in 80% of cases in which catheters could not be advanced [12]. Fluoroscopy or a plain X-ray can be used to verify correct guide wire placement. Be sure to firmly secure the distal end of the guide wire before advancing any catheters or dilators into the urethra. This can be done with a hemostat, Kelly clamp or torque vise and will prevent complete internal migration of the wire into the urethra.

To avoid urethral injury, only standard (not stiff) guide wires should be used for advancement into the urethra [14•]. If a stiffer wire is needed to facilitate catheter advancement, the standard wire can be replaced once it has entered the bladder. An open ended ureteral catheter is passed into the bladder over the existing guide wire. The standard guide wire can then be removed and safely replaced with the stiffer wire through the ureteral catheter which is then removed.

We prefer starting with a straight guide wire initially and find a torque vice to be helpful in placement, especially when hydrophilic guide wires are used. If not successful passing the guide wire initially, place the Foley catheter as far into the urethra as it will go, then try to pass the guide wire around the catheter. The Foley will stretch the urethra near the blockage which may help the guide wire to enter the correct passage and pass into the bladder.

If this fails, our preference is to go to direct vision with flexible cystoscopy and facilitated guide wire placement although some prefer an additional blind attempt with an angled- tip guide wire.

Flexible cystoscopy is recommended when blind guide wire placement has been unsuccessful. It is often performed using topical 2 % lidocaine gel lubrication, although no difference in pain scores has been consistently demonstrated compared to plain lubricating jelly [23]. Flexible cystoscopy for difficult urethral catheterizations was first described by Krikler in 1989 and was modified by Beaghler and associates in 1994 to include directed guidewire passage through obstructions [39, 40]. With cystoscopy, the correct urethral lumen is usually found easily and the cystoscope can sometimes be advanced directly into the bladder making guide wire placement simple. Even if the cystoscope cannot enter the bladder, direct visualization still helps to identify the exact location and nature of the obstruction, avoid false passages and allows for optimal guide wire placement under direct visual guidance.

The most common locations for urethral injury are in the bulbous and posterior urethra [21]. New false passages will often be lateral or posterior and tend to have sharp, bleeding edges. True urethral lumens generally have blunted edges and are usually located more anteriorly. Any small urethral dimple or crease could be the true passage into the bladder and all such potential lumens should be gently probed with the guide wire before abandoning the procedure. Applying external suprapubic pressure will often express some bladder fluid from the true lumen which assists with cystoscopic visual identification. If the urethral passage is obscured by excessive bleeding, squeezing the normal saline irrigating fluid bag can help maintain visualization; however, this technique should be used judiciously to avoid extravasation. Once the guide wire has been placed within the bladder, the cystoscope can be removed. If all attempts to place a guide wire fail, there may be no choice but to consider suprapubic catheter placement.

With the guide wire in place, several options are available, depending on the circumstances. We normally start by lubricating the lumen of a 16 French council tip Foley, which can then be advanced over the guide wire. If unsuccessful, a 12 French silicone catheter can be modified with an 18 gauge angiocath using the Blitz technique (Fig. 1), by incising the tip of the catheter with a scalpel or by using a Foley catheter hole punch (Cook Urological, Spencer Indiana) [12••, 41]. These modifications will allow a standard Foley catheter to be passed directly over a guide wire without the need for a specialized Council tip catheter which is not always readily available. If no catheter can be easily advanced over the guide wire, urethral dilation will be required.

Urethral Dilation

Urethral dilatation has traditionally been done blindly with metal Van Buren sounds or Filiforms and Followers, but this leads to greater patient discomfort, additional bleeding, creation of more false passages and increased urethral trauma. The current trend is to initially place a guide wire followed by balloon dilation or coaxial mechanical dilators inserted sequentially over the guide wire [42]. Dilation is generally done to one French size larger than the size of the intended indwelling catheter.

Mechanical dilation is typically done blindly while balloon dilation can be done with or without X-ray guidance. The use of a urethral balloon dilator, as first described by Russinovich [43] in 1980 and more recently by others

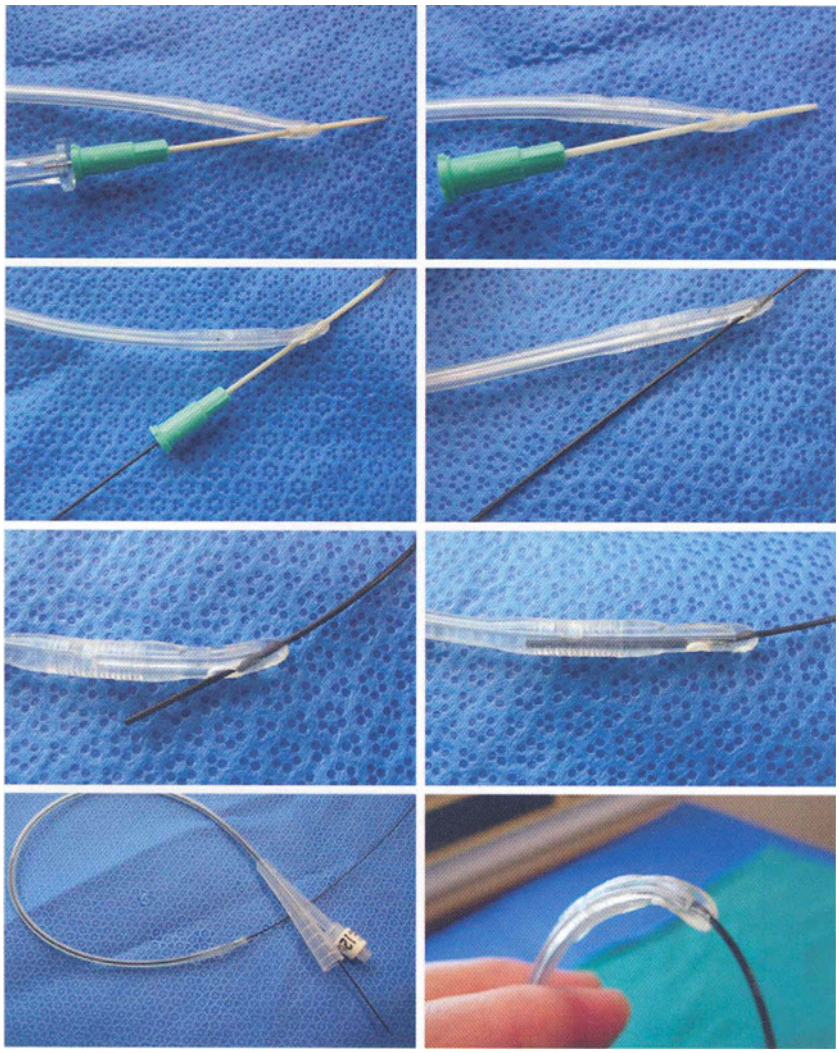

Fig. 1 The Blitz technique. An 18-gauge angiocath is placed through the eyelet of the Foley catheter and then pushed out through the catheter tip, puncturing it. When the metal needle/stylet is removed, the distal end of a 0.035-inch guide wire will easily pass through the lumen of the 18-gauge angiocath sheath. When the angiocath sheath is removed, the guide wire can then be redirected into the Foley catheter lumen to complete the procedure [12]. (*Photo illustration used with the kind permission of the American Urological Association*)

[44–46], enables a safe and controlled dilation of urethral strictures and bladder neck contractures with minimal urethral trauma or patient discomfort due to the controlled rate of radial expansion with minimal longitudinal pressure on the urethra.

Mechanical Dilation: Mechanical dilators, such as Heyman dilators, can be used and will fit over guide wires, but they tend to have relatively blunt tips especially in the smaller sizes. Use of solid metallic dilators such as Van Buren Sounds for blind urethral dilation without guide wire guidance and assistance is discouraged, although they may be appropriate for very distal strictures and meatal stenosis. We prefer ureteral dilators, starting with the 12 French Hydrophilic Nottingham ureteral dilator (Cook Urological, Spencer Indiana) and progressing sequentially to the 14, 16, and 18 French hydrophilic ureteral dilators (Boston Scientific) [38, 40, 47, 48]. These hydrophilic dilators are extremely slippery when wet, have gradually tapering tips for effective yet gentle dilation, fit easily over guide wires, are stiff enough to provide good tactile sensation with effective axial dilating force and offer relatively atraumatic mechanical urethral dilation compared to metal sounds.

Balloon Dilator—Blind Placement: A modified Foley catheter (Council tip or similar) or a flexible cystoscope can be advanced over the guide wire to the distal end of the stricture. Taking care to leave the guide wire in place, the catheter or scope can be grasped and held at the point where it exits the urethral meatus and removed. This allows the distance from the meatus to the stricture to be measured. A similar distance can then be measured from the middle of the balloon on the dilating catheter to a corresponding distance on its shaft. When advanced over the guide wire into the urethra to that distance, the balloon will be precisely straddling the stricture. This method can work for all types of urethral strictures and obstructions, including bladder neck contractures.

Balloon Dilation—X-ray Placement: The exact location of the stricture can be determined by retrograde urethrogram or by visualizing the tip of the cystoscope with X-ray when it's

maximally inserted and in direct contact with the stricture. This site can then be precisely located by temporarily placing a "sign here" or similar sticky note directly on the X-ray monitor at the exact site of the stricture. This will identify the stricture's location on the monitor when it would otherwise no longer be visible. The marker is then used to visually facilitate accurate placement of the dilating balloon.

Balloon Dilation—Inflation Technique: A 5F, 80-cm balloon catheter (Cook Urologic Accent Urethral Dilation Balloon Catheter, Maximum 12 atm. or similar) is advanced over the guide wire until the balloon is placed completely across the stricture. Inflation with sterile water to 10 atm. pressure using a Leveen or similar insufflator with a pressure gauge, is recommended. After 5 to 10 minutes, the balloon can be deflated and removed leaving the guide wire in place. If X-ray is available, fluoroscopy can help visualize successful dilation of the stricture. With long-standing strictures and some severe bladder neck contractures, standard urethral balloon dilators may not be able to deliver sufficient axial opening pressure. In these cases, a nephrostomy balloon dilator, with a maximum rated pressure of up to 30 atmospheres, can be substituted. Again, only insufflators with pressure gauges should be used to avoid balloon rupture from overinflation.

Once dilation is completed, catheters can usually be advanced into the bladder over the existing guide wire which should not be removed until the Foley is properly secured in position with its balloon inflated. Dilation is not necessarily a curative treatment; the goal is to dilate the urethra to the extent necessary to allow the smallest catheter possible to adequately drain the urinary bladder.

Slow and gentle dilation can be achieved with even relatively small catheters. When left indwelling for a day or two, even a small caliber catheter will provide significant urethral dilation just from normal activity and motion. It can almost always be replaced with the next larger French size catheter after it has been in position for at least 24 hours. This process can then be repeated every 24–48 hours until an optimally sized catheter, usually 16 or 18 French, has been placed.

Catheter Placement Using Direct Vision Urethral Imaging Guidance (PercuVision)

Microendoscopic systems with fiberoptic lights and cameras that permit real-time video monitoring while advancing specially designed coudé catheters through the urethra, have recently been developed and are now available. These systems are design exclusively for difficult urethral catheterizations and are not intended for routine cases. One such system (DirectVision System; PercuVision, Westerville, Ohio) allows insertion of an LED lighted microendoscope into one lumen of a specially designed triple lumen silicone coudé Foley catheter, providing direct urethral visualization on a video monitor throughout catheter advancement. The use of the curved tip coudé catheter allows some limited maneuverability as the catheter is manipulated under direct vision. This is particularly useful in bypassing false passages as well as identifying the nature and location of the obstruction. The instrument is not considered a diagnostic tool but rather a visual aid as the angle of visualization is limited and fixed directly forward. Therefore, it can be appropriately used by trained nursing staff, residents or any health care worker who is authorized to insert Foley catheters. A review, detailed description and standard utilization protocol for this direct vision catheter placement system has been well described elsewhere [49•].

Suprapubic Catheters

Indications

Suprapubic catheters are an invasive type of indwelling urinary catheter as they require a small surgical procedure for initial placement. They can be placed percutaneously or via a transurethral approach with the curved Lowsley tractor [50]. Suprapubic tubes are often the preferred route of drainage over transurethral catheters in patients receiving various pelvic and orthopedic surgeries when the return of normal urethral voiding is unpredictable but is reasonably expected to be lengthy. Other indications for use are when transurethral catheters cannot be inserted, cause significant urethral irritation, bladder or pelvic discomfort, or otherwise uncontrollable leakage. Difficulty in changing urethral catheters due to extensive scarring, unusual body habitus, contractures or uncontrollable patient movements are other reasons to switch to suprapubic catheters. Another advantage is the ability to use much larger diameter catheters than can easily be placed transurethrally. Further, if a confused or demented patient should violently pull out his suprapubic catheter, no significant anatomical organs are damaged, bleeding is usually minimal, there is relatively little discomfort and the tube is easily replaced.

When compared with transurethral Foleys, advantages of suprapubic catheters include prevention of urethral trauma, penile erosions, stricture formation, prostatic bleeding and some reduction in the incidence of catheter-associated urinary tract infections, at least initially. They allow attempts at normal voiding without the need for recatheterization and there is far less interference with sexual activity. All of these benefits from suprapubic catheters greatly increase patient satisfaction and comfort when compared with chronic indwelling urethral Foleys. Still, suprapubic catheter use remains significantly underutilized possibly because many potential patients hesitate due to the need for a surgical procedure for placement, even a minor one, and the psychological issues associated with altered body image including the need to accept long-term permanent catheter drainage.

A regional or general anesthetic should be used in spinal cord injured patients at risk for autonomic dysreflexia (T6 level injury or above) and in those where the bladder cannot otherwise be filled to at least 300 mL [51•].

The primary risk in placement of a suprapubic catheter is inadvertent injury to the bowel which has been reported in up to 2.7 % of patients [52, 53]. This is far more likely in patients who have had previous lower abdominal surgery and in those with neurological disease [54, 55]. In such patients, a CT scan is very helpful in identifying the exact locations and orientation of the bowel and bladder as well as to verify there is sufficient space for suprapubic tube placement without undue risk of intestinal injury [52]. This risk can be further minimized using ultrasonography immediately before suprapubic catheter placement to determine if there are any intervening loops of bowel between the skin surface and bladder that might be inadvertently injured [52]. This is particularly important if the distended bladder cannot be identified by palpation or if the patient has a history of lower abdominal surgery [51•]. If appropriate imaging is not available in such high risk cases, consideration should be given to performing the suprapubic catheter placement using an open technique [51•].

Contraindications to suprapubic tube placement include bladder cancer, unavoidable bowel loops in the anticipated passageway, uncorrected coagulapathies, active anticoagulation therapy, abdominal wall abscess or cellulitis and the presence of a subcutaneous vascular implant in the suprapubic area such as femorofemoral crossover grafts [51•].

Trocar Placement

Begin by fully distending the bladder with normal saline to minimize possible bowel injury. This can be done with a catheter, cystoscope or via a percutaneous suprapubic needle. At least 300 mL should be in the bladder for this purpose which has been shown to be sufficient for the bladder dome to extend at least 5 cm above the pubic symphysis [56]. Ultrasonography or C-arm fluoroscopy with diluted contrast for bladder instillation can be used to help identify the anatomy, particularly when the distended bladder cannot be palpated due to obesity. Local anesthesia is generally used for the skin surface and proposed tract which may require a volume of up to 20 mL of anesthetic. Care should be taken to use an appropriately diluted concentration of anesthetic to avoid possible toxicity.

Place the patient in Trendelenburg position to help move any intervening bowel loops superiorly and away from the bladder. The selected suprapubic site should be no more than 2 cm above the pubic symphysis. In obese patients with a substantial lower abdominal fat pad causing a significant skin fold in the suprapubic area, the percutaneous catheter site should ideally be slightly above or below the skin fold to minimize local infection and dermatitis [51•]. If placed above the skin fold, the trocar should be manipulated during placement so that the catheter penetrates the rectus sheath no more than 2 cm above the pubic symphysis.

Use an 18 gauge spinal needle to enter the bladder. Such a needle size is necessary for easy 0.035-inch guide wire placement. The needle should be aimed vertically. When urine or irrigation fluid is easily drained through the needle, the guide wire is inserted through the needle and well into the bladder which can be confirmed with fluoroscopy. The needle can then be removed leaving the guide wire in place. The cystostomy tract is then dilated sequentially over the guide wire with progressively sized mechanical dilators or a balloon dilator can be used [57].

There have not yet been adequate clinical trials comparing the various percutaneous suprapubic trocar kits and techniques, so selection is totally up to the discretion of the surgeon. Our preferred kit is the Cook Suprapubic Placement set (Cook Urological, Spencer Indiana) as we find it has an excellent dilator and allows for placement of an adequately sized Foley balloon catheter.

Lowsley Placement

The Lowsley method of suprapubic tube placement can only be done if transurethral access to the bladder is possible. Cystoscopy is performed first and the bladder is filled with at least 300 mL of normal saline. With the bladder full, possible cystostomy sites can be checked by pressing downwards with a finger in the suprapubic area while visualizing the location of this extrinsic pressure by looking at the bladder dome cystoscopically. Once an optimal site has been selected, it can be identified externally with a marking pen. Van Buren sounds are then used, if necessary, to dilate the urethra sufficient to allow the 20 French Curved Lowsley to enterthe bladder. With the Lowsley in the bladder, the curved tip is elevated anteriorly by pressing down on the handle. The tip can then be palpated externally from the suprapubic area in the lower abdomen and maneuvered to the previously marked site. A small injection of lidocaine for local anesthesia can be used followed by a 1-cm incision directly over the palpated tip of the Lowsley. The incision is deepened until there is direct contact between the scalpel and the Lowsley. The Lowsley can then be pushed through the incision and opened which separates the two blades at the tip, keeping the Lowsley in place [58]. The tip of the selected Foley catheter is placed between the opened blades which are then closed to secure the catheter. The Lowsley is then partially removed from the urethra which pulls the instrument tip and the attached catheter into the bladder. The balloon is inflated and the catheter is released from the Lowsley which is then closed and removed.

A repeat cystoscopy is done to be absolutely certain that the catheter is in the proper position with the inflated balloon completely within the bladder. If not, the catheter's position can be adjusted or the entire procedure can be repeated. Mild traction on the Foley will tamponade any bleeding sites or a bugbee electrode can be used. Use of the Lowsley usually requires anesthesia, but it also allows immediate placement of even very large Foley catheters into the bladder. For routine suprapubic use, our preferred size Foley is usually a 20 French catheter with a 5–10 mL balloon but a minimum size of at least 16 French is recommended. After the suprapubic catheter has been inserted, it is connected to a sterile bag creating a closed drainage system. This minimizes the risk for catheter associated urinary tract infections.

The use of an ordinary Foley is generally preferable to the catheters in most commercially available suprapubic kits because indwelling Foley catheters are not easily dislodged from the bladder during sleep or activity. In addition, Foley catheters are less costly and readily available.

While it has been traditional to secure a newly placed suprapubic catheter with non-absorbable stay sutures and for the first suprapubic catheter change to be done by the original surgeon, neither practice is currently recommended or required. The original stay sutures often pull out by themselves, providing little security and causing localized skin damage. They are also quite uncomfortable for patients. Modern Foley catheters are quite reliable and the additional security of the stay sutures is unnecessary [51•].

The initial suprapubic catheter should be left in place for at least 2 weeks (preferably 4–6 weeks) to allow the cystostomy channel to form, mature and heal. As long as the first catheter change is deferred for at least 2 weeks, it can be performed without undue risk by any qualified healthcare professional familiar with routine suprapubic tube changes [51•, 59•]. Failure to successfully replace the suprapubic tube should be referred for immediate urological care as the tract is often salvageable if treated promptly.

If the initial suprapubic catheter is smaller than 16 French, it can usually be replaced with a progressively larger Foley catheter until the optimally sized tube has been introduced.

A new FDA approved device for suprapubic catheter placement, called the T-SPeC (Transurethral SupraPubic endo-Cystostomy, Swan Valley Medical, Bigfork Montana), is based on the same principle as the Lowsley method of catheter insertion. It uses an external frame to support and line up a curved, transurethral probe and an external suprapubic receptacle. Its primary benefit compared to the standard Lowsley technique is an improved ability to treat larger and more obese patients [60].

In a few rare cases where a suprapubic catheter is desired but cannot be safely introduced by either technique described above, they can sometimes be initially placed with CT guidance by interventional radiology. We have been successful doing this in a few select cases where no other technique was suitable and open surgical placement was judged too dangerous.

Persistent or worsening lower abdominal pain as well as discomfort radiating from the new cystostomy site suggests a possible intestinal injury and requires immediate investigation as mortality due to iatrogenic intestinal injuries from suprapubic tube placement is relatively high [51•].

Suprapubic Catheters: Standard Technique for Routine Replacement

Replacement of suprapubic catheters must be done with care to avoid patient injury. A properly sized Foley should be selected, usually identical to the existing catheter. Only 5-mL to 10-mL balloon catheters should be used, as there is no reason to use 30-mL balloon Foleys for suprapubic tubes. After preparation and cleansing, the old suprapubic catheter balloon should be deflated and the tube grasped tightly at the point where it exits the body and removed. It should be placed nearby so that the exact length of the tube from the skin site opening can be measured. This can also be estimated by examining the catheter; the internal portion will tend to be much lighter in color while the externalized section will be darker due to oxidation. The cystostomy site can now be cleaned and prepped. (We do not routinely inject lidocaine jelly into the cystostomy tract, but some patients report a benefit so we do this selectively.)

The new catheter should be inserted exactly as far as the previous one [61]. If inserted too far, it could pass through the bladder neck and enter the prostate or urethra. If not inserted far enough, the balloon may not be completely inside the bladder. If the patient indicates pain when the balloon is inflated, it should immediately be deflated and the catheter repositioned. Be particularly careful in patients who are unable to feel pain or communicate discomfort.

An alternate technique has been recommended in which the new suprapubic catheter is inserted as far as possible into the cystostomy tract until the Y-hub reaches the abdominal skin; the balloon is then carefully inflated [51•]. This technique reduces the chances of the catheter not being advanced sufficiently into the bladder, but it increases the risk of the Foley balloon passing into the urethra. Great care must be taken during balloon inflation to recognize any patient discomfort or resistance to balloon inflation which suggests malposition.

After placement, the catheter should be immediately irrigated. This not only removes mucus and debris; it also helps verify its position. If fluid is expressed from the penis during irrigation, the catheter could be in the urethra. If fluid is expressed around the suprapubic tube, the catheter may not be fully inserted into the bladder. In either case, the catheter should be repositioned and rechecked.

If there is excessive granulation tissue around the suprapubic site, it can be cauterized with silver nitrate sticks to prevent bleeding. Purulent discharge around the catheter is common and can be managed with simple hygiene measures unless there is evidence of systemic infection or cellulitis [51•].

If there is hair around the cystostomy site, patients should shave the area to improve hygiene and permit better visualization. Regular examination of the skin around the catheter site for breakdown, excessive granulation or early cellulitis is recommended. Antibiotics are indicated only for symptomatic urinary tract infections and treatment of cellulitis but not for asymptomatic bacteriuria.

If a suprapubic catheter is accidentally or traumatically removed, it must be reinserted immediately and should be considered an urgent problem. The passage will quickly heal over even in well-established and mature tracts making it impossible to reinsert the suprapubic catheter without another surgical procedure unless the catheter is quickly restored.

Catheter Maintenance (Transurethral and Suprapubic)

To minimize contamination, avoid unnecessary disconnection of the closed drainage system. Several different urinary drainage bags are available; selection depends on whether it is intended for short-term drainage at the hospital or for long-term use as well as the patient's mobility, cognitive function, daily life activities, etc. A leg bag holder that shifts the weight of the bag from the usual constrictive leg straps to a waist belt, (Drainage Support System modified with additional Velcro leg strap, Nu-Hope Laboratories, Pacoima CA or similar) is recommended for active patients using leg bags long term who are physically able to operate the leg bag valve mechanism.

An alternative to a drainage bag is a catheter valve or plug. Valves allow the bladder to be used as a reservoir which preserves bladder function and health by allowing regular bladder expansion and contraction. This helps maintain bladder capacity, blood supply and nerve tone as well as increase patient comfort since no bag is required [61–64]. It reduces catheter related cystitis and helps prevent small, fibrotic, non-functional bladders possibly caused by long term continuous drainage [61–64]. However, the use of such a valve or plug may increase urinary tract infections and some patients will develop bladder spasms with leakage around the catheter. Optimal patients for possible use of a catheter valve or plug are those with atonic bladders where bladder spasms are naturally minimized and all attempts at correcting the underlying problem have failed. Patients with significant detrusor overactivity, vesicoureteral reflux, renal failure or difficulty in managing the valve mechanism are not good candidates for this option [61, 62].

Catheters are changed roughly every four weeks unless complications such as infections, blockages or bladder spasms arise that necessitate more frequent replacement. Cleansing with soap and water around the catheter daily and during bathing is usually adequate for maintenance, but careful hygiene is of utmost importance when changing catheters.

When manipulating the catheter or drainage system, non-sterile gloves should be used and discarded to limit transfer of pathogens. The drainage bag should be emptied regularly, avoiding contact between the drainage spigot and the collecting container. Adding a small amount of hydrogen peroxide to drainage bags has been suggested as a way to help minimize infections and reduce odor, but there are no studies or data to support this practice.

Complications

Urinary tract infections are the most common complication of urinary catheters and are a primary source of nosocomial infections accounting for close to 40 % of all hospitalized acquired infections [65]. Duration of catheterization is a significant risk factor for infection. Some degree of bacteriuria is inevitable and universal, so only symptomatic individuals require antibiotic therapy. Prophylactic antibiotics are recommended only if there is substantial trauma during catheter changes.

Suprapubic tubes are somewhat less likely to cause symptomatic infections compared to transurethral catheters and are preferable in appropriate patients [66]. Using closed urinary drainage systems and removing the catheters as soon as possible have all been shown to reduce the risk of catheter associated urinary tract infections. Encouraging increased patient fluid intake and optimizing hand hygiene are also helpful.

Catheter encrustation is often the result of chronic bacteriuria with organisms that produce urease such as *Proteus mirabilis*, creating an alkaline environment which is ideal for the development of triple phosphate and calcium phosphate stone material. There is weak evidence for prevention of this encrustation by using potassium citrate supplements even though they tend to increase urinary alkalinization. Larger catheter lumens and the use of pure silicone catheter materials seem to reduce the incidence of blockages and allow less frequent catheter changes.

Blockage of the catheter requiring periodic irrigation or rapid replacement is another frequent complication of indwelling urinary catheters. Some patients, especially those with spinal cord injury, may require frequent changes of their catheters; sometimes every 2 weeks or even weekly. This may increase the risk for infection which can be minimized by careful daily cleansing.

About 40–50 % of all patients with indwelling catheters experience problems with lumen blockage as a consequence of cellular debris, kinking or encrustation. Studies have shown

that more than 70 % of blocked catheters are encrusted and more than 60 % are associated with bladder stones [67].

X-ray does not reliably demonstrate smaller bladder stones, so cystoscopy is recommended in patients with unusually frequent blockages [68]. If no stones are found, then treatment focuses on the patient's fluid intake, catheter size, replacement frequency and bladder irrigations. Although often used for frequent catheter blockage and encrustation, there are no good studies on bladder irrigations comparing the different fluid compositions, volumes, concentrations or frequency of administration [69, 70]. Still, we recommend gentle irrigations of ¼% acetic acid solution periodically in selected patients who are prone to rapid encrustation and catheter blockage, as it can dissolve the calcium phosphate that forms the clogging debris.

Biofilms, thin layers of microorganisms adhering to the surface of foreign bodies, shelter bacteria and often forms in long term urinary catheters [71]. For this reason, catheters should be changed whenever the patient begins new antibiotic treatment for infection.

Formation of a catheter balloon cuff, caused by the deflated Foley balloon membrane being pushed and bunching up near the tip of the suprapubic tube, can create a significant bulge which can traumatize the bladder and cystostomy tract during catheter removal. As the catheter is withdrawn, the detrusor and rectal muscles become stimulated and grip tightly. This pressure forces the deflated balloon material towards the catheter tip where it builds up and creates a bulge [72]. This effect is more pronounced in smaller catheters so increasing the French size of the Foley is helpful. Switching to a special 100 % pure silicone catheter with an integral balloon has been recommended. In this type of catheter, the balloon edges are level with the surface of the catheter shaft, unlike most latex Foleys in which the balloon areas are typically 1–2 mm wider [73]. However, most have found a higher incidence of catheter balloon cuffing problems with silicone catheters due to stretching of the old balloon material and they recommend hydrogel-coated Latex catheters [72–74]. Very slow deflation has been suggested to minimize balloon cuff formation. If this is unsuccessful, injecting 0.5–1 mL of fluid back into the balloon is usually sufficient for partial inflation, smoothing out the cuff and retaining ridge enough to allow catheter removal [74].

Significant bleeding around a newly placed urethral catheter usually indicates either urethral trauma or malposition of the catheter. If the catheter is properly positioned, then urethral trauma is the most likely cause. This bleeding is usually self-limited but if severe, a penile tourniquet can be gently applied around the shaft of the penis to tamponade the bleeding area. **Hematuria** after catheterization is usually self limited but may require irrigation if it fails to diminish on its own.

Leakage of urine around the catheter is another common problem that may occur as a consequence of catheter blockage, kinking, malposition, sphincteric muscle insufficiency, infection or bladder spasms. Problems with drainage bag positioning can also lead to leakage or urinary retention. Leakage is not a diagnosis but rather a symptom; treatment should be aimed at the underlying cause.

When evaluating a patient with catheter leakage, the Foley can be irrigated to help check on its position. A bladder scan or ultrasound can be very helpful in verifying the exact catheter position. If the catheter is in good position and irrigates well, then the cause is probably bladder spasms or infection. In rare cases, a badly weakened sphincter muscle may require procedural intervention such as a sling or surgical urethral closure to stop the leakage [51•].

Iatrogenic trauma during urethral catheterization can create false passages, usually at the level of the prostate, bladder neck, bulbous urethra or at any pre-existing urethral stricture. In rare cases, it can also cause a urethral perforation into the rectum or abdomen. Suprapubic catheters can be malpositioned, migrate distally causing urethral strictures, obstruction or even urethral ruptures especially in patients with diminished sensation or communication problems. Complications of this kind can be reduced by an adherence to proper placement technique and the liberal utilization of ultrasound to verify final catheter placement position.

Long Term Sequelae

The most common long term complications are bladder spasms, recurrent infections, balloon diffusion, frequent catheter blockages and granulation tissue buildup. Many of these problems occur more frequently when the Foley is left in too long. This may be partially resolved by changing the catheter more often than monthly in some patients.

Bladder spasms are best managed with anticholinergic medication which can be given orally or transdermally. Should this fail, injections of botox directly into the bladder wall work well [75]. Maintaining regular bowel function with a high fiber diet and increased fluid intake helps prevent constipation which can also produce bladder spasms.

Balloon diffusion is another problem associated with long term catheter use. This occurs when the catheter balloon slowly deflates as the water from the balloon diffuses through its membrane.

Other complications from chronic catheter use include the formation of granulomas, catheter related cystitis, creation of a small fibrotic bladder from disuse and squamous cell carcinoma. Spinal cord injury patients with chronic indwelling catheters including suprapubic Foleys, have the greatest risk of developing non-schistosomiasis induced squamous cell carcinoma of the bladder [76]. Yearly cystoscopy and cytology has therefore been recommended for all

Table 3 Guide for difficult foley catheter placement: summary

Can't find or enter the urethral meatus:

- If you can't find the urethral meatus in an older lady, look inside the vagina along the midline at the roof as the urethra often retracts there. If you can't see it, use touch (the urethral meatus feels like a button hole.)
- If the penis is too edematous, try wrapping it with an Ace elastic wrap or similar for 15–20 minutes. This will reduce the edema and often allow for easier catheter placement.
- If the problem is phimosis, try grabbing the foreskin and gently pulling outwards. This will telescope the foreskin and will tend to open the central portion while lengthening it. This may be enough to allow for visualization of the meatus and catheter introduction.
- If the above tips are unsuccessful, try using a 16 French Coude (curved) tip catheter and entering the meatus by touch. In men, the meatus is just inferior (ventral) to the midline and in the center of the glans.

Can't advance the catheter into the bladder:

- Inject extra lubricant (20 mL) directly into the urethra. Can use an anesthetic gel if available.
- Start with a 16 French 10-mL Balloon Coude catheter. If that doesn't work, try a 12 French All Silicone catheter. One of these two catheters will work about 2/3 of the time.
- If this doesn't work, try stiffening the 12 French catheter by placing the floppy end of a 0.035" guidewire into the lumen and advancing it to the tip, then clamping it at the external end. This will substantially stiffen the shaft without adding rigidity to the tip which remains soft.
- If unsuccessful, next try passing just a 0.035-inch guide wire (standard, NOT stiff, to avoid injury to the urethra). 80 % of the time, the guidewire can be advanced into the bladder even if neither catheter will pass by itself.
- If not successful passing the guide wire initially, place the Foley catheter as far into the urethra as it will go, then try to pass the guide wire around the catheter. (The Foley will stretch the urethra near the blockage and may help the guidewire enter the correct lumen and pass into the bladder.)

If the guidewire plcement is successful:

- Start with a 16 French Council Tip or similar catheter (a straight catheter with a hole punched in the middle to allow a guide wire to pass through). If this is successful, you're done.
- Next, get the previously used 12 French Pure Silicone catheter. Use an 18 gauge angiocath and puncture a hole from the sidehole of the catheter coming out through the catheter tip. Remove the needle but leave the plastic sleeve in place. Advance the end of the 0.035-inch guide wire through the plastic angiocath sleeve. Remove the angiocath sleeve and manipulate the end of the wire into the lumen of the silicone catheter. Then try to pass the silicone catheter over the guide wire. (The silicone catheter is stiff enough and small enough to act as its own urethral dilator most of the time.
- If unsuccessful, use a hydrophilic ureteral dilator such as the 12 French Nottingham Dilator and advance it over the guidewire into the bladder, then repeat the above with the 12 French Silicone catheter. Or you can use a balloon dilator.

If the guidewire placement is unsuccessful, flexible cystoscopy:

- If the flexible cystoscope enters the bladder, leave a guidewire and treat as above. Urethral lumen is often located anteriorly and will have blunted edges. False passages will have sharp, bleeding edges and are likely to be more posterior. Try angle tip as well as straight tip guide wires. If unable to find the true lumen, suprapubic pressure may cause a small gush of fluid from the urethra which may help identify it. Any small dimple or crease might be the urethral lumen and should be probed gently. If unable to advance a guidewire into the bladder with direct vision cystoscopic guidance, consider placement of a suprapubic tube.

patients with chronic indwelling catheters to help identify such aggressive cancers as early as possible [77].

Catheter removal and balloon deflation may become difficult or impossible due to calcifications forming on the balloon or catheter. Difficulties may also be caused by salt crystals or debris in the valve mechanism or balloon inflation lumen. The valve itself may be defective. Treatment includes cutting the valve mechanism off or even below the bifurcation which may result in deflation. Passage of a very small wire through the lumen to the balloon may sometimes facilitate its deflation. If this fails, ultrasound-guided transabdominal balloon puncture can be done. Should this method be employed, it is important to cystoscope the patient afterwards to ensure that all balloon fragments have been removed from the bladder.

Extreme catheter related cystitis can contribute to bleeding, spasms and leakage. A closed system catheter drainage bag that is held far below bladder level can exert considerable negative vacuum pressure from its siphoning effect. This stimulates mucosal overgrowth which can block the catheter's eyelets causing obstruction, pain, bleeding and spasm. Treatment involves raising the drainage bag to limit the siphoning suction pressure and possibly eliminating the dependent drainage bag entirely by using a catheter plug or valve.

Routine urine cultures in patients with chronic indwelling catheters are of no clinical value since bacterial colonization is inevitable and rapidly changing. Low-dose antibiotic prophylaxis is also not recommended or supported by current data or guidelines as this will only lead to the more rapid development of resistant organisms and yeast overgrowth [78•].

Conclusion

A reasonable, progressive approach to the common problem of difficult urethral catheterizations will help minimize urinary trauma and long term urological disorders. Blind procedures with stiff or metal sounds are being rapidly replaced by guide wires, balloon dilators and direct vision techniques. All health care professionals and staff who are authorized to place urinary catheters, should be instructed in proper techniques and encouraged to call for help if they encounter difficulties beyond their ability to resolve. A brief summary of our recommended protocol can be found in Table 3.

Compliance with Ethics Guidelines

Conflict of Interest Dr. Cameron Ghaffary reported no potential conflicts of interest relevant to this article.

Dr. Amanuel Yohannes reported no potential conflicts of interest relevant to this article.

Dr. Carlos Villanueva reported no potential conflicts of interest relevant to this article.

Dr. Stephen W. Leslie reported four patents licensed to Boston Scientific relating to kidney stone baskets and royalties paid to him by Boston Scientific based on sales of kidney stone baskets.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:

- • Of importance
- •• Of major importance

1. • Villanueva C, Hemstreet III G. Difficult male urethral catheterization: a review of different approaches. Int Braz J Urol. 2008;34(4):401–12. PMID: 18778491 *This is the first comprehensive review of all the various techniques available at the time for difficult urethral catheterization*.
2. Lopez Pacios JC, Sanchez Merino JM, Pineiro Fernandez MD, Bouso Montero M, Parra Muntaner L, Garcia Alonso J. Fournier's gangrene secondary to urethral catheterization. Arch Esp Urol. 2005;58(2):167–70. PMID: 15847276.
3. Conn IG, Lewi HJ. Fournier's gangrene of the scrotum following traumatic urethral catheterisation. J R Coll Surg Edinb. 1987;32(3):182–4, PMID: 3656248.
4. Karim MS. Fournier gangrene following urethral necrosis by indwelling catheter. Urology. 1984;23(2):173–5. PMID: 6695486.
5. Davoodian P, Nematee M, Sheikhvatan M. Inappropriate use of urinary catheters and its common complications in different hospital wards. Saudi J Kidney Dis Transpl. 2012;23(1):63–7. PMID: 22237221.
6. Gokula RR, Hickner JA, Smith MA. Inappropriate use of urinary catheters in elderly patients at a Midwestern community teaching hospital. Am J Infect Control. 2004;32(4):196–9. PMID: 15175612.
7. Hazelett SE, Tsai M, Gareri M, Allen K. The association between indwelling urinary catheter use in the elderly and urinary tract infection in acute care. BMC Geriatr. 2006;6:15. PMID: 17038177.
8. Jain P, Parada JP, David A, Smith LG. Overuse of the indwelling urinary tract catheter in hospitalized medical patients. Arch Intern Med. 1995;155(13):1425–9. PMID: 7794092.
9. Gardam MA, Amihod B, Orenstein P, Consolacion N, Miller MA. Overutilization of indwelling urinary catheters and the development of nosocomial urinary tract infections. Clin Perform Qual Health Care. 1998;6(3):99–102. PMID: 10182561.
10. Fernandez-Ruiz M, Calvo B, Vara R, Villar R, Aguado J. Inappropriate use of urinary catheters in patients admitted to medical wards in a university hospital. Enferm Infecc Microbiol Clin. 2013; doi:10.1016/j.eimc.2013.02.013. PMID 23601704.
11. Ortega R, Ng L, Sekhar P, Song M. Videos in clinical medicine: female urethral catheterization. NEJM. 2008;358(14):e15. PMID: 18385493.
12. •• Villanueva C, Hemstreet III GP. Difficult catheterization: tricks of the trade. AUA Update Series. 2011;30:41–8. PMID: 21176277 *This was the first article to present a clear, standardized, evidence based, modern protocol for difficult catheterizations for urologists including clear, detailed instructions on the extremely useful and often overlooked Blitz technique for modifying catheters for placement over guide wires*.
13. Sinese V, Hendricks M, Morrison M, Harris J. SUNA clinical practice guidelines: female urethral catheterization. Society of Urologic Nurses and Associates; 2005. http://www.suna.org/sites/default/files/download/femaleCatheterization.pdf.
14. • Willette P, Coffield S. Current trends in the management of difficult urinary catheterizations. West J Emerg Med. 2012;13(6):472–8. PMID: 23359117. *This article gives a comprehensive rational protocol for difficult urinary catheterizations but from the perspective of an ER physician*.
15. Shlamovitz GZ, McCullough L. Blind urethral catheterization in trauma patients suffering from lower urinary tract injuries. J Trauma. 2007;62(2):330–5. PMID: 17297322.
16. Chapple C, Barbagli G, Jordan G, Mundy AR, Rodrigues-Netto N, Pansadoro V, et al. Consensus state on urethral trauma. BJU Int. 2004;93(9):1195–202. PMID: 15180604.
17. Ramchandani P, Buckler P. Imaging of genitourinary trauma. Am J Roentgenol. 2009;192(6):1514–23. PMID: 19457813.
18. Ingram M, Watson S, Skippage P, Patel U. Urethral injuries after pelvic trauma: evaluation with urethrography. Radiographics. 2008;28(6):1631–43. PMID: 18936026.
19. Sinese V, Hendricks M, Morrison M, Harris J. SUNA clinical practice guidelines: Male urethral catheterization. Society of Urologic Nurses and Associates; 2005. http://www.suna.org/sites/default/files/download/maleCatheterization.pdf.
20. Vaidyanathan S, Hughes PL, Soni BM. A simple radiological technique for demonstration of incorrect positioning of a foley catheter with balloon inflated in the urethra of a male spinal cord injury patient. Sci World J. 2006;6:2445–9. PMID: 17619716.
21. Daneshgari F, Krugman M, Bahn A, Lee R. Evidence-based multidisciplinary practice: improving the safety and standards of male bladder catheterization. Medsurg Nurs Off J Acad Med Surg Nurs. 2002;11(5):236–41. PMID: 12830746.
22. Hadfield-Law L. Male catheterization. Accid Emerg Nurs. 2001;9(4):257–63. PMID:11855766.
23. Patel AR, Jones JS, Babineau D. Lidocaine 2 % gel versus plain lubricating gel for pain reduction during flexible cystoscopy: a meta-analysis of prospective, randomized, controlled trials. J Urol. 2008;179(3):986–90. PMID: 18206920.
24. Chan M F, Tan H Y, Lian X, Ng L Y G, Ang L L E, Lim L H L, …, Taylor B J. A randomized controlled study to compare the 2 % lignocaine and aqueous lubricating gels for female urethral catheterization. Pain Practice. 2013; doi:10.1111/papr.12056. PMID: 23560476.
25. Aaronson DS, Walsh TJ, Smith JF, Davies BJ, Hsieh MH, Konety BR. Meta-analysis: does lidocaine gel before flexible cystoscopy provide pain relief? BJU Int. 2009;104(4):506–9. PMID: 19239453.
26. Schede J, Thuroff J. Effects of intraurethral injection of anaesthetic gel for transurethral instrumentation. BJU Int. 2006;97(6):1165–7. PMID: 16686705.
27. Chen YT, Hsiao PJ, Wong WY, Wang CC, Yang SS, Hsieh CH. Randomized double blind comparison of lidocaine gel and plain lubricating gel in relieving pain during flexible cystoscopy. J Endourol. 2005;19(2):163–6. PMID: 15798411.
28. Siderias J, Guadio F, Singer AJ. Comparison of topical anesthetics and lubricants prior to urethral catheterization in males: a randomized controlled trial. Acad Emerg Med. 2004;11(6):703–6. PMID: 15175214.

29. Walden T. Urethral catheterization in anasarca. Urology. 1979; 13(1):82. PMID: 442329.
30. Rubenstein SC. Catheterization of edematous uncircumcised penis. Urology. 1994;43(1):100. PMID: 8284865.
31. Goel MD. Catheterization of edematous uncircumcised penis. Urology. 1994;44(2):296. PMID: 8048213.
32. Nathan BN. Method of catheterising patients with gross swelling of the penis. Br J Urol. 1990;65(5):550. PMID: 2354327.
33. Hewes JC, Kelly J, Hashemi M. Buried penis in super obesity: a technique for urethral catheterization under direct vision. Surg Obes Relat Dis. 2011;7(3):332. PMID: 21429819.
34. Liss MA, Leifer S, Sakakine G, Esparza M, Clayman RV. The Liss maneuver: a nonendoscopic technique for difficult Foley catheterization. J Endourol. 2009;23(8):1227–30. PMID: 19558222.
35. Carter HB, Chan DY. Basic instrumentation and cystoscopy. 8th ed. Philadelphia: Campbell's Urology, Saunders; 2002. p. 111–21.
36. Thomsen TW, Setnik GS. Videos in clinical medicine: male urethral catheterization. N Engl J Med. 2006;354(21):e22. PMID: 16723610
37. Alkhayal S. A simple method to overcome difficult male urethral catheterisation. Ann R Coll Surg Engl. 2008;90(4):343. PMID: 18521978.
38. Freid R, Smith A. The Glidewire technique for overcoming urethral obstruction. J Urol. 1996;156(1):164–5. PMID: 8648783.
39. Krikler S. Flexible urethroscopy: use in difficult male catheterization. Ann R Coll Surg Engl. 1989;71(1):3. PMID: 2923416.
40. Beaghler M, Grasso M, Loisides P. Inability to pass a urethral catheter: the bedside role of the flexible cystoscope. Urology. 1994;44(2):268–70. PMID: 8048205.
41. Blitz BF. A simple method using hydrophilic guide wires for the difficult urethral catheterization. Urology. 1995;46(1):99–100. PMID: 7604486.
42. Herschorn S, Carrington E. S-shaped coaxial dilators for male urethral strictures. Urology. 2007;69(6):1199–201. PMID: 17572215.
43. Russinovich NA, Lloyd LKL, Griggs WP, Jander HP. Balloon dilatation of urethral strictures. Urol Radiol. 1980;2(1):33–7. PMID: 7233640.
44. Giesy JD, Finn JC, Hermann GD, et al. Coaxial balloon dilation and calibration of urethral strictures. Am J Surg. 1984;147(5):611–4. PMID: 6721037.
45. Daughtry JD, Rodan BA, Bean WJ. Balloon dilatation of urethral strictures. Urology. 1988;31(3):231–3. PMID: 3347972.
46. MacDiarmid SA, Harrigan CT, Cottone JL, et al. Assessment of a new transurethral balloon dilation catheter in the treatment of urethral stricture disease. Urology. 2000;55(3):408–13.
47. Zammit P, German K. The difficult urethral catheterization: use of a hydrophilic guidewire. BJU Int. 2004;93(6):883–4. PMID: 15050011.
48. Chelladurai A, Srirangam S, Blades R. A novel technique to aid urethral catheterization in patients presenting with acute urinary retention due to urethral stricture disease. Ann R Coll Surg Engl. 2008;90(1):77–8. PMID: 18210681.
49. • Willette P, Banks K, Shaffer L. Visually guided male urinary catheterization: a feasibility study. J Emerg Nurs. 2013;39(1):27–32. PMID: 21937096 *First description of a valuable new catheterization aid suitable for use by nurses*.
50. Zeidman EJ, Chiang H, Alarcon A, Raz S. Suprapubic cystostomy using Lowsley retractor. Urology. 1988;32(1):54–5. PMID: 3388660.
51. • Harrison SC, Lawrence WT, Morley R, Pearce I, Taylor J. British Association of Urologic Surgeons' suprapubic catheter guidelines. BJU Int. 2011;107(1):77–85. PMID: 21052755. *This excellent consensus review provides comprehensive recommendations regarding all aspects of suprapubic catheter placement and maintenance*.
52. Jacob P, Rai B, Todd. Suprapubic catheter insertion using an ultrasound-guided technique and literature review. BJU Int. 2012;110(6):779–84. PMID: 22257272.
53. Sheriff MK, Foley S, Mcrfarlane J, Nauth-Misir R, Craggs M, Shah PJ. Long-term suprapubic catheterization: clnical outcome and satisfaction survery. Spinal Cord. 1998;36(3):171–6. PMID: 9554016.
54. 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(2):210–3. PMID: 16551422.
55. Levrant SG, Bieber EJ, Barnes RB. Anterior abdominal wall adhesions after laparotomy or laparoscopy. J Am Assoc Gynecol Laparoscopy. 1997;4(3):353–6. PMID: 9154785.
56. Albrecht K, Oelke M, Schultheiss D, Troger HD. The relevance of urinary bladder filling in suprapubic bladder catheterization. Urologe A. 2004;43(2):178–84. PMID: 14991120.
57. Chiou RK, Aggarwal H, Chen W. Glidewire-assisted Foley catheter placement: a simple and safe technique for difficult male catheterization. Can Urol Assoc J. 2009;3(3):189. PMID: 19543460.
58. Edokpolo LU, Foster Jr HE. Suprapubic cystostomy for neurogenic bladder using lowsley retractor method: a procedure revisited. Urology. 2011;78(5):1196–8. PMID: 21908021.
59. • Anderson PJ, Walsh JM, Louey MA, Meade C, Fairbrother G. Comparing first and subsequent suprapubic catheter change: complications and costs. Urol Nurs. 2002;22(5):324–30. PMID: 12432718 *Surprising information that changes our traditional approach that required the first catheter change be done only by the surgeon*.
60. Karsh LL, Egerdie RB, Albala DM, Flynn BJ. The transurethral suprapubic endo-cystostomy (T-SPeC): a novel suprapubic catheter insertion device. J Endourol. 2013;27(7):880–5. doi:10.1089/end.2013.0053
61. Robinson J. Insertion, care and management of suprapubic catheters. Nurs Stand. 2008;23(8):49–56. PMID: 18986081.
62. Addison R. Catheter valves: a special focus on the Bard Flip-Flo catheter. Br J Nurs. 1999;8(9):576–80. PMID: 10711002.
63. Addison R. Bladder health and continence care. Nurs Times. 2001;97(40):55–6. PMID: 11949363.
64. Addison R, Mould C. Risk assessment in suprapubic catheterisation. Nurs Stand. 2000;14(36):43–6. PMID: 11974265.
65. Jacobsen S, Stickler D, Mobley H, Shirtliff M. Complicated catheter-associated urinary tract infections due to Escherichia coli and Proteus mirabilis. Clin Microbiol Rev. 2008;21(1):26–59. PMID: 18202436.
66. Sethia K, Selkon J, Berry A, Turner C, Kettlewell M, Gough M. Prospective randomized controlled trial of urethral versus suprapubic catheterization. Br J Surg. 1987;74:624–5. PMID: 3304522.
67. Sabbuba N, Stickler D, et al. Genotyping demonstrates that the strains of Proteus mirabilis from bladder stones and catheter encrustations of patients undergoing long-term bladder catheterization are identical. J Urol. 2004;171(5):1925–8. PMID: 15076313.
68. Linsenmeyer M, Linsenmeyer T. Accuracy of predicting bladder stones based on catheter encrustation in individuals with spinal cord injury. J Spinal Cord Med. 2006;29(4):402–5. PMID: 17044391.
69. Sinclair L, Hagen S, Cross S. Washout policies in long-term indwelling urinary catheterization in adults: a short version Cochrane review. Neurourol Urodyn. 2011;30(7):1208–12. PMID: 21563211.
70. Hagen S, Sinclair L, Cross S. Washout policies in long-term indwelling urinary catheterization in adults. Cochrane Database Syst Rev. 2010;3. PMID: 20238325
71. Frank DN, Wilson SS, Amand ALS, Pace NR. Culture-independent microbiological analysis of Foley urinary catheter biofilms. PLoS One. 2009;4(11):e7811. PMID: 19907661.
72. Parkin J, Scanlan J, Woolley M, Grover D, Evans A, Feneley R. Urinary catheter 'deflation cuff' formation: clinical audit and quantitative in vitro analysis. BJU Int. 2002;90(7):666–71. PMID: 12410744.
73. Robinson J. Deflation of a Foley catheter balloon. Nurs Stand. 2003;17(27):33–8. PMID: 12683117.

74. Gonzalgo ML, Walsh PC. Balloon cuffing and management of the entrapped Foley catheter. Urology. 2003;61(4):825–7. PMID: 12670575.
75. Lekka E, Lee KL. Successful treatment with intradetrusor botulinum-A toxin for urethral urinary leakage (catheter bypassing) in patients with end-staged multiple sclerosis and indwelling suprapubic catheters. Eur Urol. 2006;50(4):806–10. PMID: 16413661.
76. Shokeir AA. Squamous cell carcinoma of the bladder: pathology, diagnosis and treatment. BJU Int. 2004;93(2):216–20. PMID: 14690486.
77. Navon J, Soliman H, Khonsari F, Ahlering T. Screening cystoscopy and survival of spinal cord injured patients with squamous cell cancer of the bladder. J Urol. 1997;157(6):2109–11. PMID: 9146592.
78. • Tenke P, Kovacs B, Bjerklund Johanse TE, Matsumoto T, Tambyah PA, Naber KG. European and Asian guidelines on management and prevention of catheter-associated urinary tract infections. Int J Antimicrob Agents. 2008;31 Suppl 1:568–78. PMID: 18006279 *A very good report on the important topic of catheter related infections*.