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**Case Report** 



# Ureteral Obstruction Due to Inadvertent Placement of the Suprapubic Catheter and Bladder Indwelling Catheter: Presentation of Two Clinical Cases and Review of the Literature

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### **Abstract**

**Introduction:** Suprapubic catheter (SPC) and bladder indwelling catheter (BIC) placement are among the most common urological procedures. Inadvertent misplacement of the catheter tip into the ureteral orifice is an infrequent event with potentially critical complications.

Case Presentation: We describe two cases of inadvertent intraureteral misplacement of an SPC and a BIC. A 66-year-old man with chronic kidney disease (CKD) stage G3b, urethral stenosis, long-term SPC who attended the emergency room (ER) 6 hours after the last catheter replacement due to low back pain, fever, deterioration of the general condition, anuria, acute kidney injury (AKI); CT-scan revealed a left uretero-hydronephrosis secondary to obstruction of the catheter balloon misplaced inside the distal ureter. A 59-year-old woman with CKD stage G3b, post-radiotherapy cystitis, and small capacity bladder, long-term BIC who attended the ER a few hours after the last BIC replacement due to abdominal pain, anuria, AKI; CT-scan revealed left hydronephrosis secondary to catheter obstruction within the distal ureter. In both patients, management was conservative, consisting of removing the catheter and repositioning it inside the bladder, in addition to hydration and antibiotherapy.

**Conclusions:** These cases illustrate that awareness of this rare complication can be prevented by confirming the correct positioning of SPC or BIC after its replacement. Early detection and management of this complication can prevent a serious clinical setting.

Keywords: Suprapubic Catheter, Cystostomy, Urinary Catheter, Hydronephrosis, Hydroureter, Neurogenic Bladder, Ureteral Trauma, Ureteral Obstruction, Urosepsis, Renal Failure

## 1. Introduction

The suprapubic catheter (SPC) and bladder indwelling catheter (BIC) are useful devices widely used in urological patients, and their iterative replacement is necessary for patients with pharmacologically intractable bladder emptying disorder. Urinary catheterization is associated with complications over the short (trauma, urosepsis, acute kidney injury (AKI)) and long term (urethral stricture), leading to a greater cost burden on medical departments (1-3). Unintentional intraureteral misplacement of SPCs and BICs is infrequent, with potentially life-threatening complications, such as ureteral trauma. Although it has been described mostly in patients with neurogenic bladder, its mechanism remains unclear. This paper aims to describe two rare cases of unintentional ureteral obstruction after routine replacement of an SPC and BIC that occurred in our

institution, review the literature, explain possible factors favoring this occurrence and suggest measures to manage and prevent it.

# 2. Case Presentation

Patient 1: 66-year-old man with medical and surgical antecedents of chronic kidney disease (CKD) stage 3b of multifactorial origin, right renal atrophy, transurethral resection of the prostate, multi-operated bulbar urethral stricture, recurrent urinary tract infections (UTI), and carrier of an SPC with iterative changes. Six hours after the last 12Fr siliconized SPC replacement, he attended the emergency room (ER) with deterioration of the general condition, lumbar pain, anuria, and fever of 39°C. He was tachycardic (heart rate of 120 beats/min), with no hypotension or respiratory alterations (detailed laboratory findings in

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Table 1). Blood tests showed an elevated leukocyte count of 21.34  $\times$  10<sup>3</sup> cells/ $\mu$ L, elevated c-reactive protein (CRP) of 194.9 mg/L, GFR according to CKD-EPI was 4 mL/min/1.73 m<sup>2</sup>, with creatinine of 13.7 mg/dL, and urea of 294 mg/dL, hyperkalemia of 6.6 mmol/L; metabolic acidosis. Urine culture was positive for E. coli and P. aeruginosa (Figure 1). CT scan revealed a left uretero-hydronephrosis secondary to obstruction by the inflated SPC balloon in the distal ureter 4 cm from the vesicoureteral junction (VUJ). He was admitted for urosepsis and AKI. The catheter's balloon was deflated, and the catheter was carefully removed and repositioned into the bladder with 5 mL of sterile water in the balloon; the correct position was confirmed with ultrasound; he was hospitalized, and antibiotic treatment was started. Decreased hydronephrosis was confirmed three days later with renal ultrasound. The patient was discharged on the fifth day of hospitalization with clinical and analytical improvement.

Patient 2: 59-year-old woman with medical and surgical antecedents of CKD stage 3b of multifactorial origin, low anterior resection, and radio-chemotherapy for rectal adenocarcinoma, bowel perforation, permanent discharge colostomy, micro-bladder (maximum capacity 50 cc), severe urinary incontinence, recurrent UTI and permanent 16Fr siliconized BIC. She attended the ER 24 hours after the last BIC replacement for hypogastric pain radiating to the left lumbar fossa, nausea, hematuria, oliguria, and peri-catheter urine leakage. Normal vital parameters. Blood tests showed a normal amount of leukocytes, CRP 89.8 mg/L, creatinine 6.13 mg/dL, CKD-EPI 6.9 mL/min/1.73 m<sup>2</sup>, and hyperkalemia 4.9 mmol/L. Urine culture was positive for P. aeruginosa (Figure 1). CT scan revealed a left uretero-hydronephrosis secondary to obstruction by the inflated SPC balloon in the intramural tract of the ipsilateral ureter. The balloon was deflated, and the catheter was carefully removed and replaced; the intravesical position was confirmed by ultrasound. She was admitted for AKI and UTI. Decreased hydronephrosis was confirmed three days later with renal ultrasound, renal function improved, hematuria was self-limited, and she was discharged with oral antibiotics.

# 3. Discussion

The most frequent injuries associated with BIC are urethral trauma and retention of the catheter's balloon within the urethra (4); placement of an SPC is technically more complex with a risk of abdominal organ injury and mortality risk of up to 2,4% (5). Other complications include hematuria, spasms, stone formation, obstructions, catheter leakage, and a tendency to dislocate, especially in cognitively impaired persons (1).

Inadvertent placement of BIC and SPC within the ureter is a rare event, with only 27 and 8 cases reported respectively so far, of which 12 right and 15 left for BIC and three right and 5 left for SPC (Table 2). There is no significant difference in terms of laterality, inadvertent placement of BIC has a female predominance of 3.5:1, while in the case of PCS it is more frequent in men at 7:1. Of the 35 patients reported, 28 (80%) underwent iterative catheter changes, mostly due to neurogenic bladder (17 cases). Although in less than half of the cases (6), there were no reported consequences, the most frequent ones were pyelonephritis (8 cases) and ureteral rupture (6 cases).

Long-term urinary catheter users often have multiple medical, surgical, and even radiotherapeutic background, following damage to the detrusor muscle's structure, and consequent bladder alteration emptying, recurrent UTI, and high prevalence of renal scarring, caliectasis, and CKD (33). These antecedents associated with the permanent presence of a catheter increase the risk of suffering urosepsis (34).

Possible reasons for inadvertent ureteral catheterization have been described (22, 27, 30):

- In patients with long-term catheterization, the bladder tends to contract and decrease its capacity (alteration of the anatomical relationship between the bladder neck and ureteral orifices).
- Each change of catheter increases the chances of ectopic catheterization, especially if the bladder is empty.
- In patients with neurogenic bladder, there may be ureteral reflux with patulous ureteral orifices, which may facilitate catheter entry into the ureteral meatus.

In addition, in women, the absence of the median prostatic lobe could justify the higher proportion of patients with BIC misplacement than in men; this is deduced by the almost absence of reported cases of SPC misplacement in women. These conditions may explain the intraureteral entry of BIC or SPC during their placement or the spontaneous intraureteral migration of the catheter, which can occur on more than one occasion in the same patient (19, 27); six reported cases attended the ER between 10 and 60 days after the last catheter replacement. However, this event can also occur in patients with unknown neurological or urological pathology, and two incidental findings have been reported during laparotomy and two cases in the perioperative period of cesarean section (6, 12, 16, 17, 23, 26, 30). The most frequent clinical presentation was a pain in 65% of cases, although this may be absent, especially in patients with upper motor neuron disease due to impaired pain perception. A diagnostic confirmation has been in almost all cases radiological with ultrasound or CTscan, although MRI has been described to visualize the bal-

<b>Table 1.</b> Details of Laboratory Findings in Patients 1 and 2. Baseline Values, at the Time of Admission and at the Time of Discharg		
	vd 2. Raceline Values, at the Time of Admission and at th	Time of Discharge

Variables	Reference Ranges		Patient 1			Patient 2	
variables	Reference Ranges	Baseline Values	Admission	Discharge	Baseline Values	Admission	Discharge
GFR CKD-EPI	> 60 mL/min/1.73 m <sup>2</sup>	18	4	19	12	6.9	8
Creatinine	0.7 - 1.3 mg/dL	3.23	13.7	3.28	3.76	6.13	5.28
Leucocyte	3.5 - 11.00 $ imes$ 10 $^3$ cells/ $\mu$ L		21.34	4.74		8.27	7.43
CRP	< 10 mg/L		194.9	3.6		89.9	6.3
Urea	17 - 48 mg/dL	48	294	53	92	134	123
Potassium	3.4 - 4.5 mmol/L		6.6	4.3		4.9	4.1
Bicarbonate	22 - 28 mmol/L		10	20		18	18
рН	7.35 - 7.45		7.4	7.4		7.4	7.39
Lactate	< 2 mmol/L		3.5			2	

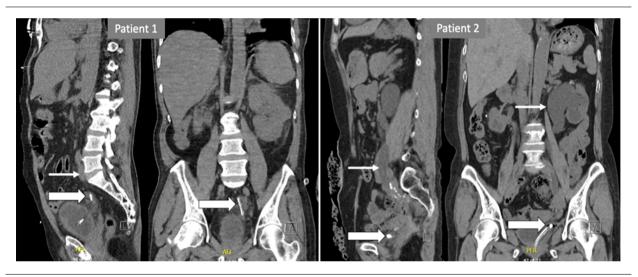


Figure 1. Patient 1: Large arrows indicate the suprapubic catheter into the left distal ureter up to 4 cm from the VUJ; a small arrow indicates the left hydroureter. Patient 2: Large arrows indicate the bladder catheter within the intramural tract of the left distal ureter. Small arrows indicate left hydronephrosis.

loon and tip of the catheter, hydroureteronephrosis, and in case of ureter rupture a urinoma and extravasation of contrast in the damaged area (20). In most cases, management has been conservative by catheter repositioning into the bladder and confirming fluid leakage. If a deflation of the balloon is not possible, a percutaneous attempt can be made; an endoscopic incision of the ureteral orifice has also been described (11). In case of ureteral injury, management might require DJ stent placement or surgical repair (10, 17, 18).

Our two patients suffered from CKD, recurrent UTI, and iterative catheter changes, both attended to the ER for pain, and oliguria within the first 24 hours after catheter replacement, patient one, who had a single functional kidney, had rapid deterioration of the general condition, patient 2 presented peri-catheter urine leakage. At the

ER, AKI and UTI were found, CT scan revealed ureterohydronephrosis secondary to obstruction by the inflated catheter balloon in the distal ureter. In both cases, management consisted of deflating the balloon, carefully removing the catheter, and replacement; positioning was confirmed with saline flushing and ultrasound; hydration, antibiotic treatment, and control with ultrasound three days later, with clinical improvement of renal function and decrease of hydronephrosis. Three weeks later, an ultrasound confirmed both patients' complete resolution of hydronephrosis.

Use short-tipped catheters whenever possible. If urine does not drain spontaneously after catheter insertion, catheter irrigation should be performed before balloon inflation. Observe carefully if balloon inflation is accompanied by pain, although this may be absent in patients with

sensory disorders. At the end of the procedure, gently pull out the catheter (22). In case of an SPC, it's recommended, before deflating the balloon of the old catheter, gently pull the catheter completely and mark the catheter at the point where it enters the skin; this length will serve as a reference to confirm the depth of the new CSP or replace the CSP over a guidewire (19).

This review if the literature emphasize the importance of confirming the intravesical position of CSP and BIC after every replacement, inadvertent ureteral catheterization has the potential to provoke a serious clinical situation, although it is extremely uncommon. Medical staff should be aware of this possibility in order to be able to handle it quickly and efficiently.

#### **Footnotes**

**Authors' Contribution:** Development of the original idea, bibliographic review, drafting of the manuscript: VC; critical revision of the manuscript: MT, LJ and JN; study supervision: JN.

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**Informed Consent:** For this case report, we have obtained written and signed informed consent from patients.

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Authors         Gendle         Linked Condition         Childer         Side         Chilated Precentation         Clinical Diebut         Consequence         Authors           Reaction         Mile         Nal         80         cle         144         Novinte convoit during application         108         CC           Reaction         Franke         Sinch bilacent VIII         80         144         Novinte convoit during application         108         80         CC           Reaction         Manner et al. (1)         Nal         Fibriotic bidder         80         144         Novinte convoit during application         108         80         108         80           Manner et al. (1)         Nal         Fibriotic bidder         80         164         Palmic bidger         144         No         108         <	Table 2. Patient Characteristics in the Literature	iterature							
Maile   Na	Author	Gendre	Linked Condition	Catheter	Side	Clinical Presentation	Clinical Debut	Consequence	Management
(4)         Female         Nish         Bild         Right         Non-tunidate         Immediate         URR           (9)         Female         Sin, bilancal VIM         BIC         Light         Non-tuning spatiation         1 dh         No.           (9)         Female         Sin, bilancal VIM         BIC         Right         Pain         Ah         No.         No.           (1)         Amale         Fibroit-bildeder         BIC         Right         Pain         Ah         No.         No.           (1)         Amale         Nish         BIC         Lich         Pain, behavior         1-4         No.           (1)         Female         Nish Special Color         BIC         Lich         Pain, color         1-4         Poleboraphitis           (2)         Female         Nish Special Color         BIC         Lich         Pain, color         No.         No.           (2)         Female         Nish Special Color         BIC         Lich         Pain, bernantural         1-4         No.           (2)         Female         Nish Special Color         BIC         Lich         Pain, bernantural         1-4         No.           (2)         Female         Nish Specia	Borrero et al. (7)	Male	NB	SPC	Left	Fever, pain		NC	20
Fernale   Sin, bilateral VIS   Dic   Lief   No utine came cord clutring application   Immediate   No Remale   Sin, bilateral VIS   Big   Right   Pain   Pain   At h   NC	Singh and Eardley (8)	Female	NB NB	BIC	Right				
19   Hemale   Hemale   Bic   Right   Pain   Pain	Kato (9)	Female	Sin, bilateral VUR	IDC	Left	No urine came out during aspiration	Immediate		20
Maile   Prioric bladder   BC   Right   Pain, kelage around the carleter   14	Ogan and Berger (10)	Female		BIC	Right	Pain		UR	SR
Frenak   Putrig Lipparotomy   Bic   Right   Pain, leakage amound for carbeter   14   NC	Muneer et al. (11)	Male	Fibrotic bladder	BIC	Right	Pain		NC	Endo. incision
Female   Nale   Nale   Nale   Right   Pain, lookage around the catherer   1 d   Net of the profession   Net of Right   Pain, lookage around the catherer   1 d   Net of Right   Pain, lookage   Net of Right   Pain, lo	Hara et al. (12)	Female	<b>During laparotomy</b>	BIC	Left	Pain	4 h	NC	Ía
Female         Right         Left         Pain         Pain         Dyalonephilits           Female         Affer pyeloplasy         SC         Left         Pain         14         Polonephilits           Female         Affer pyeloplasy         SC         Left         Pain         Pain         14         Polonephilits           1         Female         Durnig laparotomy         BC         Left         Pain         Pain         14         Dyalonephilits           1         Kemale         Durnig laparotomy         BC         Left         Pain         Pain         BC	George and Tharion (13)	Male	SN N	BIC	Right	Pain, leakage around the catheter	14	NC	CC
Female         MB         Right         Palm         Palm         Hasplorephilits           et al.(17)         Female         Micropotolopiasy         SRC         Left         Palm objuria         14         Pyelonephilits           et al.(17)         Female         Duringlaparonomy         SRC         Left         Palm         Palm         UR           (17)         Female         NB         SRC         Right         Palm objuria         Few hours         UR           (18)         Female         NB         BK         Left         Palm objuria         Left         Perale         Perale         Phylorophilits           (23)         Female         NB         BK         Left         Perale colliderate the balloon         During ceasers         UR           (34)         Asia         NB         BK         Left         Perale colliderate the balloon         During ceasers         NC           (35)         Female         During current         BK         Left         Palm, mable to deflate the balloon         During ceasers         NC           (34)         Asia         Repart         Palm, mable to deflate the balloon         During ceasers         NC           (34)         Asia         Right	Maegele et al. (14)	Female		BIC	Left	Pain, fever, vomit		Pyelonephritis	SS
ernale         Alter pyeloplasty         SPC         Left         Pain, oligunta         144         Pyelonophitits           1         Kenale         During loparotomy         BC         Left         Pain         Intraoperative         UR           1         Kenale         NRB         SIC         Left         Pain, oligunta         Few hours         UR           1         Kenale         NRB         BC         Left         Pain, harmaturia         Few hours         UR           1         Kenale         NRB         BC         Left         Pain, harmaturia         1 d         AR           1         Kenale         NRB         BC         Left         Pain, harmaturia         1 d         AR           1         Kenale         NRB         BC         Left         Pain, mable cordenercy pain         1 d         AR           2         Male         NRB         BC         Left         Pain, unable corenowe the carbeter         1 d         AR           3         Male         NRB         Right         Pain, unable corenowe the carbeter         Same day         NC           4         Fernale         Protocophitis         BC         Left         Pain, unable corenowe the carbeter	Kim and Park (15)	Female	NB	BIC	Right	Pain		UR	PCN (DJ failed)
ctal (7)         Female         During lajaunoomy         BIC         Left         Palm         Palm         Intraoperative         UR           (2)         Hemale         NRB         SR         Left         Oliguria         60         Predonephrids           (c)         Hemale         NRB         BIC         Left         Oliguria         1d         AR           (c)         Male         NRB         BIC         Left         Palm, haematuria         1d         AR           (3)         Male         NRB         BIC         Left         Palm, haematuria         1d         AR           (3)         Male         NRB         BIC         Left         Palm, haematuria         1d         AR           (3)         Male         NRB         BIC         Left         Palm, haematuria         1d         AR           (3)         Male         NRB         BIC         Right         Palm, haematuria         1d         NR           (3)         Male         NRB         Right         Palm, mable to catheter, pall to the palm,	Dangle et al. (16)	Female	After pyeloplasty	SPC	Left	Pain, oliguria	14	Pyelonephritis	SS
(a)         Remale         BIG         Left         Palin, oliguria         60         Pyclonophitis           (a)         Male         NB         SIG         Left         Palin, oliguria         Few hours         UR           (c)         Female         NB         BG         Left         Palin, hematuria         1 d         AR           (c)         Female         NB         BG         Left         Pemale         1 d         AR           (c)         Female         NB         BG         Left         Pemale         Pyclonophitis           (c)         Female         NB         BG         Left         Palin, mable to deflate the balloon         During ceasers           (c)         Female         Duplex ureter         Right         Palin, mable to remove the catheter         Sime day         NG           (c)         Female         Ectopic ureter         BG         Left         Palin, mable to remove the catheter         Sime day         NG           (c)         Female         Duport ureter         BG         Left         Palin, mable to remove the catheter         Sime day         NG           (c)         Female         Retopic ureter         BG         Left         Hemale uretarin, mable to remove t	Papacharalabous et al. (17)	Female	<b>During laparotomy</b>	BIC	Left		Intraoperative	UR	SR
Hander   H	Hale et al. (18)	Female		BIC	Left	Pain		UR	SR
enulud (2)         Female         NB         BIC         Left         Plani, haematuria         Tew hours         UR         AB           enlund (2)         Man         NB         BIC         Left         Pani, haematuria         1 d         AB           (2)         Female         NB         BIC         Left         Teages around the catheter; pain         2 d         NC           (2)         Female         NB         BIC         Left         Pewer         3 d         Pyclonephritus           (2)         Female         Duplex ureter         BIC         Right         Pain, unable to deflate the balloon         During cesaren         NC           (2)         Female         Duplex ureter         BIC         Right         Pain, unable to remove the catheter         Same day         NC           (3)         Female         Frozoic ureter         BIC         Right         Pain, unable to remove the catheter         Same day         NC           (3)         Female         Frozoic ureter         BIC         Right         Pain, unable to remove the catheter         Same day         NC           (3)         Female         Post reductivities         BIC         Right         Haematuria, pain, evert, incontinence         1         P	Adeyemo et al. (19)	Male	NB	SPC	Right	Pain, oliguria	09	Pyelonephritis	CC
cnlund(21)         Fmale         NB         BIC         Right         Pain, haematuria         1 d         AR           culturd(21)         Am         NB         BC         Left         Leakage around the catheter, pain         2 d         NC           1)         Female         NB         BC         Left         Leakage around the catheter, pain         2 d         NC           3)         Male         NB         BC         Left         Rever         3 d         Pyclonephritis           3)         Female         NB         BC         Right         Pain, unable to remove the catheter         3 d         Pyclonephritis           4)         Female         Duplic untert         BC         Right         Pain, unable to remove the catheter         Same day         NC           Ala         NB         BC         Right         Pain, unable to remove the catheter         Same day         NC           Alae         NB         BC         Right         Pain, unable to remove the catheter         Same day         NC           Alae         NB         BC         Right         Haematuria, pain, unable to remove the catheter         During tesser         NC           Ande         NB         Right         Haematuria, pain,	Baker et al. (20)	Female	NB	BIC	Left	Oliguria	Few hours	UR	PCN
cnlund (21)         Man         NB         BIC         Left         Pain, haematuria         1 d         NC           5)         Fenale         NB         BC         Left         Leakge around the catheter, pain         2 d         NC           5)         Male         NB         BC         Left         Pain, unable to deflact the balloon         During cesarean         NG           23)         Female         Duplex ureter         BC         Right         Pain, unable to deflact the balloon         During cesarean         NC           3)         Interstrial cistits         BC         Right         Pain, unable to deflact the balloon         During cesarean         NC           Alae         Interstrial cistits         BC         Left         Pain, unable to cesarean section         NC         NC           Alae         NB         BC         Left         Pain, unable to cesarean section         NC         NC           Alae         NB         BC         Left         Pain, unable to cesarean section         NC         NC           Alae         NB         BC         Left         Haematuria, pain, fever, pain         NC         NC           Alae         Urethral stricture         SC         Right         Haematuria, pai	Anderson and Greenlund (21)	Female	NB	BIC	Right	Pain, haematuria	1 d	AR	CC
(2)         Female         NB         BIC         Left         Leakage around the catheter, pain         2 d         NC           (3)         Male         NB         BIC         Left         Rever         3 d         Pyclonephritis           (3)         Female         NB         BIC         Right         Pain, unable to deflate the balloon         During cesarean         NR           (3)         Female         NB         BIC         Right         Pain, unable to remove the catheter         Same day         NR           (3)         Female         Ectopic urrieter         BIC         Right         Pain, unable to remove the catheter         Same day         NC           (4)         NB         BIC         Right         Pain, unable to remove the catheter         Same day         NC           (5)         Left         Pight         Pain, unable to remove the catheter         Same day         NC           (6)         Male         Nephrolithiasis         BIC         Left         Haematuria, pain, fever, incontinence         12         NC           (30)         Female         Urethral stricture         SrC         Left         Haematuria, pain, fever, incontinence         13         NC           (30)         Female	Anderson and Greenlund (21)	Man	NB	BIC	Left	Pain, haematuria	1.d	NC	CC
(23)         Remale         NB         Etcf         Left         Pewer         13 d         Pyelonephritis           (23)         Female         NB         BIG         Left         Pain, unable to deflate the balloon         Duting cesarean         NG           (23)         Female         NB         Right         Pain, unable to remove the catheter         Same day         NG           (3)         Female         Interstitial cistitis         BIG         Right         Pain, unable to remove the catheter         Same day         NG           (4)         Nale         NB         Right         Pain, unable to remove the catheter         Same day         NG           (5)         Remale         Oxtradiotherapy         BIG         Left         Haematuria, pain, fever, incontinence         12         NG           (30)         Female         Urethral stricture         SPG         Right         Haematuria, pain, fever, incontinence         13         NG           (30)         Female         Urethral stricture         SPG         Right         Haematuria, pain, inable to deflate the balloon         14         NG           (30)         Female         Nephrolithiasis         BIG         Left         Haematuria, pain, inable to deflate the balloon         14	Ishikawa et al. (22)	Female	NB	BIC	Left	Leakage around the catheter, pain	2 d	NC	CC
(23)         Male         NB         BIC         Right         Pani, unable to deflate the balloon         During cesarean         Pyclonephritis           (23)         Female         Duplex ureter         BIC         Right         Pani, unable to remove the catheter         During cesarean         NC           (1)         Female         Interstitial cistitis         BIC         Right         Pani, unable to remove the catheter         Same day         NC           (1)         Remale         Ectopic ureter         BIC         Right         Pevert Pain         2d         Pyclonephritis           (24)         NB         BIC         Right         Haematuria, pain, fever, frontinence         12         Pyclonephritis           (25)         Male         NB         BIC         Right         Haematuria, pain, fever, incontinence         12         Pyclonephritis           (26)         Left         Haematuria, pain, mable to deflate the balloon         1 d         NC           (304)         Female         NB         Right         Haematuria, pain, unable to remove the catheter         Inmediate         NC           (305)         Female         NB         Right         Nguerrania         10         NC           (307)         Right         Nguerran	Ishikawa et al. (22)	Female	NB	BIC	Left	Fever	18 d	Pyelonephritis	SS
(23)         Female         Duplex ureter         RIC         Right         Pain, unable to deflate the balloon         During cesarean         NC           s)         Female         Interstitial distitis         BIC         Right         Pain, unable to remove the cather         Same day         NC           s)         Female         Ectopic uréter         BIC         Left         Oliguria post-cesarean section         2d         Pyclonephritis           s male         Post radiotherapy         BIC         Right         Hewer, Pain         2d         Pyclonephritis           s male         Post radiotherapy         BIC         Left         Heamaturia, pain, fever, incontinence         12         Pyclonephritis           s male         Urethral stricture         SPC         Left         Heamaturia, pain, fever, incontinence         12         Pyclonephritis           30         Male         Urethral stricture         SPC         Left         Heamaturia, pain, fever, incontinence         12         Pyclonephritis           30         Male         Urethral stricture         SPC         Right         Heamaturia, pain, fever, incontinence         12         Pyclonephritis           30         Male         Nephrolithiasis         BIC         Left         Heamaturia, pain, fever	Ishikawa et al. (22)	Male	NB	BIC	Left	Fever	3 d	Pyelonephritis	CC
(b)         Right         Right         Pain, unable to remove the catheter         Same day         UR           (c)         Right         Pain, unable to remove the catheter         Same day         NC           (c)         Left         Oliguria post-cesarean section         2d         Pyelonephritis           (c)         Male         Right         Revert, Pain         2d         Pyelonephritis           (c)         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           (c)         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           (d)         Victorial stricture         SPC         Left         Haematuria, pain, inable to deflate the balloon         14         NC           (d)         Na         Right         Haematuria, pain, unable to remove the catheter         Immediate         NC           (d)         No antecedents         BC         Left         Haematuria, pain, unable to remove the catheter         Immediate         NC           (d)         No antecedents         BC         Left         Haematuria, pain, oliguria         10         NC           (d)         NB         SPC         Right         Haematuria, pain, oliguria         10         NC <th>Viswanatha et al. (23)</th> <th>Female</th> <th>Duplex ureter</th> <th>BIC</th> <th>Right</th> <th>Pain, unable to deflate the balloon</th> <th>During cesarean</th> <th>NC</th> <th>URS</th>	Viswanatha et al. (23)	Female	Duplex ureter	BIC	Right	Pain, unable to deflate the balloon	During cesarean	NC	URS
()         Female         Interstitial cistitis         Right         Pain, unable to remove the catheter         Same day         NC           Remale         Destrict current         BIC         Left         Oliguria post-cesarean section         2 d         Pyelonephritis           Female         Post radiotherapy         BIC         Right         Haematuria, pain, fever, incontinence         12         Pyelonephritis           Male         Urethral stricture         SPC         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           Shale         Urethral stricture         SPC         Right         Haematuria, pain, unable to defiate the balloon         1 d         NC           Shownight         NB         Right         Haematuria, pain, unable to remove the catheter         Immediate         NC           Adevani(3)         Male         NB         Right         Night         Nanceadant         NC           Advani(3)         Male         NB         Right         Pain, haematuria         1         NC           Advani(3)         Male         NB         Right         Pain, haematuria, oliguria         1         Pyelonephritis           Advani(4)         Male         Post radiotherapy         Right         Pain, haematu	Modi et al. (24)	Female	NB	BIC	Right			UR	PCN (DJ failed)
Male         Ectopic urefer         BIC         Right         Pewer, Pain         2 d         Pyelonephritis           Female         Nost radiotherapy         BIC         Right         Maematuria, pain, fever, incontinence         L2         Pyelonephritis           Male         Urethral stricture         SPC         Left         Haematuria, pain, innable to deflate the balloon         1 d         Pyelonephritis           30         Female         Northral stricture         SPC         Right         Haematuria, pain, unable to deflate the balloon         1 d         N/C           30         Female         Nophrolithiasis         BIC         Left         Haematuria, pain, unable to deflate the balloon         1 d         N/C           30         Female         No antecedents         BIC         Right         Haematuria, pain, unable to remove the carbeter         Immediate         N/C           30         Male         No antecedents         BIC         Right         Pain, haematuria         10         N/C           12         Male         N/B         Right         Pain, haematuria, oliguria         1         Pyelonephritis           12         Male         Post radiotherapy         BIC         Left         Pain, haematuria, oliguria         1         Pyelonephriti	Crawford et al. (25)	Female	Interstitial cistitis	BIC	Right	Pain, unable to remove the catheter	Same day	NC	PTCB, DJ
Male         NB         Right         Fewer, Pain         2 d         Pyelonephritis           Female         Post radiotherapy         BIC         Left         Haematuria, pain, fever, incontinence         12         NC           Male         Urethral stricture         SPC         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           Alale         Urethral stricture         SPC         Left         Haematuria, pain, unable to deflate the balloon         1 d         NC           Adevani(31)         Male         Nephrolithiasis         BIC         Left         Alae         NC         NC           Adevani(31)         Male         No antecedents         BIC         Left         Nausea, pain, oliguria         NG         NC           Adevani(31)         Male         NB         SPC         Left         Nausea, pain, oliguria         NG         NC           Adevani(31)         Male         Urethral stricture         SPC         Right         Pain, haematuria         10         NC           Adevani(31)         Male         Urethral stricture         SPC         Left         Pain, haematuria         10         NC           Adevani(32)         Male         Urethral stricture         SPC <th>Yune et al. (26)</th> <th>Female</th> <th>Ectopic uréter</th> <th>BIC</th> <th>Left</th> <th>Oliguria post-cesarean section</th> <th></th> <th></th> <th></th>	Yune et al. (26)	Female	Ectopic uréter	BIC	Left	Oliguria post-cesarean section			
Female         Post radiotherapy         BIG         Right         NG           Female         UR, psychiatric drugs         BIG         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           Male         Urethral stricture         SPC         Left         Haematuria, pain, unable to deflate the balloon         1 d         NG           30)         Female         Nephrolithiasis         BIG         Left         Haematuria, pain, unable to remove the catheter         Immediate         NG           30)         Male         No antecedents         BIG         Right         Oliguria, unable to remove the catheter         Immediate         NG           4vdevani (3)         Male         NB         SPC         Left         Nausea, pain, oliguria         10         NG           2)         Male         NB         SPC         Right         Pain, haematuria         1         Pyelonephritis           3)         Male         Orethral stricture         SPC         Left         Pain, nausea, haematuria, oliguria         1         Pyelonephritis	Luo et al. (27)	Male	NB	BIC	Right	Fever, Pain	2 d	Pyelonephritis	S
Female         UR, psychiatric drugs         BIC         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           Male         Urethral stricture         SPC         Right         Haematuria, pain, unable to deflate the balloon         1 d         NC           30)         Female         Nephrolithiasis         BIC         Left         Haematuria, pain, unable to deflate the balloon         1 d         NC           30)         Female         No antecedents         BIC         Right         Oliguria, unable to remove the catheter         Immediate         NC           vdevani (31)         Male         NB         SPC         Left         Nausea, pain, oliguria         10         NC           13)         Male         NB         SPC         Right         Pain, haematuria         10         NC           13)         Male         Urethral stricture         SPC         Left         Pain, nausea, nauria         1         Pyelonephritis           Remale         Post radiothera py         BIC         Left         Pain, nausea, nauria         1         Pyelonephritis	Luo et al. (27)	Female	Post radiotherapy	BIC	Right			NC	CC
Male         NB         SPC         Left         Haematuria, pain, fever, incontinence         12         Pyelonephritis           30)         Female         Urethral stricture         SPC         Right         Haematuria, pain, unable to deflate the balloon         1 d         NC           30)         Female         Nephrolithiasis         BIC         Left         Haematuria, pain, unable to remove the catheter         Immediate         NC           Adevani(3)         Male         NB         SPC         Left         Nausea, pain, oliguria         10         NC           23         Male         NB         SPC         Right         Pain, haematuria         2         NC           33         Male         Urethral stricture         SPC         Left         Pain, fever, anutia         1         Pyelonephritis           45         Post radiotherapy         BIC         Left         Pain, nausea, haematuria, oliguria         1         Pyelonephritis	Luo et al. (27)	Female	UR, psychiatric drugs	BIC	Left			NC	S
Aale         Urethral stricture         SPC         Right         Haematuria, pain, unable to deflate the balloon         1d         NC           (30)         Female         Nephrolithiasis         BIC         Left         Haematuria, pain, unable to remove the catheter         During URS         NC           vdevani(31)         Male         No antecedents         SPC         Left         Nausea, pain, oliguria         Immediate         NC           12)         Male         NB         SPC         Right         Pain, haematuria         2         NC           Male         Urethral stricture         SPC         Left         Pain, fever, anutria         1         Pyelonephritis           Female         Post radiotherapy         BIC         Left         Pain, nausea, haematuria, oliguria         1d         Lower UTI	Agarwal et al. (28)	Male	NB	SPC	Left	Haematuria, pain, fever, incontinence	12	Pyelonephritis	CC
Female         NB         BIC         Left         Haematuria, pain, unable to deflate the balloon         1d         NC           Female         Nephrolithiasis         BIC         Left         Oliguria, unable to remove the catheter         Immediate         NC           vani(31)         Male         NB         SPC         Left         Nausea, pain, oliguria         10         NC           Male         NB         SPC         Right         Pain, haematuria         2         NC           Male         Urethral stricture         SPC         Left         Pain, fever, anuria         1         Pyelonephritis           Female         Post radiotherapy         BIC         Left         Pain, nausea, haematuria, oliguria         1d         Lower UTI	Persaud et al. (29)	Male	Urethral stricture	SPC	Right	Flank pain	30	NC	R
Female         Nephrolithiasis         BIC         Left         Oliguria, unable to remove the catheter         During URS         NC           vani (31)         Male         No antecedents         BIC         Right         Oliguria, unable to remove the catheter         Immediate         NC           Male         NB         SPC         Left         Pain, hematuria         2         NC           Male         Urethral stricture         SPC         Left         Pain, fever, anunia         1         Pyelonephritis           Female         Post radiotherapy         BIC         Left         Pain, nausea, haematuria, oliguria         1 d         Lower UTI	Agarwal et al. (28)	Female	NB	BIC		faematuria, pain, unable to deflate the balloon	1 d	NC	PPCB
Male         No antecedents         Right         Oliguria, unable to remove the catheter         Immediate         NC           Male         NB         SPC         Left         Nausea, pain, oliguria         10         NC           Male         NB         SPC         Right         Pain, haematuria         2         NC           Male         Urethral stricture         SPC         Left         Pain, fever, anuria         1         Pyelonephitis           Female         Post radiotherapy         BIC         Left         Pain, nausea, haematuria, oliguria         1 d         Lower UTI	Locherbach et al. (30)	Female	Nephrolithiasis	BIC	Left		During URS	NC	CR
Male     NB     SPC     Left     Nausea, pain, oliguria     10     NC       Male     NB     SPC     Right     Pain, haematuria     2     NC       Male     Urethral stricture     SPC     Left     Pain, fever, anuria     1     Pyelonephritis       Female     Post radiotherapy     BIC     Left     Pain, nausea, haematuria, oliguria     1 d     Lower UTI	Cho et al. (6)	Male	No antecedents	BIC	Right	Oliguria, unable to remove the catheter	Immediate	NC	CC
g(32)     Male     NB     SPC     Right     Pain, haematuria     2     NC       Male     Urethral stricture     SPC     Left     Pain, fever, anuria     1     Pyelonephritis       Female     Post radiotherapy     BIC     Left     Pain, nausea, haematuria, oliguria     1 d     Lower UTI	Mekayten and Duvdevani (31)	Male	NB	SPC	Left	Nausea, pain, oliguria	10	NC	CC
Male     Urethral stricture     SPC     Left     Pain, fever, anuria     1     Pyelonephritis       Female     Post radiotherapy     BIC     Left     Pain, nausea, haematuria, oliguria     1 d     Lower UTI	Saad and Zhong (32)	Male	NB	SPC	Right	Pain, haematuria	2	NC	CR
Female Post radiotherapy BIC Left Pain, nausea, haematuria, oliguria 1 d Lower UTI	VC et al. (2022)	Male	Urethral stricture	SPC	Left	Pain, fever, anuria	п	Pyelonephritis	S
	VC et al. (2022)	Female	Post radiotherapy	BIC	Left	Pain, nausea, haematuria, oliguria	14	Lower UTI	CC

Abbreviations: NB, neurogenic bladder; SIn, severe incontinence; VUR, vesico-ureteral reflux; BIC, bladder indwelling catheter; SPC, suprapubic catheter; VUR, vesico-ureteral reflux; NC, no consequence; UR, ureteric rupture; AR, autonomic response; UTI, urinary tract infection; CC, catheter changement; SR, surgical repair; DJ stent; double j stent; PCN, percutaneous nephrostomy; URS, ureteroscopy; PTCB, punction through the catheter balloon; CR, catheter repositioning; PPCB, percutaneous puncture of the catheter balloon.