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Case Series

Submucosal guidewire passage during percutaneous nephrolithotomy creating an iatrogenic false urothelial tunnel

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ABSTRACT

Tract dilation in percutaneous nephrolithotomy (PCNL) must follow a guidewire lying in the true pelvicalyceal lumen. Submucosal (false-passage) wire migration is an under-recognised access complication that may be mistaken for satisfactory placement and its management is not standardised. We describe five patients treated between 2020 and 2026 in whom the guidewire tracked beneath the urothelium during PCNL for large pelvic, multicalyceal or staghorn stones. The submucosal wire arose at a middle-calyx puncture in three patients and at a lower-pole puncture in two. Nephroscopic and fluoroscopic findings, intraoperative decisions and outcomes are presented. In two patients a new puncture at a different calyx in the same sitting achieved stone clearance. In three patients the false tract was abandoned and clearance was staged: retrograde intrarenal surgery (RIRS) in two sittings (n=2) or repeat PCNL after two weeks (n=1). Bleeding forced abandonment in one patient. In the patient with nephroscopic confirmation, the false tract was not dilated. Submucosal guidewire passage is recognisable and manageable if dilation is withheld until true-lumen position is confirmed. Re-puncture at a different calyx or abandonment with staged RIRS or repeat PCNL allowed all five patients to proceed to definitive stone treatment.

Keywords: Percutaneous nephrolithotomy, Submucosal guidewire, Staghorn stones, Renal calculi, PCNL complication

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the first-line treatment for renal calculi larger than 2 cm and for staghorn stone burdens, offering high stone-free rates through a tract established over a guidewire.[1] Safe dilation depends on that wire lying within the true pelvicalyceal lumen.[2] Various complications of PCNL are well characterised and are graded with the modified Clavien system.[3]

Guidewire-related mishaps reported during PCNL include knotting, fracture or retention of a wire fragment, looping or entrapment and stripping of guidewire. Submucosal (false-passage) migration is a distinct variant in which the tip dissects a plane beneath the urothelium instead of advancing in the open collecting system.

Endoscopic wire-relocation work has shown that a wire assumed on fluoroscopy to be coiled within a calyx may in fact have perforated the mucosa and that dilation over it would have been hazardous.[4]

Dilating a tract over a submucosal wire risks extensive urothelial tearing, haemorrhage and potentially delayed stricture.

CASE SERIES

Five patients: four men and one woman, aged in the 40s (n=2), 60s (n=2) and 70s (n=1). Procedures took place in 2020 (n=2), 2022 (n=1), 2025 (n=1) and 2026 (case 1). Laterality was left in three and right in two. All patients had a large or complex stone burden, renal pelvic stones of 17 to 41 mm (largest dimension) in four patients, one of them a staghorn calculus and multicalyceal stones in the fifth. Two had an additional lower-pole stone (13 mm and 18 mm).

The submucosal wire arose at a middle-calyx puncture in three patients (case 1, 3 and 4) and a lower-pole puncture in two (case 2 and 5). Two patients (case 2 and 5) had a new puncture at a different calyx (middle and upper) in the same sitting with stone clearance. Three patients had the tract abandoned: staged RIRS in two sittings (case 1 and 4) or repeat PCNL after two weeks (case 3). In case 4 the separate lower-pole stone was cleared in the same sitting through a fresh lower-pole puncture. The interval to staged clearance was two weeks (case 3 and 4).

Bleeding necessitating abandonment occurred in case 3, and haemorrhagic mucosa was seen in case 1. No pleural injury was reported. All five patients proceeded to definitive stone treatment.

Table 1: Case 1.

Domain	Details
Patient	Man in his 40s; year 2026
Stone burden	Bilateral renal calculi. Left lower, middle and upper-pole calyceal stones . Right side managed with a double-J stent
Index access	Prone left PCNL; lower-pole puncture, standard dilation, lower-pole stone cleared. Middle and upper stones not reachable through this tract
Submucosal event	Second puncture, supra-11th rib, aimed at middle / upper stones
Recognition	Wire followed a fixed, rigid, wall-hugging course . Nephroscopy through the lower-pole tract showed blanched, haemorrhagic mucosa over the wire .
Action	Tract not dilated. Attempts to bring stones to the lower-pole tract failed. Further high supracostal puncture avoided (pleural risk). Procedure abandoned.

Table 2: Case 2.

Domain	Details
Patient	Woman in her 60s; 2020
Stone burden	4.1 × 2.5 cm left renal pelvic calculus and 1.3 × 1.0 cm lower-pole calculus
Index access	Lower-pole puncture
Submucosal event	Wire from the lower-pole puncture tracked submucosally
Action	New puncture at the middle-pole calyx
Definitive treatment	Stone cleared through the new tract in the same sitting

Table 3: Case 3.

Domain	Details
Patient	Man in his 40s; 2020
Stone burden	Right renal pelvic calculus, 16.6 × 17 mm
Index access	Middle-calyx puncture
Submucosal event	Wire tracked submucosally
Action	Procedure abandoned because of bleeding
Definitive treatment	PCNL completed two weeks later

Table 4: Case 4.

Domain	Details
Patient	Man in his 70s; 2022
Stone burden	Left staghorn calculus 34 × 28 mm (pelvis calculus extending to upper, middle and interpolar calyces) and 18 mm lower-pole calculus
Index access	Middle-pole puncture
Submucosal event	Wire tracked submucosally
Action	Lower-pole stone cleared in the same sitting through a separate lower-pole puncture
Definitive treatment	Staghorn stone cleared by RIRS in two sittings; 2 weeks from index procedure

Table 5: Case 5.

Domain	Details
Patient	Man in his 60s; 2025
Stone burden	Right renal pelvic calculus 3.6 × 2.9 cm extending into upper, middle and lower calyces
Index access	Lower-pole puncture
Submucosal event	Wire tracked submucosally
Action	New puncture at the upper-pole calyx
Definitive treatment	Stone cleared through the new tract in same sitting

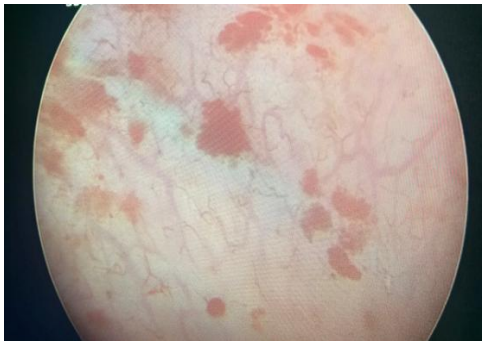


Figure 1: Nephroscopic view: patchy submucosal haemorrhage and blanched disrupted mucosa over the wire tract.

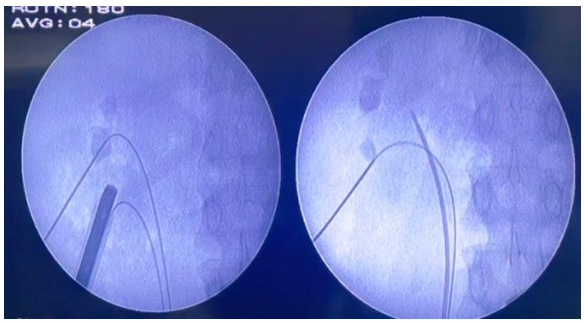


Figure 2: Fluoroscopy: the lower-pole access wire in the true lumen beside the second wire, which takes a fixed, rigid, wall-hugging course without a free loop.

Table 6: Comparative summary of the five cases.

Case	Age (years)/sex	Year	Side	Stone burden	Failed puncture	Action at index sitting	Definitive treatment
1	40/M	2026	L	Lower, middle, upper calyceal stones; sizes	2nd puncture, supra-11th rib, middle pole	Tract not dilated; lower-pole stone cleared; concluded	RIRS × 2
2	60/F	2020	L	Pelvis 4.1 × 2.5 cm; lower pole 1.3 × 1.0 cm	Lower pole	New puncture, middle-pole calyx	Cleared via new tract
3	40/M	2020	R	Pelvis 16.6 × 17 mm	Middle calyx	Abandoned	Repeat PCNL at 2 weeks
4	70/M	2022	L	Staghorn 34 × 28 mm; lower pole 18 mm	Middle pole	Lower-pole stone cleared via lower-pole puncture	Staghorn by RIRS × 2 (15 days)
5	60/M	2025	R	Pelvis 3.6 × 2.9 cm into upper, middle, lower calyces	Lower pole	New puncture, upper-pole calyx	Cleared via new tract

DISCUSSION

Published guidewire complications in PCNL are dominated by knotting, fracture or retention and ureteral looping or entrapment.[5] The most among all is stripping of the wire. Knotting and looping typically occur in a tortuous, oedematous or previously obstructed ureter and present as resistance to withdrawal of the wire or endoscope. Patil et al described several knot configurations encountered during PCNL and emphasised that gentle fluoroscopically confirmed manipulation prevented ureteral injury.[6] Fracture and retention are usually delayed or incidental findings. Oh et al followed a retained 0.018 inch guidewire fragment conservatively for five years without sequelae.[7] While Xiong et al reviewed seven previously reported cases of a ruptured intrarenal guidewire and noted that retained foreign bodies can act as a nidus for stone formation if left in place.[8] None of these

reports describes failure of the wire to enter the lumen at the time of puncture, which is the defining feature of submucosal passage. A further, mechanistically unrelated variant is direct venous false tracting. Mahmood and Toffeq reported a case in which the nephroscope tracked into the renal vein and inferior vena cava and required tamponade with the Amplatz sheath to control torrential bleeding.[9] Submucosal urothelial passage, as in our five patients, is considerably less dangerous than this vascular variant.

Submucosal passage is best understood as failure of the wire tip to enter or remain within the open lumen after an adequate puncture. The tip may catch on a mucosal fold or oedematous, inflamed urothelium and dissect a submucosal plane. Because the tract can resemble satisfactory placement on one fluoroscopic frame, recognition depends on integrating several clues, of which direct endoscopic confirmation is the most reliable.

The closest available proxy regarding incidence of submucosal guidewire passage is the experience of Javali et al who found that the guidewire failed to advance from the punctured calyx into the pelvis and ureter in 85 of 675 PCNLs (12.6%), and devised a technique of passing a percutaneously introduced ureteroscope alongside the wire to relocate it under direct vision, succeeding in 82 of the 85 cases (96.5%).[4]

Patient and technical factors that plausibly contribute are multiple or sequential punctures in one sitting, supracostal access with a steep tangential trajectory, stone-distorted infundibulo-pelvic anatomy, inflamed or friable urothelium, a stiff or hydrophilic-tipped wire advanced under fluoroscopy alone and reliance on a single projection. All our patients had large pelvic or multicalyceal burdens. Pelvic stones are conventionally approached through an upper or middle calyx because the lower-pole route is technically unfriendly, owing to its anterior tilt.[10]

Binbay et al analysed pelvicalyceal anatomy in a large PCNL cohort and found that the infundibulopelvic angle and infundibular length and width independently predict stone-free outcome.[11] It is plausible that the same anatomical distortion produced by a large pelvic or staghorn stone that complicates stone clearance also narrows the margin for wire error during puncture.

The guiding principle is to stop compounding the injury and re-establish true-lumen access before any dilation. Steps are: halt pushing and dilating force; withdraw the wire into the open pelvis under fluoroscopy, attempt re-entry with an angled hydrophilic wire and open-ended catheter while re-distending the system, use direct vision through an established tract or a percutaneously introduced ureteroscope where available, exchange for a safety wire only after true-lumen access is confirmed by pyelography or direct vision, otherwise abandon the tract rather than force it. This principle has direct published precedent: Javali et al used a percutaneously placed ureteroscope threaded alongside the errant wire to visualise and redirect it before dilation and Aghamir et al described a comparable direct vision plus fluoroscopy strategy to relocate a lost percutaneous tract during second look nephroscopy when a guidewire could not be passed through an existing nephrostomy.[4,12] Our case 1 applied the same logic in reverse using nephroscopy through an already dilated lower-pole tract to diagnose the submucosal course of a second wire.

The choice between re-puncture and staging depends on visibility, bleeding, the number of tracts already made and the risk of the alternative site. In cases 2 and 5 a fresh puncture at another calyx succeeded. Staging was chosen in case 1 where an infracostal alternative was unavailable and a further high supracostal puncture carried an elevated risk of pleural transgression and hydrothorax in case 3 where bleeding compromised the procedure and in case 4 for the staghorn component.[13,14] Staged RIRS clears residual stone without another percutaneous tract and combined or staged endoscopic strategies can reduce the number of tracts in complex burdens.[15] Unlike the venous false tract reported by Mahmood and Toffeq where ongoing haemorrhage forced an immediate decision, submucosal urothelial passage in our series was self-limited once further pushing stopped which is what allowed elective staging in three of five patients rather than emergency intervention.[9]

Clinical significance and surgical learning include the following: Plan access to reach as much stone as possible through one well-triangulated puncture limiting sequential access in a decompressed system. Before a second puncture, re-distend the collecting system (saline or dilute contrast via the tract or a ureteric catheter). Confirm free intraluminal looping in more than one projection, ideally endoscopically through an existing tract, before any dilator advances, using a percutaneously introduced ureteroscope where available.[4] Favour infracostal over supracostal access when stone distribution allows.[13] In complex anatomically distorted pelvicalyceal systems consider planned combined (ECIRS) or staged RIRS strategies.[15] Stop and reassess rather than push through resistance.

CONCLUSION

Submucosal guidewire passage is an under-recognised access complication of PCNL that can mimic satisfactory tract placement. Vigilant integration of tactile, fluoroscopic and endoscopic clues allows early recognition and a disciplined stepwise response halting dilation, re-routing with an angled wire, using retrograde assistance where available and abandoning the tract when true-lumen access cannot be safely secured minimises morbidity. Withholding dilation until true-lumen position is confirmed and then choosing between re-puncture at a different calyx and abandonment with staged RIRS or repeat PCNL to proceed to definitive stone treatment.

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