Urology Case Reports 55 (2024) 102771

Contents lists available at ScienceDirect

Urology Case Reports

journal homepage: www.elsevier.com/locate/eucr

Endourology

Erosion of embolization coil into the renal collecting system: Retrograde fragmentation of stone and coil via thulium laser lithotripsy

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ARTICLE INFO

Keywords:
Kidney stone
Percutaneous nephrolithotomy
Thulium laser
Pseudoaneurysm
Embolization
Coil erosion

ABSTRACT

A 50-year-old female developed kidney stones on an eroded embolization coil 16 months after percutaneous nephrolithotomy (PCNL) related bleeding complications. Retrograde ureteroscopy and thulium laser lithotripsy was performed to fragment the exposed portion of the coil into clinically insignificant pieces. Thulium laser coil fragmentation remains a potential strategy to remove eroded coils and their associated kidney stones; however, recurrent stone formation on the coil stump may necessitate repeat intervention if this conservative approach is pursued over radical antegrade coil removal. This case highlights the importance of continued surveillance and multidisciplinary management in preventing and treating coil erosion after PCNL.

1. Introduction

Percutaneous nephrolithotomy (PCNL) is considered one of the safest and most effective therapies for large renal stones (>2cm), staghorn calculi, symptomatic calyceal diverticular stones, and upper tract calculi.[1] Despite generally favorable outcomes, PCNL complications occur with an estimated incidence ranging from 10 % to 20 %.[2,3] Specifically, bleeding complications such as pseudoaneurysm formation and arteriovenous fistulas have been reported to occur with an estimated incidence of 0.6 %–1 %.[4] While venous bleeding typically warrants conservative management, arterial hemorrhage occasionally necessitates transarterial embolization with success rates as high as 90 %.[2] Despite the generally accepted safety profile of embolization coil use, rare instances of coil erosion and subsequent migration into the renal collecting system have been reported, with clinical manifestations emerging anywhere from the acute postoperative period to more than 15 years following the procedure.[4,5] Standardized guidelines for managing coil erosion are lacking, with reports detailing various innovative approaches to clinical management.[6] Given the low rates of coil erosion and the absence of standardized treatment pathways, we present a case outlining a novel approach to treating embolization coil erosion with recurrent stone formation after PCNL via retrograde thulium laser coil fragmentation.

2. Case presentation

A 50-year-old female patient with a history of COPD presented to the Emergency Department (ED) with symptoms of left renal colic and was diagnosed with a 6 mm left ureteral stone and a 15 mm left renal pelvis stone on computed tomography (CT) (Fig. 1). Urgent left ureteral stent placement was performed, followed by an uneventful delayed left percutaneous nephrolithotomy (PCNL) with one access site the following month. On postoperative day (POD) one, she was discharged with a stent, but returned later to the ED later that evening with hematuria, clot retention, and acute blood loss anemia. After an initial attempt at conservative management, further diagnostic evaluation with CT angiography revealed an active arterial bleed arising from the PCNL access site. Interventional radiology performed selective coil embolization of the pseudoaneurysm on POD five using Nester Microcoils (x 9) and Tornado Microcoils (x 2) (Fig. 2), resulting in prompt resolution of bleeding (Fig. 2).

Initial office surveillance encounters with abdominal radiography (KUB) re-demonstrated previously known right-sided stone burden without left sided recurrence until one year and four months later, when a new 4mm stone was noted to appear in the left lower pole (Fig. 3). The right stones were treated with ureteroscopy (URS), but the left sided stone was surveyed. The following year (2 years after the initial PCNL

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https://doi.org/10.1016/j.eucr.2024.102771
Received 31 May 2024; Accepted 19 June 2024
Available online 20 June 2024

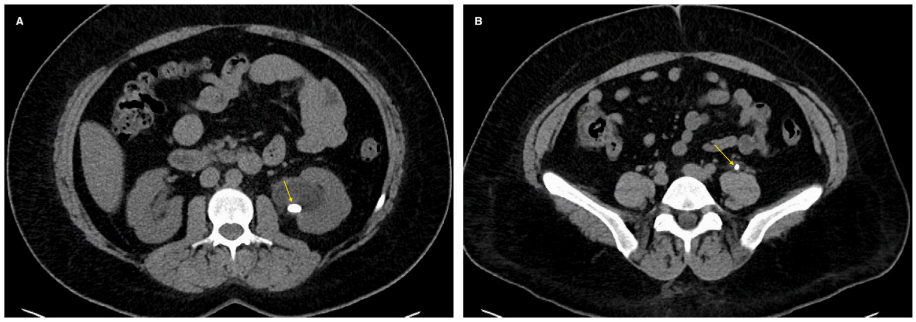

Fig. 1. Unenhanced CT abdomen/pelvis study demonstrating the pre-operative stone burden in the renal pelvis (A) and left ureter (B).

Fig. 2. CT angiography demonstrating a coronal view of the active arterial hemorrhage arising from the left lower pole PCNL site (A). Selective left renal arteriogram showing the pseudoaneurysm pre- (B) and post-embolization (C).

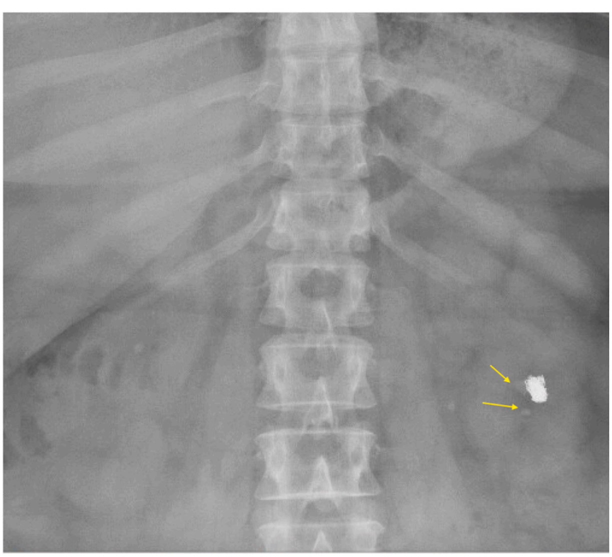

Fig. 3. KUB demonstrating signs of stone formation on the embolization coils one year and four months post-op.

and embolization) a CT and KUB revealed progression of bilateral stone burden.

Bilateral ureteroscopy was subsequently performed, uncovering the presence of an eroded left embolization coil with stones adhering to its surface. Both the coil and the stone were treated with retrograde ureteroscopy and laser lithotripsy until the coil was no longer extending into the collecting system (Fig. 4, **Video Clip 1**). A 200-μm thulium fiber laser fiber at laser settings of 0.2 J and a frequency of 120 Hz was used to dust the stone and fragment the coil, with modified settings of 0.8 J 20 Hz to fragment larger coil fragments into pieces less than the diameter of the laser fiber. The base of the coil remained at the urothelium surface and was left in-situ, rather than aggressively extracted to avoid bleeding recurrence from this site. Ureteral stents were placed at the conclusion of the procedure.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.eucr.2024.102771

Ureteral stents were removed 2-weeks postoperatively. Unfortunately, a subsequent ED encounter a week later revealed CT evidence of possible obstructing stone and coil fragments in the left ureter, necessitating an additional left URS. Semirigid ureteroscopy was negative for ureteral obstruction, but flexible ureteroscopy was performed to fragment any remaining embolization coil fragments in the collecting system.

Further office surveillance visits three months later showed no recurrence. However, KUB imaging in seven months noted possible recurrent stone formation vs retained coil fragments at the site of the embolization coil and in the left lower pole.

3. Discussion

We presented a complex endourologic case and a conservative approach to management after embolization coil erosion and migration into the urinary collecting system resulting in stone formation. We described a technique which attempted retrograde ureteroscopy and thulium laser lithotripsy to fragment both the coil and resulting stone into small, clinically insignificant pieces. The goal was to endoscopically remove the protruding coil from the collecting system lumen to prevent recurrent stone formation; however, complete removal of the coil from the underlying renal parenchyma could not be safely performed.

From a technical standpoint, embolization coil fragmentation was possible via thulium laser lithotripsy. The patient, however, required second-look ureteroscopy within two weeks due to renal colic, although there was no evidence of ureteral obstruction intraoperatively. It is worth noting the morbidity experienced by the patient after the initial

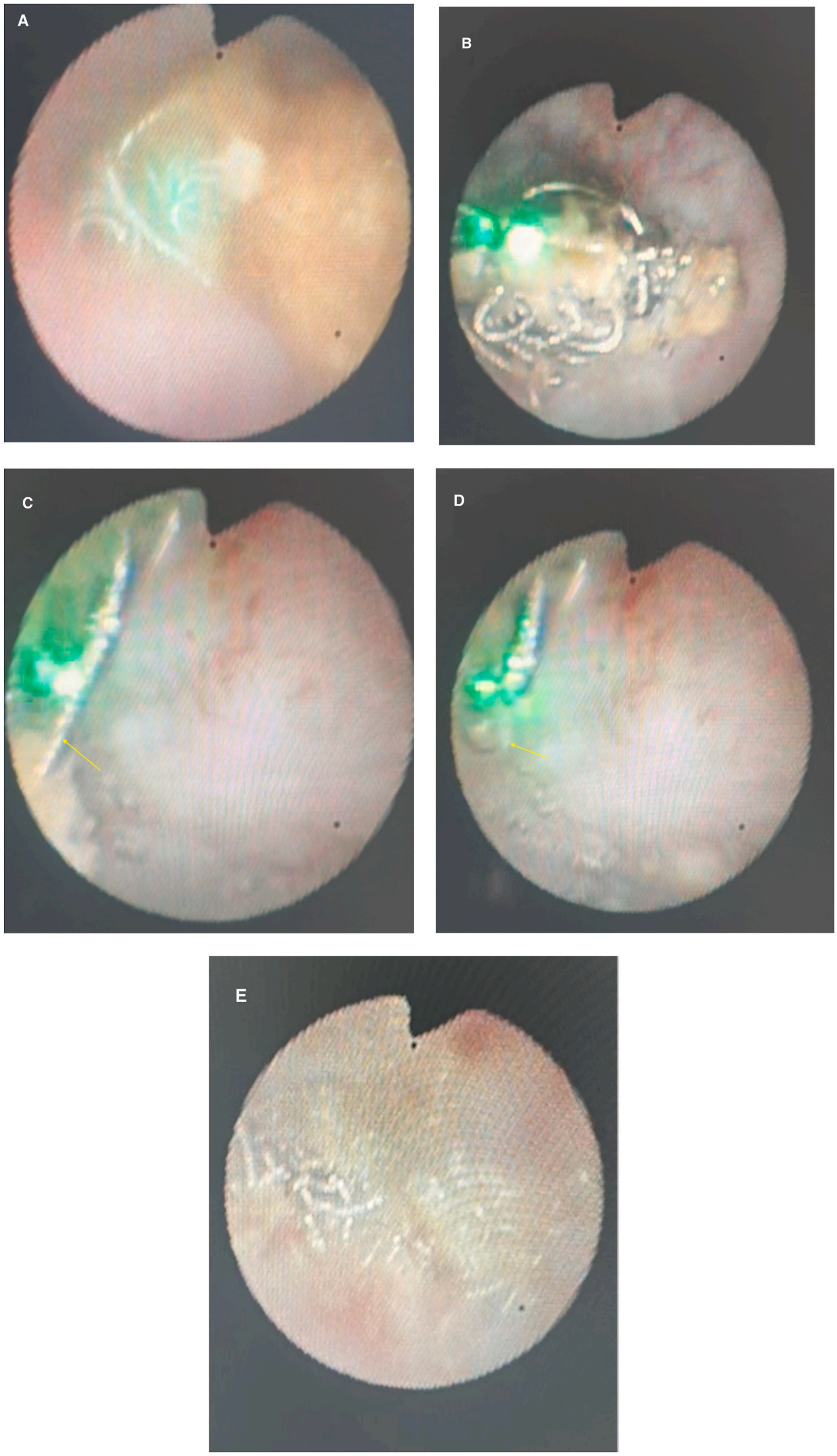

Fig. 4. Still images of the stone formed on the embolization coil (A), mid procedure (B), pre-coil fragmentation (C), post-coil fragmentation (D), and post-treatment (E).

fragmentation, with renal colic symptoms lasting several months post-intervention, as well as delayed radiographic evidence of recurrent stone formation roughly one year post-operatively. Consequently, it may be reasonable to expect complex course after conservative treatment to coil erosion and migration.

Although the mechanism of coil erosion is not currently well understood due to a sparsity of case reports in the literature, certain mechanisms have been proposed.[4] One possibility involves selection of an embolization coil that is unexpectedly smaller than the arterio-caliceal communication, leading to subsequent coil extrusion through the communication. Another possible mechanism of coil erosion is due to chronic irritation of the coil itself or inflammation from infection, leading to expansion of the arteriocaliceal communication. Lastly, a pseudoaneurysm could result in a weakened vascular wall and subsequent widening or rupture of a microscopic arteriocaliceal communication.[7] Coil composition can be considered and may play a role in erosion and migration, as well as stone formation, but ultimately the primary consideration by interventional radiologist is to provide adequate hemostasis in the setting of an uncontrolled arterial bleed, and coil embolization remains the standard of care. In the above case, the coils used were made of soft platinum for tight packing and are fully fibered for thrombogenicity.[8,9] Although limited research has been published, some literature suggests hydrogel-coated coils may be better suited for high-flow vessels with elevated coil migration risk due to their enhanced packing density compared to platinum coils.[10]

Given the low incidence of coil erosion after PCNL related arterial bleeding, definitive guidelines for the management of symptomatic coil erosion do not exist, therefore experience must be obtained through limited case reports and case series available. There are previous reports of outright surgical removal of the embolization coil, ultrasound fragmentation, as well as holmium laser lithotripsy.[6] Kumar et al. described a patient with multiple renal calculi following coil erosion treated with treated percutaneously with a pneumatic lithotripsy and stone/coil retrieval without postoperative complications.[2] Yeow et al. described a case with successful basket extraction of migrated coil fragments several years after embolization; however, substantial intraoperative bleeding was encountered when attempting basket removal on a second patient. This suggests that an increased timeline (i.e. years) between embolization and coil extraction does not guarantee vascular closure of the affected vessels, and outright coil extraction should be proceeded with caution given risk of intraoperative bleeding.[6] Interestingly, Srinivasa et al. detailed use of combined antegrade nephroscopy (urology) with prone *trans*-radial arteriography (Interventional Radiology) to facilitate safe coil removal in two patients.[11] One patient experienced substantial arterial bleeding following coil extraction but was successfully managed with glue embolization given the concurrent arterial access. A multidisciplinary approach with transarterial access should be considered when aggressive coil extraction is planned, to avoid bleeding complications. Our case is the first to describe a retrograde approach with thulium laser fragmentation, thus providing another option for less aggressive approaches to coil removal; however, stone recurrence is expected if any coil remains exposed. More studies are needed to determine the optimal approach.

4. Conclusion

This case outlines a complex clinical course following PCNL-related bleeding complications treated with coil embolization, ultimately resulting in the erosion of embolization coils into the collecting system and subsequent stone formation. Retrograde thulium laser treatment remains a potential strategy to address eroded coils and associated kidney stones. However, it is important to note the possibility of recurrent stone formation and the need for repeat interventions. This case highlights the importance of vigilant surveillance and multidisciplinary management approaches in preventing and addressing coil erosion after PCNL.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Informed consent

Obtained.

Declaration of AI in scientific writing

During the preparation of this work, the study authors used ChatGPT to spellcheck and optimize readability, language, and grammar. After using this tool, all authors reviewed and edited the content as needed and take full responsibility for the content of the publication. Artificial intelligence and AI-assisted technologies were not used to analyze or draw insights from data or data sources.

CRediT authorship contribution statement

Kyle J. Kopechek: Conceptualization, Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Matthew Satariano:** Conceptualization, Writing – original draft. **Mina S. Makary:** Conceptualization, Supervision, Writing – review & editing. **Michael Sourial:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

None.

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