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Renal Collecting System Injury During Percutaneous Nephrolithotomy, More Likely When Using Continuous Flow Sheaths?

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Abstract

Background: Renal collecting system injuries are a rare occurrence during percutaneous nephrolithotomy (PCNL). However, when they do happen, the potential for complications rises exponentially the longer the injury goes undetected. This case highlights a possible higher rate of injury when using continuous flow sheaths.
Case Presentation: A 65-year-old woman with history of large volume obstructing left-sided renal pelvis stone had an emergent ureteral stent placed for infection and was referred for interval management. Patient was taken for PCNL in the prone split-leg position where a continuous flow ureteral access sheath and a continuous flow nephrostomy sheath was used. Puncture and dilatation were performed under endoscopic guidance to avoid collecting system injury during access. The anesthesiologist discovered abnormalities in the patient's pulmonary ventilation settings. This allowed the surgical team to quickly halt the procedure and place the patient supine where a distended abdomen was discovered consistent with irrigation fluid extravasation into the abdominal cavity. Given concern for abdominal compartment syndrome, interventional radiology was then called to assist in placing a drain in the right lower quadrant of the patient to evacuate the irrigation fluid. This is the second such occurrence in a span of 6 months when using continuous flow ureteral access and nephrostomy sheaths.
Conclusion: Renal collecting systems injuries are infrequent when access is obtained under endoscopic guidance. Prompt recognition of physiologic breathing abnormalities allowed the surgical team to quickly treat the injury, preventing further complications from arising in the setting of a diagnosis where time to detection plays an important role in prognosis. However, given that this is the second such injury, the usage of continuous flow sheaths and their rate of associated complications and injuries must be thoroughly examined.

Keywords: continuous flow sheath, renal pelvis extravasation, PCNL, irrigation fluid

Introduction and Background

Percutaneous Nephrolithotomy (PCNL) has been widely adopted as the preferred treatment for large complicated nephrolithiasis since its introduction in 1976 by Fernstrom et al.[1] Patients burdened with stones >2 cm or those that do not respond to less invasive techniques are often good candidates for PCNL. With a myriad of tools having been developed to assist surgeons, including CT, fluoroscopy, and ultrasonography, severe complications (0.5%—Clavien–Dindo Grade 4–5) infrequently occur.[1] Despite injury to the renal collecting system being a rare complication during PCNL, especially when combined endoscopic guidance, complications such as abdominal compartment syndrome (ACS) can arise because of irrigation fluid extravasation.[2] When something as serious as ACS does occur, the time it takes for the signs to be noticed can be the difference between life and death.

This case represents the possibility that the usage of continuous flow sheaths increases the probability of renal collecting system injury leading to the potential for more complications to arise.

Presentation of Case

A 65-year-old woman with history of left 1.4 cm ureteropelvic junction (UPJ), additional 1 cm lower pole stones and severe hydronephrosis (Fig. 1) status poststent placement 6 weeks prior at an outside hospital was referred to our urology clinic for surgical management. Urine

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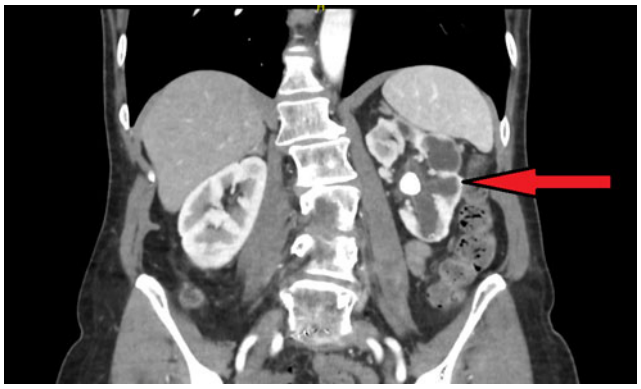

FIG. 1. Representative selection of CT abdomen and pelvic image showing location of UPJ stone along with thinned renal parenchyma and marked hydronephrosis (indicated by *red arrow*). UPJ, ureteropelvic junction.

culture and coronavirus disease 2019 nasal swabs were both found to be negative before surgery.

Once under general anesthesia, the patient was placed in a prone split-leg position, and flexible cystoscopy was performed. A hybrid wire was then placed alongside the existing ureteral stent and the cystoscope was reinserted and the stent was removed with a grasper with no resistance or difficulty under fluoroscopic guidance. A 12F Foley catheter was placed and a 14F ClearPetra ureteral access sheath (UAS) was then placed into the left proximal ureter with no difficulty. A ureteroscope was then used to observe the significantly impacted large stone at the UPJ. An air pyelogram was performed and the lower pole posterior calix was identified. Using fluoroscopic and endoscopic assistance, access was gained with a single puncture.

A through-and-through wire was established and the tract was dilated with a 24F Bard X-Force balloon. The balloon was removed and a 24F ClearPetra nephrostomy obturator and sheath were placed under vision just into the lower pole calix. The ClearPetra access sheath and nephrostomy sheath were not connected to suction throughout the entirety of the case. The collecting system was completely decompressed from the onset of nephroscopy, and this was initially thought to be secondary to outflow from the access sheath. A 1000 μm-holmium laser was used to ablate the stone with the renal pelvis under complete observation and with no visible injury to the renal pelvis from laser or endoscope trauma.

As stone fragments were carefully being extracted, the anesthesiologist noted an elevation in peak inspiratory pressure (PIP) of 31 cm H_2O from baseline 15 cm H_2O $\sim$ 90 minutes into the case. This caused an immediate halt to the procedure because of concern of intra-abdominal fluid accumulation. A 6 $\times$ 24 cm ureteral stent was advanced over a super-stiff wire with coils appropriately placed in the upper pole and bladder. Patient was turned back to supine position and the abdomen was notably distended. Interventional radiology was consulted and placed a drain in the right lower quadrant leading to immediate evacuation of 300 to 400 mL straw-colored fluid, consistent with irrigation fluid. Abdominal distention improved and PIP returned to a near baseline of 17 cm H_2O.

Chest kidney, ureter, and bladder radiograph performed intraoperatively revealed no obvious pneumothorax or hydrothorax. The patient was then taken to the postoperative care unit in stable condition.

There was 1.4 L of irrigation fluid evacuated with the drain and on postoperative day #3 the drain was removed after CT scan confirmed no renal collecting system extravasation and resolution of intra-abdominal fluid collection. The patient was discharged and the Foley catheter was removed 7 days postoperative.

Discussion and Literature Review

PCNL has routinely demonstrated its safety and efficacy when treating patients burdened with large stone volumes.[1] Although outcomes are usually favorable, similar to any procedure, PCNL does carry risk of complications. One such complication is a renal collecting system injury. Owing to the utilization of technique advancements such as endoscopic guidance, injuries are rare, but when they do occur, severe complications such as ACS may arise. As irrigation fluid and urine start to accumulate within the peritoneum, prompt surgical intervention becomes crucial.

In a similar case of a 65-year-old man undergoing PCNL for right-sided stone burden, the same ClearPetra continuous flow sheaths were used. In this case, the suction functionality was used on both the UAS as well as the nephrostomy sheath. Again, the patient suffered a renal collecting system injury leading to irrigation fluid extravasating into the peritoneal cavity. During this operation, anesthesia noticed no abnormal vitals until surgery had concluded and abdominal distention was noted. Unfortunately, this patient suffered from a postoperative stroke, likely because of his history of heart disease and hypertension. In the previous 400 endoscopic-guided PCNLs performed by the senior surgeon a collecting system injury has only occurred in the two cases in which the continuous flow irrigation sheaths were used.

The ClearPetra continuous flow sheaths allow for simultaneous negative pressure aspiration of both irrigation fluid and stone. One primary concern during endourologic procedures is that of intrarenal pressure (IRP) fluctuations. IRP changes, specifically increased IRPs, have been shown to be a negative predictor of various complications, including, but not limited to pyelorenal backflow, urosepsis, and fluid extravasation.[3] An investigation into IRP changes when performing vacuum-assisted mini-PCNL demonstrated that the greatest IRP was often recorded when vacuum aspiration was closed and during pyelograms, but otherwise, IRPs rarely surpassed a threshold peak.[4] Given that collecting system injuries were encountered in a case while using suction and also in a case without suction, it is hypothesized that the continuous flow sheath design itself may be increasing the likelihood of a collecting system injury with their use.

These cases, to our knowledge, represents the first documented series that involves renal collecting system injury when continuous flow sheaths were used for PCNL. This calls to attention the need for thorough research and validation with regard to the safety and efficacy of using continuous flow sheaths.

Conclusion

Although PCNL is a safe and effective procedure when performed by the hands of a skilled endourologist, the risk of complications can arise as with any surgical intervention.

To safeguard the health and well-being of the patient, every member of the operating room must be vigilant with intraoperative monitoring to notice any abnormalities with the patient's vitals. This series of two cases features a unique but unfortunate outcome where the usage of continuous flow sheaths led to intraoperative complications of renal collecting system injuries. These examples justify a further investigation toward these sheaths and the associated complications that may arise from them.

Disclosure Statement

No competing financial interests exist.

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Abbreviations Used

ACS = abdominal compartment syndrome
CT = computed tomography
IRP = intrarenal pressure
PCNL = percutaneous nephrolithotomy
PIP = peak inspiratory pressure
UAS = ureteral access sheath
UPJ = ureteropelvic junction

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