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Case Report

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Two Distinct Delayed Vascular Complications Following Pediatric Percutaneous Nephrolithotomy: Renal Arteriovenous Fistula and Pseudoaneurysm

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ABSTRACT

Introduction: Ultra-mini percutaneous nephrolithotomy (UMPNL) is one of the minimally invasive methods increasingly preferred in the treatment of childhood urolithiasis. In this study, rare vascular complications after UMPNL in the paediatric age group and our experience in the management of these complications are presented.

Case Presentation: Two paediatric cases, a 4-year-old boy and a 12-year-old girl who underwent UMPNL due to recurrent urolithiasis, are presented. Vascular complications developed in both cases during the postoperative period and were successfully treated with interventional radiologic methods. In the first case, spontaneous nephrostomy tract bleeding and hematoma developed in the postoperative period; an arteriovenous fistula was detected and successfully treated with two sessions of selective embolization. In the second case, macroscopic haematuria and a decrease in haematocrit were detected on the sixth day after discharge; a pseudoaneurysm was detected in the imaging and treated with selective embolization.

Conclusion: UMPNL is a minimally invasive and effective treatment option in paediatric stone surgery. However, although rare, serious vascular complications may develop after this procedure. Early findings, such as macroscopic haematuria, may be a sign of vascular complications.

In such cases, early diagnosis and minimally invasive treatment approaches, such as selective embolization, offer a successful and safe treatment opportunity.

Keywords:

Ultra-Mini Percutaneous Nephrolithotomy (UMPNL), Renal arteriovenous fistula, Pseudoaneurysm (PA), Arteriovenous Fistula (AVF), Computed Tomography (CT), Angiography.

Introduction

The management of urolithiasis in children differs significantly from that in adults due to several distinctive factors, including underlying anatomical and metabolic abnormalities, relatively smaller and more mobile kidneys, a more fragile parenchymal structure, and higher recurrence rates. This situation increases the importance of minimally invasive urological approaches in the treatment of paediatric urolithiasis [1].

Currently, a variety of minimally invasive techniques—including shock wave lithotripsy, standard Percutaneous Nephrolithotomy (PNL), mini-PNL, retrograde intrarenal surgery, micro-PNL, and ultra-mini-PNL (UMPNL) are recommended for the management of nephrolithiasis in both pediatric and adult populations [2].

Percutaneous nephrolithotomy is widely regarded as the gold standard technique for the management of renal calculi. Despite its high stone-free rate, this method is associated with some complications [2]. Postoperative bleeding represents one of the most frequent morbidities associated with this procedure. The predominant etiology of clinically significant bleeding requiring intervention is vascular injury, most commonly the development of renal Pseudoaneurysm (PA) or Arteriovenous Fistula (AVF), which occurs in fewer than 1% of cases [3].

Smaller surgical instruments have been developed to reduce the diameter of tract dilatation and prevent complications. Along with these new instruments for percutaneous nephrolithotomy, new terminology has also emerged. UMPNL (12–15 Fr) was first introduced by Desai et al. at the 28th European Congress of Urology in Milan [2].

There are a limited number of small case series in the literature on UMPNL, and these studies report its applicability and efficacy. Although PA and AVF formation are well-known complications of percutaneous renal interventions, the number of cases in the literature regarding vascular complications after UMPNL is quite low [2,3]. A Pseudoaneurysm (PA) is defined as a hematoma encapsulated by the arterial adventitia that results from high-pressure arterial leakage, with blood within the hematoma maintaining communication with the parent vessel through a defect in the arterial wall. PA carries a considerable risk of rupture. An Arteriovenous Fistula (AVF) represents an abnormal communication between an artery and a vein and may manifest clinically with macroscopic hematuria. The coexistence of PA and AVF has not yet been clearly elucidated. This case report underscores the importance of early recognition of PA and AVF following Percutaneous Nephrolithotomy (PNL) and highlights that timely angioembolization in the setting of delayed bleeding can prevent unnecessary nephrectomy. In this study, we aimed to draw attention to the rare vascular complications seen in our two paediatric cases and to share our experiences in the management of these complications.

Case Presentation 1

A 4-year-old male patient was followed up with a history of recurrent kidney stones; the previous analysis was reported as a cystine stone. A 2 cm diameter stone was detected in the left

kidney in the imaging. Retrograde pyelography was performed. Renal access was achieved in a monoplanar fashion through the selected calyx using a 16-gauge intravenous cannula (angiocut) under fluoroscopic guidance. The calyceal system was then entered over a sensor guidewire employing a single-shot technique with a 12 Fr dilator. For tract establishment, a 14 Fr sheath was utilized as the access sheath. Subsequently, Ultra-Mini Percutaneous Nephrolithotomy (UM-PNL) was performed using a 14 Fr sheath in combination with a 9.5 Fr pediatric cystoscope (12 cm in length, Karl Storz, Japan). A Double J Stent (DJS) was placed. No intraoperative complications were observed. The nephrostomy catheter was removed on the 2nd postoperative day, but spontaneous bleeding occurred from the nephrostomy tract. The macroscopic hematuria that developed due to this bleeding caused the Foley catheter to become blocked. Despite appropriate erythrocyte replacement three times per kilogram, the Haematocrit (Hct) value continued to decrease. The Hgb value was 26 g/dL. Interventional radiology was consulted. Contrast-enhanced Computed Tomography (CT) angiography revealed an AVF in the lower pole (Figure 1), and embolization was performed from the segmental artery proximal to the bleeding. Vascular Plug (Amplatzer™) was used for embolization. Since the Hct continued to decrease after the first embolization, the patient underwent repeat CT angiography. The renal artery and its branches were visualized using Digital Subtraction Angiography (DSA). DSA was performed under general anesthesia. DSA was performed using a 4 Fr vascular sheath (Cordis, Johnson and Johnson, Miami, USA) using the Seldinger technique. A 3 Fr Cobra catheter (Cordis, Johnson and Johnson, Miami, USA) was advanced over a 0.035-inch guidewire (Terumo, Osaka, Japan). Subsequently, abdominal aortography was performed by administering 8–10 ml of contrast medium. Then, the renal artery and its branches were visualized to determine the location of the lesion. Since the vascular injury was located in a subsegmental branch, a superselective microcatheter (Progreat, Terumo) was employed. The catheters were advanced as close to the lesion as possible, and the embolic material was subsequently delivered. For superselective vascular occlusion, fiber coils (VortX, Boston Scientific) were deployed. Selective embolization was performed by interventional radiology, and the patient was discharged without any problems after the procedure. A new bleeding focus that had been overlooked was detected, and a second embolization was performed in the same session. The patient, who was stable during the follow-up, was discharged.

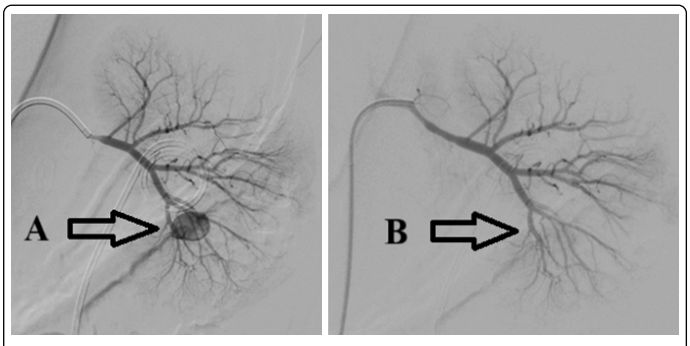

Figure 1: AVF image on angiography; **A):** AVF seen before the procedure; **B):** Successful vessel closure achieved after the procedure.

Case Presentation 2

A 12-year-old female patient presented to our clinic with complaints of flank pain. In the evaluation, a stone measuring approximately 3 cm in diameter extending from the lower pole of the right kidney to the renal pelvis was detected. Retrograde pyelography was performed. Monoplanar renal access to the selected calyx was achieved under fluoroscopic guidance using a 16-gauge intravenous cannula (angiocut). The calyceal system was then entered over a sensor guide with the single-shot technique (12 Fr dilator). A 14 Fr sheath served as the access sheath. For the UM-PNL procedure, a 14 Fr sheath in combination with a 9.5 Fr pediatric cystoscope (12 cm in length, Karl-Storz, Japan) was utilized. DJS was placed. Intraoperative stone-free status was achieved, and no complications were observed during the procedure. The nephrostomy catheter was withdrawn on the first postoperative day, while the Foley catheter was removed on the second postoperative day. The patient, who was stable, was discharged with recommendations. However, she re-applied on the 6th post-operative day with complaints of renal colic and macroscopic haematuria. The Hgb value was 24 g/dL. Upon observation of a decrease in Hct values in serial hemogram follow-ups, CT angiography was performed, and PA was diagnosed in the middle pole (Figure 2). The renal artery and its branches were visualized using Digital Subtraction Angiography (DSA). DSA was performed under general anesthesia. DSA was performed using a 6 F vascular sheath (Cordis, Johnson and Johnson, Miami, USA) using the Seldinger technique. A 5-Fr Cobra catheter (Cordis, Johnson and Johnson, Miami, USA) was advanced over a 0.035-inch guidewire (Terumo, Osaka, Japan). Subsequently, abdominal aortography was performed by injecting 8-10 mL of contrast medium. Then, the renal artery and its branches were visualized to determine the location of the lesion. As the vascular injury was localized to a subsegmental branch, a superselective microcatheter (Progreat, Terumo) was employed. The catheters were advanced as close to the lesion as possible, and the embolic agent was subsequently administered. For superselective vascular occlusion, fiber coils (VortX, Boston Scientific) were deployed. Selective embolization was performed by interventional radiology, and the patient was discharged without any problems after the procedure.

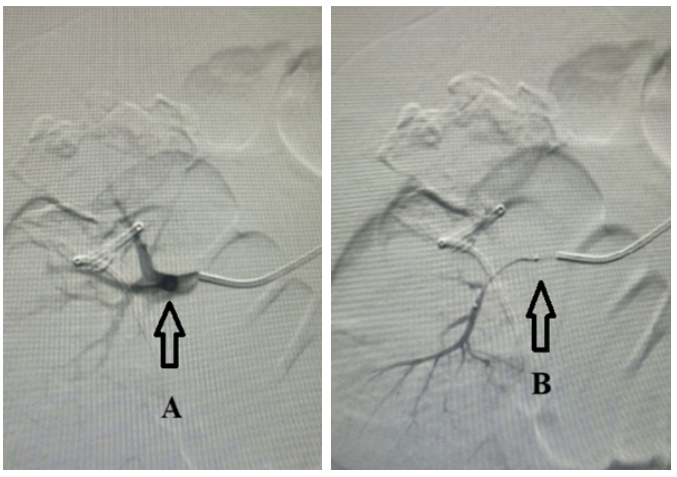

Figure 2: Pseudoaneurysm image on angiography; **A):** PA seen before the procedure. **B):** Successful vessel closure achieved after the procedure.

Discussion and Conclusion

PNL is a widely used procedure for the treatment of kidney stones. Bleeding is the most common complication of this procedure, with an incidence of approximately 1% [3]. Severe bleeding usually originates from segmental arteries, and the most common causes are AVF and PA development [4]. Cases of AVF and PA following PCNL in the pediatric age group are extremely rare in the literature; there are no large patient series on this subject, and most existing reports are based on adult cases.

Global PCNL data from the Clinical Research Office of the Endourological Society show that a larger accessory sheath diameter increases the risk of vascular complications [3]. UMPNL, as described by Desai et al., is considered a more minimally invasive treatment option due to its smaller diameter than mini-PNL [5].

Overall complication rates are generally low in pediatric PCNL series; however, the true incidence of renal artery pseudoaneurysms associated with PCNL in pediatric patients is not well defined [6]. The literature indicates that arteriovenous fistulas and/or pseudoaneurysms are the primary causes of delayed bleeding after PCNL, and these conditions can be detected by CT angiography/DSA and treated with high success with superselective embolization [6].

Reducing the tract diameter may prevent possible complications by reducing the invasiveness of the procedure. Three prospective comparative studies have focused on the efficacy and safety of reducing tract diameter, showing that UMPNL reduces the risk of bleeding and length of hospital stay while maintaining stone-free rates [2].

There are few case series in the literature on UMPNL, and the technique has been reported as feasible and effective in these studies [2]. However, vascular complications, such as pseudoaneurysms and AVF, after UMPNL are quite rare, and endovascular methods are at the forefront in the management of these complications [2].

In a study by Hong et al., selective renal artery embolization was applied to 35 patients who developed serious bleeding after PNL. It was determined that the posterior segment artery was the most common source of bleeding, and delayed (>24 hours) bleeding was observed in 80% of the cases. Renal functions were preserved after embolization, and the rate of recurrent bleeding was low [7].

In another study, haemorrhagic complications developed in 59 (4.4%) patients after 1,335 PNL surgeries were performed over a 10-year period; PA (54%) and AVF (14%) were detected most frequently according to arteriography findings [8]. These findings emphasize the importance of early diagnosis and minimally invasive endovascular treatment.

Although UMPNL is considered a minimally invasive procedure, the risk of haemorrhagic complications should not be ignored. In patients with early macroscopic haematuria, complications such as PA and AVF should be kept in mind, and diagnostic evaluation should not be delayed. In cases of PA and AVF occurring after PNL, effective treatment can be provided with selective embolization.

Conflict of interest

None.

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