INTERNAL MEDICINE

□ CASE REPORT □

Transcatheter Embolization of High-flow Renal Arteriovenous Fistula Using N-butyl Cyanoacrylate Accompanied by Delayed Hydronephrosis

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Abstract

Renal arteriovenous fistula (AVF) is an uncommon anomaly characterized by the communication between renal arteries and veins. Renal AVFs are often asymptomatic but are occasionally accompanied by hematuria or heart failure. Transcatheter closure with embolization is a safe and effective treatment for renal AVF. We herein report an 87-year-old patient with heart failure due to renal AVF who was treated by transcatheter embolization. She developed bacteremia with hydronephrosis, which is a rare complication following the embolization of renal AVF.

Key words: arteriovenous fistula, kidney, embolization, hydronephrosis, NBCA

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Introduction

Arteriovenous fistula (AVF) is a disorder characterized by the direct communication between arteries and veins. High-output cardiac failure develops when the shunted blood volume exceeds the limits of cardiac compensation (1, 2). Although transcatheter embolization carries a risk of coil migration, there have been several attempts to control high-flow AVFs with various embolization materials (3-5). We herein describe a female patient with a renal high-flow AVF treated by n-butyl cyanoacrylate (NBCA), in whom cardiac failure subsided immediately but hydronephrosis associated with bacteremia occurred as a delayed complication.

Case Report

Clinical course

An 87-year-old woman complained of leg edema and nocturnal dyspnea. She had begun to feel dyspnea on exertion two months prior to hospital admission. Her temperature was 35.5℃, her blood pressure was 148/57 mmHg, her heart rate was 80/min, her respiratory rate was 20/min, and her oxygen saturation 95% on 2 L of oxygen. Chest radiograph showed severe cardiomegaly with dilated pulmonary vessels (Fig. 1A). Echocardiography showed dilatation of both the right ventricle and atrium with severe tricuspid regurgitation. The left ventricular ejection fraction was 61.5%, and she had severe tricuspid regurgitation associated with a trans-tricuspid pressure gradient of 46.9 mmHg (Fig. 1C). Contrast-enhanced computed tomography revealed a renal AVF, with the conglomerated dilated vessels visualized at the center of the right kidney draining to the inferior vena cava (Fig. 2A). She did not have any pain, including back pain, and her serum creatinine level was 0.54 mg/dL (estimated glomerular filtration rate: 78.1 mL/min/1.73 m^2). The urine reaction findings were 2+ for protein and 2+ for occult blood, and the spot urine total protein-creatinine ratio was 183 mg/g.

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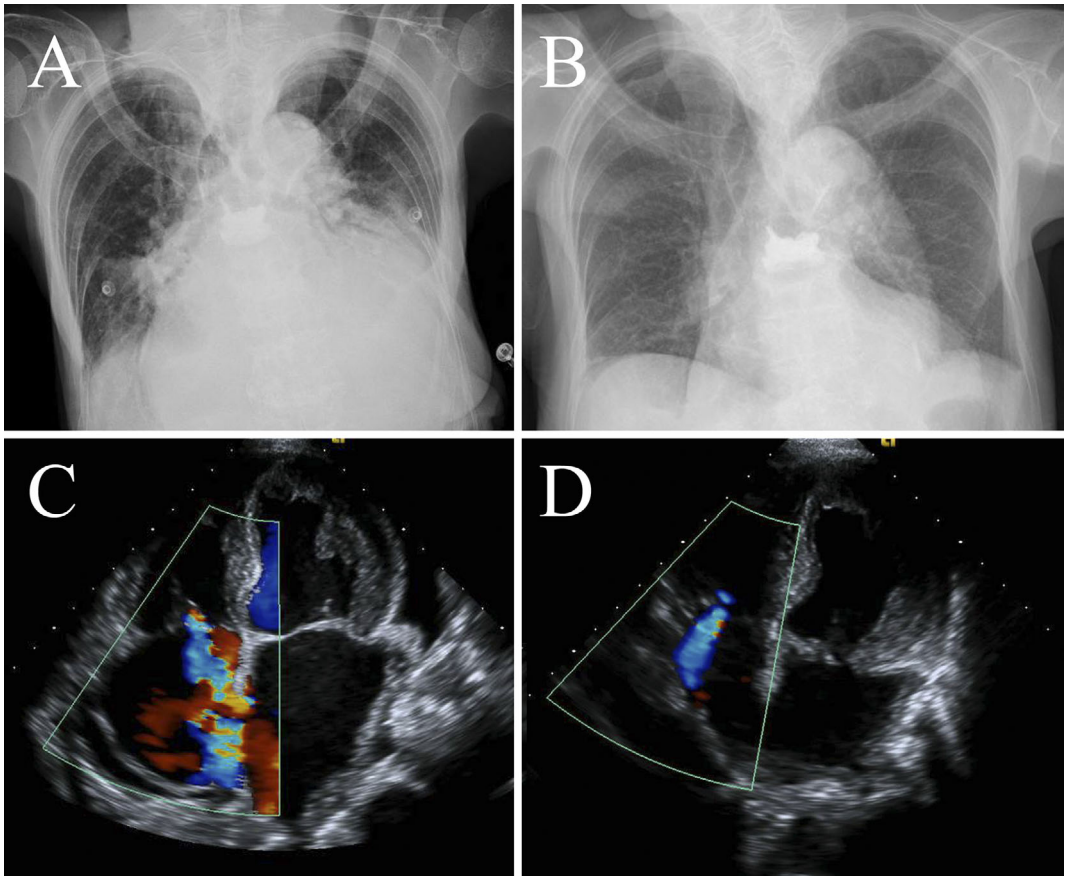

Figure 1. **The cardiomegaly and pulmonary congestion of the chest X-ray improved before (A) and after the procedure (B). (C) Echocardiography showed right heart dilatation, pericardial effusion, and severe tricuspid regurgitation before the procedure. (D) After the procedure, the tricuspid regurgitation improved.**

Transcatheter embolization

As the shunt was considered to be the cause of the patient's cardiac failure, we performed transcatheter embolization after obtaining informed consent from the patient. Direct renal angiography confirmed the findings of a high-flow renal AVF. The lower polar artery was the main feeder artery, measuring about 8 to 10 mm in diameter (Fig. 2B). Two dilated and tortuous draining veins were continuously visualized (Fig. 2C). Peripheral renal arteries were poorly visualized because of steal phenomenon. Two balloon catheters were employed: one at the distal portion of the dilated lower polar artery, and the other at the mid-portion of the right renal vein. The arterial flow was almost completely cut off by balloon inflation, but the renal vein occlusion remained incomplete despite full inflation.

Given the risk of coil migration, we decided to use NBCA instead of interlocking detachable coils. The microcatheter tip was positioned at the shunting point, where only the renal veins were gradually visualized by manual injection of the contrast media. Following injection of a sufficient amount of 10% glucose solution, a 50% mixed solution of NBCA with Lipiodol was slowly injected until the dilated venous sacs were completely filled (total: 6 mL) (Fig. 2D). Post-procedure angiography showed that the renal AVF had been completely resolved, and the lower polar artery was obstructed at the mid portion. The parenchymal impairment corresponded to the area fed by the lower polar renal artery (Fig. 2E).

Post-procedural clinical course

The patient's symptoms subsided immediately after the treatment, and a chest radiograph taken after 10 days showed normal findings (Fig. 1B). Her creatinine level was 0.57 mg/dL (estimated glomerular filtration rate: 73.6 mL/min/1.73 m^2), and the urine reaction findings for protein were negative, thought the findings for occult blood remained the same (2+). Her tricuspid regurgitation had also diminished (Fig. 1D). Before discharge, her body temperature increased once to 38℃, and her urine culture was found to be positive for *E. coli*, *Proteus penneri*, and *Klebsiella pneumaniae*. Her fever was well controlled by the administration of antibacterial drugs and she was discharged 28 days after hospital admission. She developed a fever again three months later (40℃) with right costovertebral angle tenderness. CT showed newly developed right-sided hydronephrosis (Fig. 3A), and *Proteus vulgaris* was cultured in both blood and urine. After ureteral stent placement

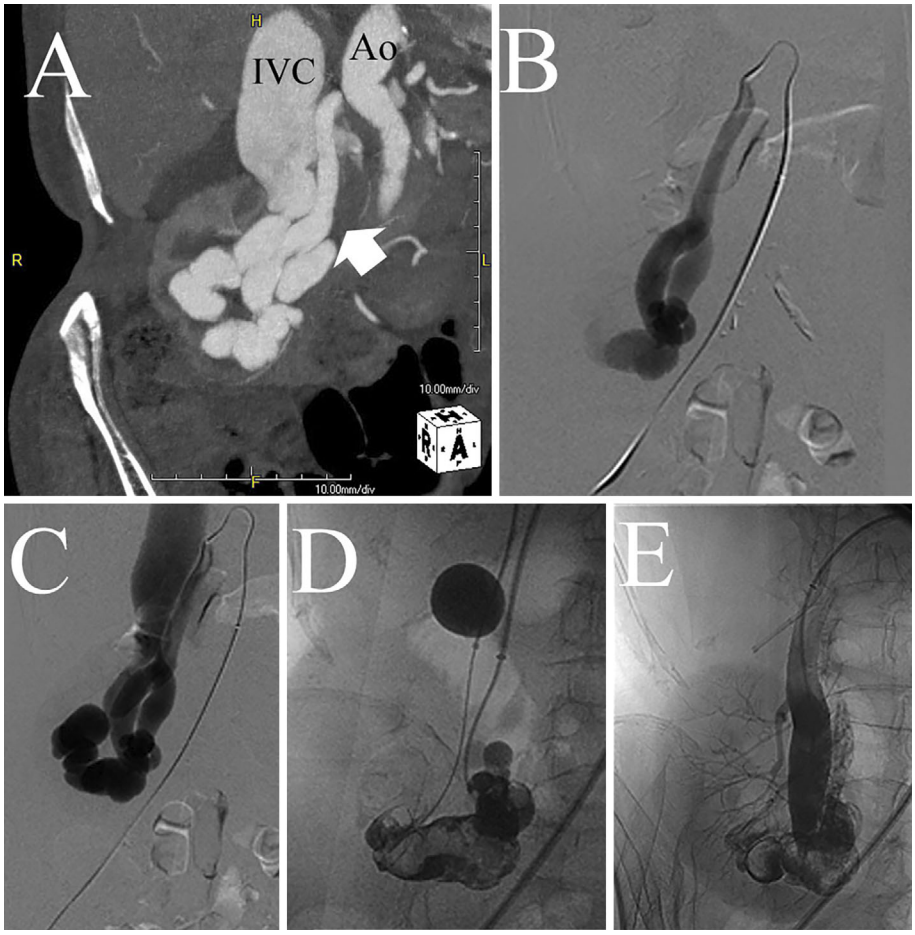

Figure 2. **(A) Contrast-enhanced computed tomography showed significant dilatation of the feeding artery and the draining vein at the right renal hilum. The dilated inferior vena cava (IVC) is indicated by arrows. One feeding artery (B) and two drainage veins (C) were visualized by transcatheter angiography. The venous sacs were filled with NBCA and Lipiodol© (D). Post-embolization angiography showed stoppage of the dilated renal lower artery at the mid-portion (E).**

(Fig. 3B), she recovered well and was discharged from the hospital 4 days after the second admission.

Discussion

We herein presented was a patient with a high-flow AVF associated with cardiac failure as a consequence (1, 2). Although the AVF was successfully treated with NBCA embolization, the patient unfortunately developed hydronephrosis with bacteremia as a rare complication.

Renal vascular abnormalities are divided into arteriovenous malformations and AVFs. Given that the present case had a single direct communication between a renal artery, she was diagnosed with an AVF (6). Arteriovenous malformations are characterized by tortuous, varix-like arterial venous communications, and gross hematuria is the most frequent symptom (72% of patients) (7). The present patient had no history of operation or trauma of the renal system, so we considered this case to the congenital type of arteriovenous fistula.

Renal vascular abnormalities in 5-32% of patients are associated with heart failure (6). A renal AVF can be responsible for increased cardiac flow volume by increased venous return due to left-to-right shunting, which results in diastolic volume overload (1). High-output heart failure associated with renal vascular abnormalities can be treated by repairing the vascular abnormalities (2). Although transcatheter embolization was the first choice for treating the renal AVF in the present case, treating a high-flow AVF is still challenging due to the risk of coil migration.

There have been several attempts in the literature to use embolic materials such as interlocking detachable coils and Amplatz Vascular Plugs Wall stent or some combination thereof (3-5). In the present patient, only NBCA was used. The procedure was performed while controlling the renal arterial flow with balloon inflation, as reported previously (3). A microcatheter tip was placed at the shunt point. We encountered no technical problems with the injection of the 50% NBCA mixture with Lipiodol. The patient's heart failure symptoms were successfully controlled after NBCA embolization.

Recently, several reports have been published concerning NBCA embolization for a renal AVF. These reports cited several complications, such as lateral flank pain, hematuria,

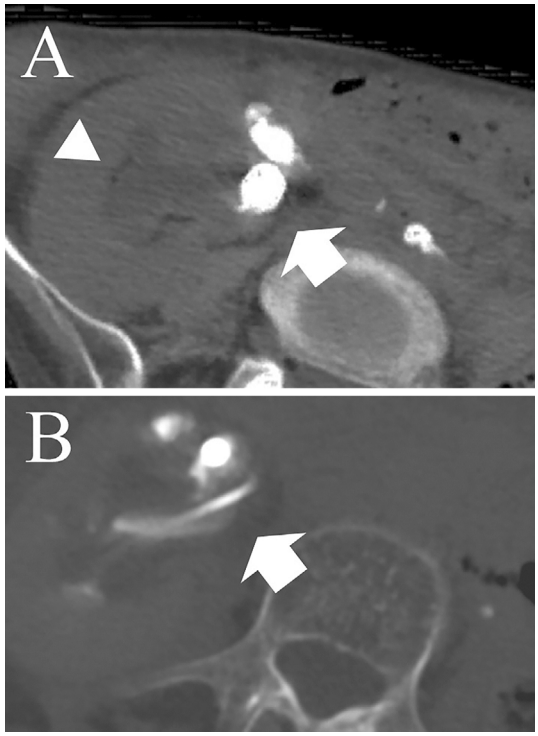

Figure 3. (A) Computed tomography revealed hydronephrosis of the right kidney (arrowhead). The white arrow indicates the stenotic lesion behind the coil. (B) After inserting the ureteral stent, the hydronephrosis improved. The white arrow indicates the inserted ureteral stent.

and post-embolization syndrome (5, 8, 9). Although the first fever episode in the present patient may have been considered to be due to post-embolization syndrome, the later septic shock episode suggested that the first episode had been a urinary tract infection. We should have considered the possibility of a urinary tract infection following embolization after arteriovenous malformation (AVM), especially when using NBCA.

The patient developed bacteremia due to a urinary tract infection. Urinary tract infections are frequent in adults, with an incidence rate of about 10% in women over the age of 80 (10). An indwelling catheter was associated with bacteriuria in about 26% of cases, 24% of which resulted in a urinary tract infection (11). We diagnosed the patient with a catheter-related urinary tract infection at the first fever episode and did not consider other possibilities, such as a complicated urinary tract infection. Bacteremia unexpectedly developed in the patient three months later. Post-treatment CT showed that embolization materials had not overflown nor escaped outside the vascular lumen. We therefore hypothesized two possible causes of the hydronephrosis with bacteremia: urinary tract obstruction, and ischemia of the renal pelvis.

The recurrence of urinary tract infection prompted us to perform computed tomography, and we found hydronephrosis, which meant a urinary tract obstruction (12). A firm coil or NBCA in the renal arteriovenous fistula near the pelvis could indirectly press against the urinary tract, in theory. However, no previous reports had been published regarding such a phenomenon. Embolization with NBCA can be injected more slowly than solid material, improving the control of the injection, which might result in a more natural vascular form after embolization. Clarifying whether or not NBCA or coil can impede the urinary tract will require further data from other facilities.

Hydronephrosis can occur as a consequence of ischemia of the renal pelvis or proximal ureter and has been reported as a complication after renal implantation (13-15). We were able to find one case report on pure alcohol injection to treat a renal AVM (16). The renal pelvis and ureteral arteries often originate from the proximal portion of the main renal artery or from the lower polar renal artery (17, 18). In the present patient, we were unable to identify the renal pelvic or ureteral arteries retrospectively on either CT scans or angiographic images. Post-procedural angiography showed that the lower polar renal artery had lost its normal flow, from which the renal pelvis or ureteral artery might originate. To avoid the occurrence of delayed hydronephrosis, we should be aware of the vascular anatomy of the renal pelvic or ureteral artery and provide more detailed information to the patients concerning the risk of delayed complications.

We herein reported a case of transcatheter embolization of a renal high-flow AVF using NBCA. The patient's cardiac failure subsided immediately after treatment, although hydronephrosis appeared as a delayed complication. We conclude that transcatheter embolization of a renal high-flow AVF with NBCA is clinically feasible, and that more attention should be focused on the late occurrence of hydronephrosis as a result of ischemia of the renal pelvis and ureter.

The authors state that they have no Conflict of Interest (COI).

References

1. Bates MC, Almehmi A. High-output congestive heart failure successfully treated with transcatheter coil embolization of a large renal arteriovenous fistula. Catheter Cardiovasc Interv **63**: 373-376, 2004.
2. Ozaki K, Kubo T, Hanayama N, et al. High-output heart failure caused by arteriovenous fistula long after nephrectomy. Heart Vessels **20**: 236-238, 2005.
3. Mansueto G, D'Onofrio M, Minniti S, Ferrara RM, Procacci C. Therapeutic embolization of idiopathic renal arteriovenous fistula using the "stop-flow" technique. J Endovasc Ther **8**: 210-215, 2001.
4. Idowu O, Barodawala F, Nemeth A, Trerotola SO. Dual use of an amplatzer device in the transcatheter embolization of a large high-flow renal arteriovenous fistula. J Vasc Interv Radiol **18**: 671-676, 2007.
5. Sundarakumar DK, Kroma GM, Smith CM, Lopera JE, Suri R. Embolization of a large high-flow renal arteriovenous fistula using 035'' and 018'' detachable coils. Indian J Radiol Imaging **23**: 151-154, 2013.
6. Cura M, Elmerhi F, Suri R, Bugnone A, Dalsaso T. Vascular malformations and arteriovenous fistulas of the kidney. Acta Radiol **51**: 144-149, 2010.
7. Takebayashi S, Hosaka M, Kubota Y, Ishizuka E, Iwasaki A,

Matsubara S. Transarterial embolization and ablation of renal arteriovenous malformations: efficacy and damages in 30 patients with long-term followup. J Urol **159**: 696-701, 1998.

8. Poh PG, Tan BS, Tham SC, et al. The use of n-butyl-2 cyanoacrylate as an embolic agent in the minimally invasive treatment of renal arteriovenous malformations. Ann Acad Med Singapore **42**: 207-209, 2013.

9. Eom H-J, Shin J, Cho Y, Nam D, Ko G-Y, Yoon H-K. Transarterial embolisation of renal arteriovenous malformation: safety and efficacy in 24 patients with follow-up. Clin Radiol **70**: 1177-1184, 2015.

10. Foxman B, Brown P. Epidemiology of urinary tract infections: transmission and risk factors, incidence, and costs. Infect Dis Clin North Am **17**: 227-241, 2003.

11. Saint S, Veenstra DL, Lipsky BA. The clinical and economic consequences of nosocomial central venous catheter-related infection: are antimicrobial catheters useful? Infect Control Hosp Epidemiol **21**: 375-380, 2000.

12. Kawashima A, LeRoy AJ. Radiologic evaluation of patients with renal infections. Infect Dis Clin North Am **17**: 433-456, 2003.

13. Friedland GW, Droller MJ, Stamey TA. Obstruction of ischemic ureteropelvic junction. Urology **4**: 439-442, 1974.

14. Rattazzi LC, Simmons RL, Spanos PK, Najarian JS. Late ureteropelvic necrosis after transplantation. Urology **05**: 326-330, 1975.

15. Sporer A, Seebode JJ. Study of renal blood supply and its implication in renal pelvic surgery. Urology **17**: 18-21, 1981.

16. Fujita M, Takahashi T, Sato O, et al. Effect and complications of embolization therapy using absolute ethanol for renal arteriovenous malformation. Nihon Igaku Hoshasen Gakkai Zasshi **53**: 369-374, 1993 (in Japanese, Abstract in English).

17. Lang EK. The arteriographic diagnosis of primary and secondary tumors of the ureter or ureter and renal pelvis. Radiology **93**: 799-805, 1969.

18. Schapira HE, Mitty HA. Tumors of the renal pelvis: clinical review with emphasis on selective angiography. J Urol **106**: 642-645, 1971.