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Clinical Case Report

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Application of Onyx for Renal Arteriovenous Malformation With First Case Report of a Renal Hyperdense Striation Sign

A CARE-Compliant Article

Yu-Hsiang Juan, MD, Yu-Ching Lin, MD, Ting-Wen Sheng, MD, Yun-Chung Cheung, MD, Shu-Hang Ng, MD, Chin-Wei Yu, MD, and Ho-Fai Wong, MD

Abstract: Onyx is an emerging treatment modality for visceral vascular malformations, especially in cases in which delicate nidal penetration of the arteriovenous malformation (AVM) is desired. A computed tomography (CT) image presentation of hyperdense striations along the renal medulla secondary to the tantalum powder has not been previously reported.

A 65-year-old woman presented to our institution with intermittent gross hematuria and left flank pain for 10 days. Both CT and conventional angiographies confirmed cirsoid-type renal AVM, which was successfully treated with Onyx. Follow-up CT after treatment revealed presence of hyperdense striations along the renal medulla, which resolved during later image follow-up.

Despite its frequent usage in neural intervention, the application of Onyx in visceral AVM is gradually gaining interest, especially in cases in which delicate nidal penetration of the AVM is desired. Renal hyperdense striation sign should be recognized to avoid confusion with embolizer migration, and further studies in patients with renal function impairment may be helpful in understanding its influence of renal function.

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Abbreviations: AVM = arteriovenous malformations, CT = computed tomography, DMSO = dimethyl sulfoxide, EVOH = ethylene-vinyl alcohol, NBCA = N-butyl cyanoacrylate.

INTRODUCTION

Renal arteriovenous malformations (AVMs) are rare anomalous arterial and venous connections commonly presenting with spontaneous hematuria and recurrent flank pain.[1,2] Onyx—a liquid embolizer composed of ethylene-vinyl alcohol (EVOH) dissolved in dimethyl sulfoxide (DMSO), mixing with tantalum powder for radio-opacity,[2]—is emerging as a new treatment modality for visceral AVMs due to its inherent benefit of obtaining good nidal penetration and ease of embolizer control.[2] We present a case of renal AVM after Onyx embolization, which is the first reported case of hyperdense striations along the renal medulla, secondary to tantalum powder on computed tomography (CT). Renal hyperdense striation sign should be recognized to avoid confusion with embolizer migration.

CASE PRESENTATION

The institutional review board approved this study (Chang Gung Memorial Hospital) and waived the need for the patient's inform consent. A 65-year-old woman, without a significant history, presented to our institution with intermittent gross hematuria and left flank pain for 10 days. Physical examination, noncontrast CT, cystourethroscopy, and laboratory examinations were all unremarkable, except for hematuria (color of urine: red and red blood cell count >500 /μL) and blood clot in the left renal pelvis. Blood test showed no obvious anemia (red blood cell count 4.43 million/μL and hemoglobin level 13.6 g/dL). Subsequent renal artery CT angiography demonstrated a tangled cluster of vessels in the left peripelvic region with arterial feeders and early draining vein, consistent with a cirsoid-type renal AVM (Figure 1A, CT image) and confirmed by conventional transcatheter angiography (Figure 1A, angiography image). Two arterial feeders arising from posterior segmental artery of the left kidney supply the renal AVM. One is originated from the proximal portion of the posterior segmental artery, and the other one is from the distal portion (Figure 1A, CT image).

As an effort to achieve a satisfactory distal penetration of the nidus, we used Onyx instead of coil and N-butyl cyanoacrylate (NBCA). To ensure adequate mixing and homogenous radiopacity of the Onyx mixture, the vials were kept on a shaker (Vortex-Genie; Scientific Industries, Inc. Bohemia, NY, USA) for at least 20 minutes before embolization. Superselective coaxial catheterization of the distal feeder was performed using an Echelon 10 microcatheter. Onyx 34 (8% EVOH and 92% DMSO, Onyx 34; Micro Therapeutics, Inc., Irvine, CA, USA) is chosen for the embolization of distal feeder to achieve higher occlusion speed. The microcatheter was preflushed with DMSO, and Onyx 34 was injected slowly under fluoroscopic control until occlusion of the distal feeder. The total amount of injected Onyx 34 was 0.8 mL. Angiography after embolization of the distal feeder showed occlusion of distal feeder and lateral portion of the nidus, but the AVM was still supplied by the proximal feeder. Therefore, we cannulated the proximal feeder

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From the Department of Medical Imaging and Intervention, Chang Gung Memorial Hospital, Linkou and Chang Gung University, Taoyuan, Taiwan (YHJ, TWS, YCC, SHN, HFW); Healthy Aging Research Center, Chang Gung University, Taiwan (YHJ); Department of Medical Imaging and Intervention, Chang Gung Memorial Hospital, Keelung and Chang Gung University, Taoyuan, Taiwan (YCL); and Department of Emergency Medicine, Chang Gung Memorial Hospital, Keelung and Chang Gung University, Taoyuan, Taiwan (CWY).
Correspondence: Ho-Fai Wong, Department of Medical Imaging and Intervention, Chang Gung Memorial Hospital, Linkou, Chang Gung University, Taoyuan, Taiwan (e-mail: hfwong4720@gmail.com).
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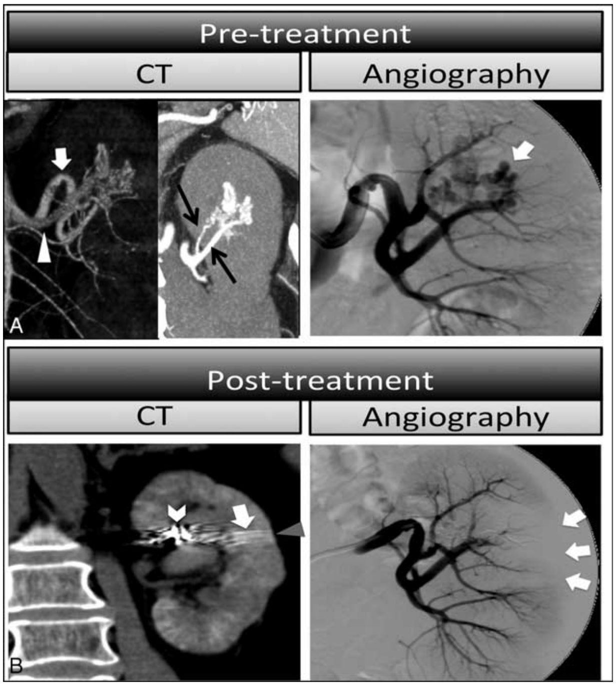

FIGURE 1. (A) Pretreatment image (CT image) CT angiography (CTA) with volume-rendering reformatted image of the left kidney (a) demonstrated a cirsoid-type renal arteriovenous malformation (AVM) at the upper pole of the left kidney with arterial feeder (bold arrow) and draining vein (triangular arrowhead). Oblique coronal image with maximal-intensity projection showed two arterial feeders (thin arrows, proximal and distal) arising from posterior segmental artery of the left kidney supply the renal AVM (angiography image). Transcatheter angiography of the left kidney confirms the CTA findings of renal AVM (bold arrow). (b) Post-treatment image (left) noncontrast-enhanced CT performed on the 5th postembolization day shows fine linear hyperdense striations in the left renal parenchyma (bold arrow). Note the confinement of the hyperdense striations within the renal contour (red triangular arrowhead) and also the height difference between the peripelvic embolizer (small arrowhead) and the striations (bold arrow) exclude beam-hardening artifact. (Right) Control angiography after the embolization showed complete obliteration of the renal AVM with resultant infarction at the lateral aspect of the mid portion of the kidney (bold arrows). CT, computed tomography.

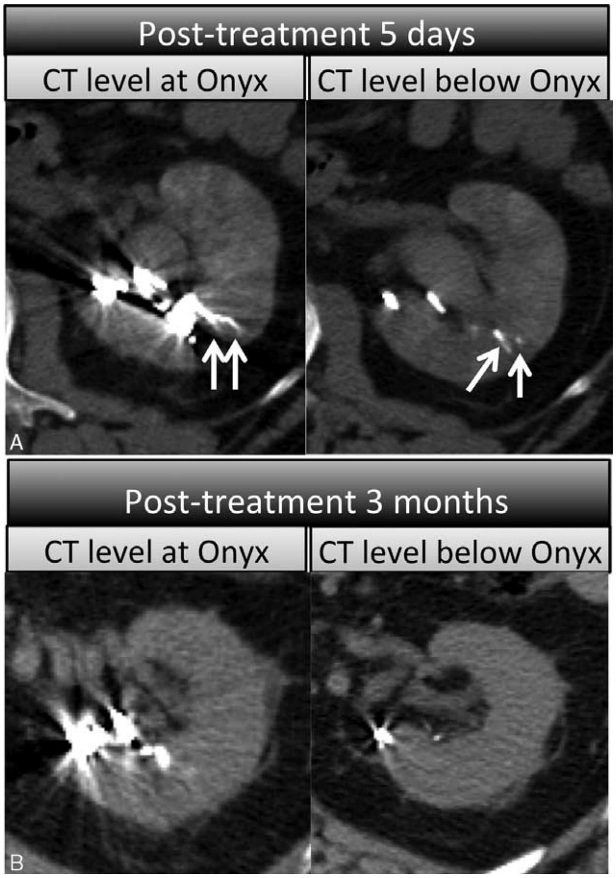

FIGURE 2. Multipanel imaging with comparison of the initial postembolization CT at 5 days after embolization and the subsequent CT at 3 months follow-up revealed the resolution of the striated tantalum powder. (A) Post-treatment follow-up (5 days): axial CT scan at the level of Onyx embolizer (left) and at a level below the Onyx embolization (right) revealed presence of hyperdense renal striation sign(arrows). (B) Post-treatment follow-up (3 months): axial CT scans at the same levels confirmed disappearance of the tantalum powder. CT, computed tomography.

using a Marathon flow-directed microcatheter coaxially through a 6 Fr. Envoy guiding catheter. Since the angiography of the proximal feeder showed a relative slow-flow vascular malformation, embolization was performed with Onyx 18 (6% EVOH and 94% DMSO, Onyx 18; Micro Therapeutics, Inc., Irvine, CA, USA) to obtain a better penetration into the nidus. The total amount of injected Onyx 18 was 0.6 mL. No obvious visible overflow of Onyx was seen during the embolization procedure, but subtle overflow of Onyx cannot be completely excluded under angiography. Control angiography after embolization of both feeders demonstrated complete obliteration of the renal AVM, with a resultant infarction at the lateral aspect of the middle left kidney (Figure 1B, right image).

The patient was asymptomatic with clear urine within 24 hours. Nonenhanced abdominal CT was performed on the 5th postembolization day to follow up the extent of injected Onyx. Onyx was localized within the expected region of the AVM. However, diffuse fine hyperdense linear striations were incidentally found along the course of the left upper renal medulla, which favored the presence of tantalum powder rather than intravascular migration of embolizer (Figures 1B, left image). The patient was discharged uneventfully, and follow-up CT 3 months later confirmed the disappearance of the tantalum powder from the renal medulla and the resolution of the renal striation sign (Figure 2). Both blood test (red blood cell count 4.50 million/μL and hemoglobin level 13.4 g/dL) and urinary analysis (color of urine: yellow and red blood cell count 1 /μL) were normal during postembolization follow-up.

DISCUSSION

Treatment of renal AVM is often necessary when complications such as heart failure, uncontrolled hypertension, hemorrhage, or recurrent flank pain occur,[1] as the case of our patient. The optimal treatment of renal AVM should include complete eradication for the vascular lesion while preserving the maximal-functioning renal parenchyma. In this study, transarterial embolization became the treatment of choice because the peripelvic location of the nidus posed a high risk of renal parenchymal injury, if surgery was performed. Even though several embolic materials are available, the lava-like flow pattern and long solidification time of Onyx allow better nidal penetration and more controllable embolization procedure,[2] which is particularly beneficial in treating visceral AVM. In addition, Onyx injection can be interrupted and continued again until the desired result is achieved.[3] Even if the catheter was entrapped by Onyx, catheter removal could still be done due to its nonadhesive property.[4] There are two mixtures of Onyx. Onyx 18 has a lower EVOH concentration, resulting in slower occlusion speed and allows better nidal penetration distally, whereas Onyx 34 has a higher concentration of EVOH and allows a higher occlusion speed, but less nidal penetration ability.[5] The two mixtures can be selected according to the need of embolization speed and distal nidal penetration. As previously mentioned, we employed Onyx 34 for the distal feeder to achieve higher occlusion speed and Onyx 18 for the proximal one for better nidal penetration.

As for the other embolizers, metallic coils are not suitable embolic agents because the delivery catheters cannot superselectively enter the nidus for the placement of the coils. The proximal coil embolization may result in development of collateral branches that are difficult to treat. NBCA, which is a tissue-adhesive liquid embolic material, has the ability to penetrate and occlude at the level of the nidus of the AVM. However, there is a risk that the catheter tip may adhere to the vessel wall. The catheter should be retrieved before NBCA polymerizes, which requires great experience and skill. In addition, due to the low viscosity, the embolic material may be washed away before it polymerizes.

Although beam-hardening artifact can be an image mimicker of the renal hyperdense striation sign, the confinement of the hyperdense striations within the kidney contour, along with the height difference between the peripelvic embolizer and the striations, can allow differentiation of these two entities. This finding is further confirmed by follow-up CT with disappearance of the hyperdense striation sign. We believe the renal hyperdense striation sign is secondary to the presence of tantalum powder in the renal medulla. In one animal experimental study of transarterial embolization of the kidney, with NBCA mixed with tantalum powder, and reported by Günther et al,[6] particles of tantalum powder (average particle size of 75 μm) were found to deposit in the arteries and in the glomeruli of kidneys on histologic specimens after the embolization, and tantalum particles smaller than 7 μm were found in the pulmonary vascular system. The particle size of Onyx tantalum powder ranged from 0.7 μm to 22 μm, and it is reasonable to suspect that the diffuse linear hyperdensities in the renal parenchyma might be related to the deposition of the tantalum powder. Congenital renal AVMs had tortuous varicous vessels, which are found immediately beneath the urothelium, which is the cause of the hematuria.[7] Bypassing of the filtration barrier with subtle overflow may explain for the presence of tantalum powder in the renal medulla. Follow-up CT image reveals resolution of the striated tantalum powder, and the renal function remains normal, which probably implied that the phenomenon would not be problematic in patients with normal renal function. However, we do not know if the phenomenon affects the renal function in patients with renal insufficiency. Further studies in patients with renal function impairment may be helpful, and the recognition of the renal hyperdense striation sign is important to avoid confusion with embolizer migration and understand its influence on renal function.

CONCLUSION

Despite its frequent usage in neural intervention, the application of Onyx in AVM of visceral organs is gradually graining interest, especially in cases in which delicate nidal penetration of the AVM is desired. Renal hyperdense striation sign should be recognized to avoid confusion with embolizer migration, and further studies in the effect of tantalum powder in patients with renal function impairment may be helpful to understand its influence of renal function.

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