Radiology Case Reports 19 (2024) 2035–2038

Available online at www.sciencedirect.com

ScienceDirect

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

Case Report

Renal arteriovenous malformation treated using glue embolization under inflow and outflow control by balloon occlusion ☆,☆☆

Tensei Suzuki[a], *Hidenori Yamaguchi*[b,*], *Mitsuaki Kojima*[a], *Toshiya Kariyasu*[b], *Raira Nakamoto*[a], *Makiko Nishikawa*[b], *Haruhiko Machida*[b], *Tomohisa Shoko*[a]

[a] *Emergency and Critical Care Medicine, Tokyo Women's Medical University Adachi Medical Center, Tokyo, Japan*
[b] *Department of Radiology, Tokyo Women's Medical University Adachi Medical Center, Tokyo, Japan*

ARTICLE INFO

Article history:
Received 4 February 2024
Revised 6 February 2024
Accepted 12 February 2024

Keywords:
Embolization
Hematuria
Interventional radiology
Renal arteriovenous malformation
Transcatheter arterial embolization

ABSTRACT

A 45-year-old female presented with gross hematuria. Right renal arteriovenous malformation on abdominal contrast-enhanced computed tomography necessitated urgent transcatheter arterial embolization. Right renal digital subtraction angiography revealed a single tortuous and dilated vessel converging to an aneurysmal dilated vein. To selectively embolize the malformation, we closed the arterial side with a microballoon and attempted glue embolization; filling occurred unexpectedly early, and another balloon on the vein side helped control the renal vein blood flow. Glue embolization was performed without adverse events. Glue embolization for high-flow arteriovenous malformation under balloon occlusion-mediated inflow and outflow control can effectively and safely embolize complete target vessels.

Background

Renal arteriovenous malformations (RAVMs) are rare vascular malformations that cause hematuria [1]. Their treatment has evolved from open nephrectomy to transcatheter arterial embolization (TAE). Among the various embolization materials used during TAE, n-butyl-2-cyanoacrylate (NBCA) is a liquid embolization agent that yields relatively better outcomes [2,3]. However, liquid embolization agents are challenging to control; if uncontrolled, they may migrate to the systemic circulation, thereby increasing the risk of pulmonary arterial em-

List of abbreviations: RAVM, renal arteriovenous malformations; TAE, transcatheter arterial embolization; NBCA, n-butyl-2-cyanoacrylate; CE-CT, contrast-enhanced computed tomography; DSA, digital subtraction angiography.

☆ Acknowledgments: We would like to thank the entire staff of the Department of Emergency Medicine, Tokyo Women's Medical University Adachi Medical Center, for their support in the treatment of the patient. This study was not supported by any funding.

☆☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

* Corresponding author.
E-mail address: w.w.j.d.woodbell@ymail.ne.jp (H. Yamaguchi).

https://doi.org/10.1016/j.radcr.2024.02.032

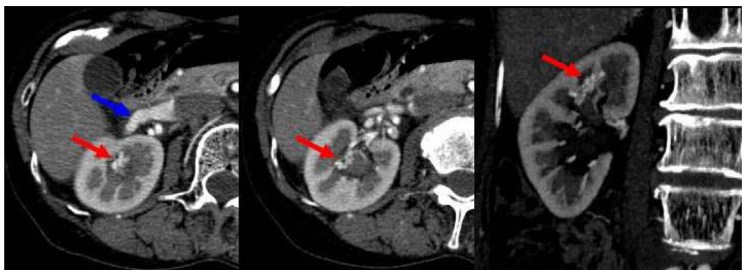

Fig. 1 – Axial and coronal contrast-enhanced computed tomography images obtained during the early arterial phase show a single tortuous and dilated vessel in the right renal sinus (red arrow) and early filling of the right renal vein (blue arrow).

bolism. Therefore, TAE is performed under inflow and outflow control.

Our objective was to demonstrate that glue embolization under inflow and outflow control by balloon occlusion is an effective technique for safely embolizing the entire target vessel.

Case report

A 45-year-old female presented to the emergency department with gross hematuria and loss of consciousness. The patient had experienced repeated hematuria several days before presentation and had a medical history of hypertension.

The patient was in shock upon arrival at the hospital, with a blood pressure of 84/62 mmHg and a heart rate of 104 bpm. Blood work revealed a red blood cell count of 250 $\times$ 10^3 μL, hemoglobin level of 8.9 g/dL, and platelet count of 12.9 $\times$ 10^4 μL; these indicated anemia and thrombocytopenia.

Contrast-enhanced computed tomography (CE-CT) of the abdomen revealed a right RAVM (Fig. 1); therefore, urgent TAE was planned to embolize the shunt.

Right renal digital subtraction angiography (DSA) revealed a single tortuous and dilated vessel converging to an aneurysmal dilated vein (Fig. 2a). Superselective DSA revealed a shunt fed by a single, enlarged, tortuous feeding artery draining into the aneurysmal draining vein (Fig. 2b). Owing to the strong tortuosity of the feeding artery, advancing the microcatheter to the shunt point was challenging.

To embolize the RAVM selectively, we first closed the arterial side of the RAVM using a microballoon (diameter 5 mm, LOGOS; PIOLAX, Inc, Yokohama, Japan) and attempted glue embolization thereafter (Fig. 3a). Our intention was to slow the flow from the artery to the right renal vein; however, filling occurred earlier than expected.

Therefore, we deployed an additional balloon (diameter 9 mm, Selecon MP catheter; Terumo Clinical Supply, Gifu, Japan) to the vein side to control the renal vein blood flow. After balloon occlusion, the renal vein could be visualized gradually (Fig. 3b). Finally, glue embolization with a mixture of NBCA and lipiodol (33%) was performed under inflow and outflow control via balloon occlusion.

Right renal DSA after embolization revealed that the shunt had disappeared completely. No perfusion defects in the renal

(A)

(B)

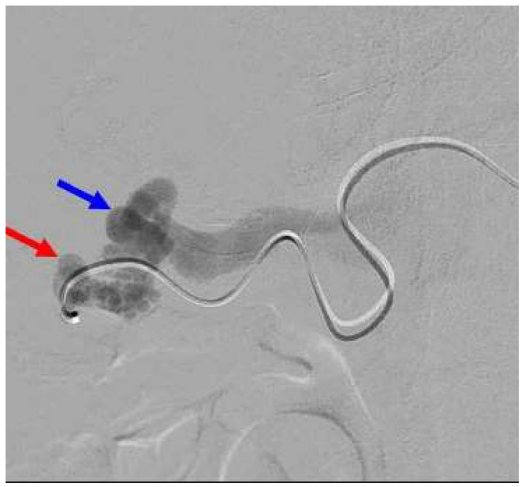

Fig. 2 – (A) Right renal digital subtraction angiography image shows a single tortuous and dilated vessel converging to an aneurysmal dilated vein. (B) Superselective digital subtraction angiography image shows the shunt fed by a single tortuous feeding artery (red arrow) and draining into an aneurysmal dilated vein (blue arrow).

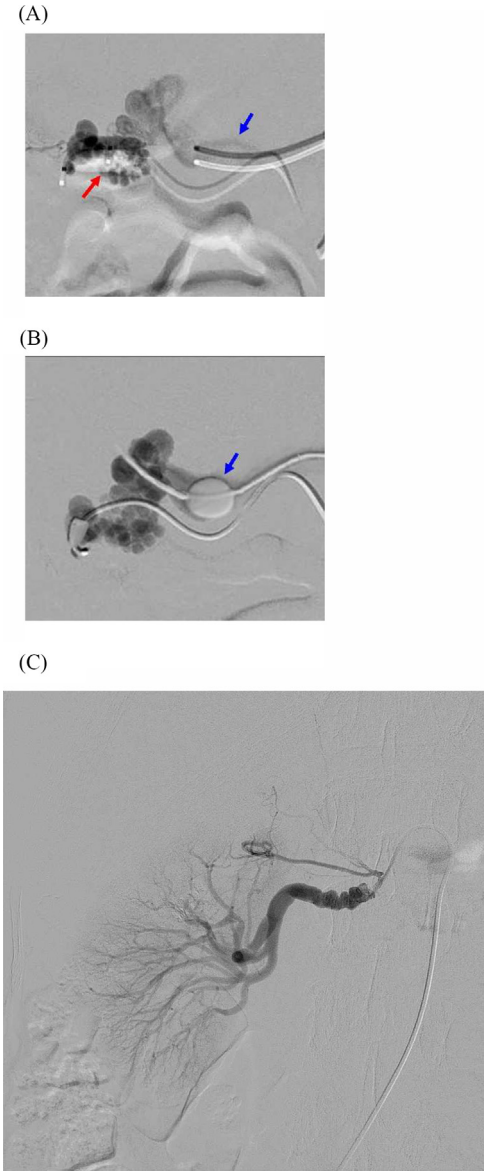

Fig. 3 – (A) Initially, the arterial side of the renal arteriovenous malformation is closed with a microballoon (red arrow), and glue embolization is attempted. However, filling of the right renal vein occurred earlier than expected (blue arrow). (B) Subsequently, the vein side is occluded with a balloon (blue arrow) to control the renal vein blood flow, such that the renal vein is slowly visualized. (C) Right renal digital subtraction angiography is performed after embolization revealed complete occlusion of the shunt. No perfusion defects are noted in the renal parenchyma, and all renal arterial branches are preserved.

parenchyma were noted, and all renal arterial branches were preserved (Fig. 3c).

The day after urgent TAE was performed, hematuria disappeared completely; 5 days later, the patient was discharged from the hospital because laboratory data did not indicate elevated inflammatory reactions or renal failure. Follow-up CE-CT performed 14 days after urgent TAE revealed a complete occlusion of the shunt (Fig. 4). Technical and clinical success were achieved without serious adverse events.

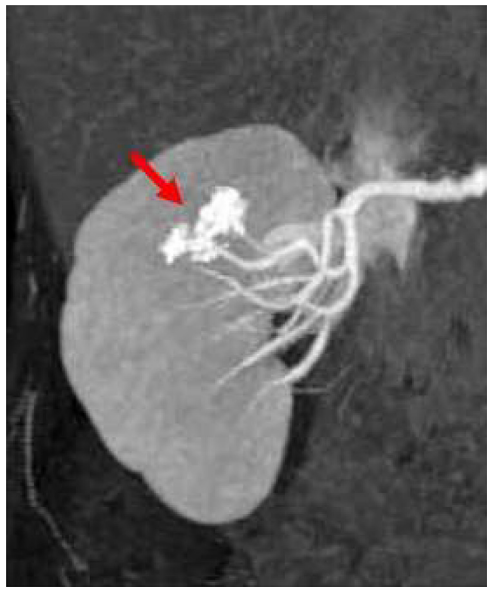

Fig. 4 – Maximum Intensity Projection Image after Embolization. The entire target renal AVM was filled with N-butylcyanoacrylate mixed with lipiodol. This is indicated by the red. All renal arterial branches and veins were preserved.

Discussion

RAVMs are relatively rare, with an estimated incidence rate of less than 0.04% [1]. While surgical procedures have traditionally been the gold standard for RAVM treatment, endovascular embolization has replaced open surgery due to its efficacy and relative noninvasiveness [2,3]. Successful embolization should involve complete and permanent occlusion of the shunt while preserving the normal renal arterial branches. Various embolization agents, including gelatin sponges, coils, and polyvinyl alcohol, have been used for treating RAVMs. Endovascular embolization for RAVMs has yielded positive outcomes, particularly with the use of liquid embolization agents [3,4].

Liquid embolization agents prove especially effective when the catheter cannot be advanced to the shunt point. The polymerization time of NBCA mixed with Lipiodol can be adjusted; in the present case, we decided to perform endovascular embolization using a mixture of NBCA and Lipiodol (33 %) at a ratio of 1:2.

However, several serious complications are associated with the use of liquid embolization agents. In the present case, potential risks included renal infarction secondary to regurgitation into the normal parenchyma as well as pulmonary embolism secondary to the embolic material entering the lungs. We avoided these complications by controlling the inflow and outflow pathways via balloon occlusion.

To summarize, for high-flow arteriovenous malformations, glue embolization under balloon occlusion-mediated inflow and outflow control is an effective technique that can safely embolize the entire target vessel.

Ethics approval and consent to participate

Not applicable.

Availability of data and material

Not applicable.

Authors' contributions

TS: performed the literature review, curated the data, and wrote the original draft of the manuscript. HY: managed the patient, performed the technique, and wrote and edited the manuscript. MK: performed the literature review, and wrote and edited the manuscript. TK: performed the literature review and edited the manuscript. HM: edited the manuscript. TS: wrote and edited the manuscript. All authors read and approved the final manuscript.

Patient consent

The patient provided written informed consent for treatment and for the report to be published.

REFERENCES

[1] Brown DB, Brandes SB. Radiofrequency ablation of a recanalized renal arteriovenous malformation. J Vasc Interv Radiol 2005;16:403–6. doi:10.1097/01.RVI.0000147073.24646.31.
[2] Chimpiri AR, Natarajan B. Renal vascular lesions: diagnosis and endovascular management. Semin Intervent Radiol 2009;26:253–61. doi:10.1055/s-0029-1225665.
[3] Jia ZY, Zhou CG, Xia JG, Zhao LB, Zhang W, Liu S, et al. Endovascular treatment of 12 cases of renal arteriovenous malformations: the experience of 1 center and an overview of the literature. Vasc Endovascular Surg 2018;52:46–51. doi:10.1177/1538574417740509.
[4] Murata S, Onozawa S, Nakazawa K, Akiba A, Mine T, Ueda T, et al. Endovascular embolization strategy for renal arteriovenous malformations. Acta Radiol 2014;55:71–7. doi:10.1177/0284185113493085.