CLINICAL STUDY

Long-term Outcomes of Selective Renal Artery Embolization for Renal Arteriovenous Fistulae with Dilated Venous Sac

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ABSTRACT

Purpose: To retrospectively evaluate the role of selective renal artery embolization for renal arteriovenous fistulae (AVFs) with dilated venous sac.

Materials and Methods: Between 2002 and 2015, 14 patients (7 men and 7 women; mean age, 60 years) with a single renal AVF with dilated venous sac underwent selective renal artery embolization. Three patients presented with gross hematuria, 4 presented with occult blood in urine, and 1 presented with chronic heart failure. Five patients had a history of renal biopsy or partial nephrectomy. Embolic agents used included pushable fibered coils, detachable microcoils, hydrogel coils, *N*-butyl 2-cyanoactylate, and/or absolute ethanol. Technical success was defined as complete angiographic occlusion of the renal AVF without visualization of the venous sac. Clinical success was defined as the disappearance of the AVF on ultrasound and contrast-enhanced computed tomography, without any symptoms.

Results: Fifteen sessions of selective renal artery embolization were performed. Technical success was achieved in 13 sessions (86.7%). Clinical success was achieved in 13 patients (92.9%) after a mean follow-up of 48 months (range, 6-155 months). Two major complications occurred—renal vein thrombosis (n = 1) and renovascular hypertension (n = 1)—and were successfully managed with warfarin and an angiotensin-II receptor blocker, respectively. The former patient required re-embolization because of recanalization. No significant changes were observed in the mean serum creatinine level (.86 mg/dL vs .85 mg/dL; $P = .67$) and the mean estimated glomerular filtration rate (66.0 mL/min/1.73m^2 vs 67.4 mL/min/1.73m^2; $P = .4$) after 6 months.

Conclusions: Selective renal artery embolization is a safe and effective treatment for renal AVFs with dilated venous sac.

ABBREVIATIONS

AVF = arteriovenous fistula, AVM = arteriovenous malformation, e-GFR = estimated glomerular filtration rate, NBCA = *N*-butyl 2-cyanoacrylate

Renal arteriovenous fistulae (AVFs) with dilated venous sac, classically called aneurysmal-type renal arteriovenous malformations (AVMs), have macro fistulae with aneurysmal formation of the draining vein. The etiology of renal AVFs with dilated venous sac can be congenital or acquired; the latter usually results from penetrating trauma, percutaneous biopsy, surgery, malignancy, or inflammation (1,2). Renal AVFs with dilated venous sac can be asymptomatic (3) but occasionally present as gross hematuria, flank pain, or heart failure (4). Selective renal artery embolization has become the treatment of choice in preference to surgical treatments such as nephrectomy and ligation of the affected vessels (5).

Recently, the efficacy of embolization for renal AVMs has been reported in several case series (5–7). However, renal AVFs with dilated venous sac and nidus-type renal AVMs were mixed together, and treatment outcomes for the nidus type were mainly discussed in these reports. In addition, the adverse effect of selective renal artery embolization on renal function remains unknown. In this study, we retrospectively

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evaluated the efficacy, safety, and effect on renal function of selective renal artery embolization for renal AVFs.

MATERIALS AND METHODS

Patients

This single-center retrospective study was approved by the institutional review board. Between November 2002 and April 2015, 14 patients underwent embolization for renal AVFs with dilated venous sac. Patient characteristics are shown in Table 1. There were 7 men and 7 women, and the mean age was 60 years (range, 40–81 years). Five patients had a history of renal biopsy or partial nephrectomy, and their renal AVFs were considered to be acquired lesions. In the remaining 9 patients, the cause of renal AVF was unknown. Three patients presented with gross hematuria, and 4 patients presented with occult blood in urine. One patient with dilated cardiomyopathy presented due to chronic heart failure. The remaining 6 patients were asymptomatic, but they underwent embolization considering the possible risks of circulatory complications due to the high-flow shunts. The maximum short axis diameter of the venous sac ranged from 7 mm to 42 mm (median, 21 mm), which was measured on preprocedural contrast-enhanced computed tomography (CT) (n = 13) or angiography (n = 1). The mean serum creatinine level and estimated glomerular filtration rate (e-GFR) were .86 ± .28 mg/dL (SD) and 66.0 ± 13.6 mL/min/1.73m^2 (SD), respectively. No patient received dialysis.

Table 1. Patients Characteristics

Patients, n	14
Age, years (mean ± SD)	60 ± 12.8
Men, n (%)	7 (50)
Laterality, right, n (%)	8 (57)
Etiology	
Renal biopsy, n (%)	4 (29)
Partial nephrectomy, n (%)	1 (7)
Congenital, n (%)	9 (64)
Clinical presentation	
Hematuria (%)	3 (21)
Uterine occult blood cells (%)	4 (29)
Chronic heart failure (%)	1 (7)
No symptoms (%)	6 (43)
Maximum short axis diameter of the venous sac, mm; median (range)	21 (7–42)
Diagnostic modality	
Contrast-enhanced CT, n (%)	8 (57)
US, n (%)	3 (21)
MR imaging, n (%)	2 (14)
Angiography, n (%)	1 (7)
Renal function (baseline)	
Creatinine, mg/dL, (mean ± SD)	.86 ± .28
e-GFR, mL/min/1.73m2, (mean ± SD)	66.0 ± 13.6

e-GRF = estimated glomerular filtration rate; MR = magnetic resonance; US = ultrasound.

Embolization Techniques

Embolization procedures were performed via a femoral artery approach. Selective renal angiography was performed to evaluate the number and size of feeding arteries, with the fistulous point entering just before the venous sac. After diagnostic angiography, a microcatheter was selectively advanced into the feeding artery as close as possible to the fistulous point via a 5-Fr balloon catheter (Selecon MP catheter, Terumo, Tokyo, Japan) or a guiding catheter (Parent Plus 45, Medikit, Tokyo, Japan) inserted in the renal artery. A tri-axial system combining a 2.6-Fr high-flow-type microcatheter (Masters HF, Asahi Intec, Nagoya, Japan) and a 1.9-Fr microcatheter (Carnelian MARVEL non-tapered, Tokai Medical Products, Kasugai, Japan) was used as needed. Balloon flow control was used to prevent migration of embolic agents into the systemic circulation. Coils and *N*-butyl 2-cyanoacrylate (NBCA: Histoacryl, B. Braun, Hessen, Germany) were mainly used as embolic agents based on the vessel size and the conditions of flow control. Coils were selected according to the operator's preference, and included pushable coils (Tornado, Hilal, and Nester, Cook Inc., Bloomington, Indiana) and detachable microcoils (Helipaq, Presidio and Cashmere, Codman Neuro, Raynham, Massachusetts; IDC, Boston Scientific Co., Marlborough, Massachusetts; Detach, Cook Inc.), and hydrogel coils (Azur, Terumo). NBCA was diluted with Lipiodol at a ratio of 1:1-3. Ethanol was added only when the target vessel was too small to place coils or to fill with NBCA-Lipiodol mixture. Embolization endpoint was occlusion of the AVFs without visualization of venous sac. At the post-embolization angiography, renal parenchymal loss was estimated.

Definitions of Technical Success and Clinical Success

Technical success was defined as complete angiographic occlusion of renal AVFs without visualization of the venous sac. Clinical success was defined as disappearance of the renal AVFs as confirmed by ultrasound and contrast-enhanced CT, without symptoms, including hemorrhage, thromboembolism, or heart failure. Complications were classified as major or minor according to the criteria of the Society of Interventional Radiology (8).

Follow-up

The patients were followed-up by outpatient clinic visit and investigated with blood tests, ultrasound, and contrast-enhanced CT. Changes in renal function were assessed by serum creatinine level and e-GFR from the medical records during the follow-up period. Six months after embolization, the renal function of each patient was compared with that before embolization using the Wilcoxon signed-rank test.

RESULTS

Fifteen sessions of selective renal artery embolization were performed. Outcomes of selective renal artery embolization