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Superselective renal artery embolization for bleeding complications after percutaneous renal biopsy: a single-center experience

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Abstract

Objective: This study aimed to determine if superselective renal artery embolization is a safe and effective method of treating bleeding complications after percutaneous renal biopsy.

Methods: From January 2006 to December 2017, 43 patients (22 men and 21 women, mean age: 44.5 ± 14.0 years) underwent angiography for post-biopsy bleeding complications following percutaneous biopsy. Patients underwent angiography and superselective artery embolization. We recorded serum creatinine and hemoglobin values to assess the effect of embolization.

Results: Successful embolization was achieved in all patients. There was a pseudoaneurysm in 10 cases, arteriovenous fistula in eight, contrast media extravasation in 16, arteriovenous fistula combined with contrast media extravasation in five, and pseudoaneurysm combined with arteriovenous fistula in four. The embolic substance was a microcoil only or combined with a gelatin sponge. The mean creatinine value was not different at 1 day and 1 week after embolization compared with before embolization. Mean hemoglobin values were significantly higher at 1 day and 1 week after embolization than before embolization.

Conclusions: Superselective renal artery embolization is a safe and effective treatment for post-biopsy bleeding complications after percutaneous renal biopsy. Lumbar or iliolumbar artery angiography is necessary if renal arteriography shows no signs of hemorrhage.

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Keywords
Superselective renal artery embolization, percutaneous renal biopsy, bleeding complications, angiography, pseudoaneurysm, arteriovenous fistula

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Introduction

At present, percutaneous renal biopsy (PRB) is widely used in clinical diagnosis and treatment of kidney diseases. Despite development of new technique and skills, post-biopsy bleeding is still unable to be completely avoided and thought to be a severe or even life-threatening complication of PRB.[1–4] Clinical findings of post-biopsy bleeding include formation of para-renal hematoma, hematuria, and the onset of loin and abdominal pain. Treatment for post-biopsy bleeding includes administration of hemostatic drugs or sometimes surgical repair or renal resection. However, transarterial embolization is the preferred approach for renal injury.[5]

A few reports have described embolization therapy of post-biopsy bleeding complications.[6,7] Most of these reports were small studies with a sample size of 20 to 30 cases. In this study, we report our experience of trans-arterial superselective embolization for treating bleeding complications of PRB and its complex causes of disease with a relatively large number of cases.

Materials and methods

General information

From January 2006 to December 2017, 43 patients underwent angiography for post-biopsy bleeding complications following percutaneous biopsy. The initial diagnosis included glomerular disease (n = 17), type II diabetes (n = 5), hypertensive nephropathy (n = 5), antineutrophil cytoplasmic antibody (ANCA)-associated vasculitis (n = 9), and lupus nephritis (n = 7) (Table 1). All renal biopsies were performed under ultrasound guidance with an 18-gauge needle. The symptoms of bleeding included hematuria (n = 43), back pain (n = 41), and decreased blood pressure (n = 39). Computed tomography (CT) was performed for all of the patients and showed para-renal hematoma in all of them (Figure 1). Blood transfusion was performed in 23 patients with hemoglobin levels $\leq$60 g/L. This study was in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) and approved by the Institutional Review Board of Peking University First Hospital. Informed consent was signed by every patient.

Superselective renal artery embolization

A 5 F pigtail catheter was introduced first and whole descending aorta angiography was performed to determine if there was extravasation of contrast medium from the intercostal arteries or the lumbar arteries. A cobra catheter was then introduced into the ipsilateral renal artery and angiography was performed to evaluate the target vessel. A 2.8 F microcatheter (Asahi Intecc Co. Ltd., Aichi, Japan) was superselectively introduced into the target artery of the bleeding site. Metallic fibred platinum microcoils (Tornado Embolization Microcoil; Cook Medical, Bloomington, IN, USA) were used for all patients.

Table 1. Clinical data and angiographic data of the patients.

Sex/age (years)	Pathological type	Symptom	Serum creatinine value (μmol/L)			Hemoglobin value (g/L)			Angiographic manifestation	Embolic agent
			Day 0	Day 1	Day 7	Day 0	Day 1	Day 7		
M/62	Glomerular disease	Back pain/hematuria	324	335	321	72	90	135	Pseudoaneurysm	Microcoil, gelatin sponge
M/52	Glomerular disease	Back pain/hematuria	465	464	463	66	87	120	Arteriovenous fistula	Microcoil, gelatin sponge
M/52	Type II diabetes	Hematuria	389	377	375	84	100	110	Pseudoaneurysm	Microcoil, gelatin sponge
M/48	Glomerular disease	Back pain/hematuria	498	487	483	92	120	130	Arteriovenous fistula	Microcoil, gelatin sponge
F/27	Lupus nephritis	Hematuria	711	710	721	55	88	130	Pseudoaneurysm	Microcoil, gelatin sponge
F/59	ANCA-associated vasculitis	Hematuria	432	434	410	62	90	128	Pseudoaneurysm	Microcoil
M/50	Glomerular disease	Back pain/hematuria	233	255	234	77	100	139	Contrast media extravasation	Microcoil, gelatin sponge
F/64	Lupus nephritis	Hematuria	220	201	210	84	105	136	Contrast media extravasation	Microcoil, gelatin sponge
F/51	ANCA-associated vasculitis	Back pain/hematuria	459	454	448	66	99	126	Arteriovenous fistula	Microcoil
M/50	Hypertensive nephropathy	Hematuria	127	110	118	69	80	140	AVF, contrast media extravasation	Microcoil, gelatin sponge
M/51	Glomerular disease	Back pain/hematuria	477	476	476	78	100	132	AVF, contrast media extravasation	Microcoil, gelatin sponge
F/49	ANCA-associated vasculitis	Hematuria	466	466	456	64	61	89	Contrast media extravasation	Microcoil, gelatin sponge
M/43	Glomerular disease	Hematuria	322	321	333	90	110	120	AVF, pseudoaneurysm	Microcoil
F/22	Lupus nephritis	Hematuria	435	435	438	55	80	90	Contrast media extravasation	Microcoil
M/72	Glomerular disease	Hematuria/shock	274	263	271	49	78	89	AVF, contrast media extravasation	Microcoil
F/43	Type II diabetes	Hematuria	728	723	710	67	78	107	Arteriovenous fistula	Microcoil, gelatin sponge
M/42	Glomerular disease	Back pain/hematuria	322	321	355	80	100	106	Pseudoaneurysm	Microcoil, gelatin sponge
F/37	ANCA-associated vasculitis	Back pain/hematuria	222	240	240	70	90	110	AVF, pseudoaneurysm	Microcoil, gelatin sponge
M/37	Hypertensive nephropathy	Hematuria	433	444	442	84	100	110	Contrast media extravasation	Microcoil, gelatin sponge
F/17	ANCA-associated vasculitis	Back pain/hematuria	121	122	100	55	87	100	Pseudoaneurysm	Microcoil, gelatin sponge
M/38	Glomerular disease	Back pain/hematuria	588	589	587	72	100	120	Pseudoaneurysm	Microcoil, gelatin sponge
M/45	Glomerular disease	Back pain/hematuria	328	340	320	64	89	118	Arteriovenous fistula	Microcoil, gelatin sponge

(continued)

Table 1. Continued

Sex/age (years)	Pathological type	Symptom	Serum creatinine value (μmol/L)			Hemoglobin value (g/L)			Angiographic manifestation	Embolic agent
			Day 0	Day 1	Day 7	Day 0	Day 1	Day 7		
F/45	ANCA-associated vasculitis	Back pain/hematuria	432	433	422	78	76	109	Pseudoaneurysm	Microcoil
M/64	Type II diabetes	Hematuria	333	322	328	54	87	129	Contrast media extravasation	Microcoil
F/22	Glomerular disease	Back pain/hematuria	476	480	472	92	121	125	Contrast media extravasation	Microcoil, gelatin sponge
F/31	ANCA-associated vasculitis	Back pain/hematuria	667	664	663	62	90	109	Arteriovenous fistula	Microcoil
M/63	Type II diabetes	Back pain/hematuria	432	410	422	62	79	134	AVF, contrast media extravasation	Microcoil, gelatin sponge
M/52	Glomerular disease	Back pain/hematuria	226	243	225	76	99	124	Contrast media extravasation	Microcoil, gelatin sponge
F/43	Lupus nephritis	Hematuria	346	376	352	87	101	119	Contrast media extravasation	Microcoil, gelatin sponge
F/42	Lupus nephritis	Back pain/hematuria	656	631	649	67	98	103	Pseudoaneurysm	Microcoil, gelatin sponge
F/42	ANCA-associated vasculitis	Hematuria	555	555	547	73	100	142	Contrast media extravasation	Microcoil
M/57	Glomerular disease	Back pain/hematuria	341	329	339	68	89	104	Contrast media extravasation	Microcoil
M/64	Hypertensive nephropathy	Back pain/hematuria	145	130	147	76	87	126	Contrast media extravasation	Microcoil, gelatin sponge
F/43	Lupus nephritis	Back pain/hematuria	511	521	520	64	79	118	AVF, pseudoaneurysm	Microcoil
F/51	Type II diabetes	Back pain/hematuria	280	276	282	99	120	122	Contrast media extravasation	Microcoil, gelatin sponge
M/54	Glomerular disease	Back pain/hematuria	222	229	230	68	90	99	Pseudoaneurysm	Microcoil, gelatin sponge
M/63	Hypertensive nephropathy	Back pain/hematuria	444	432	440	81	90	107	AVF, pseudoaneurysm	Microcoil
F/38	Hypertensive nephropathy	Back pain/hematuria	365	380	363	101	112	130	Contrast media extravasation	Microcoil, gelatin sponge
F/22	Glomerular disease	Back pain/hematuria	654	666	653	57	90	129	Contrast media extravasation	Microcoil, gelatin sponge
F/18	Lupus nephritis	Back pain/hematuria	333	321	329	55	78	119	Contrast media extravasation	Microcoil, gelatin sponge
M/31	Glomerular disease	Back pain/hematuria	213	252	217	70	100	126	Arteriovenous fistula	Microcoil
F/22	ANCA-associated vasculitis	Back pain/hematuria	200	210	200	83	100	110	Arteriovenous fistula	Microcoil, gelatin sponge
M/36	Glomerular disease	Back pain/hematuria	701	710	701	76	98	135	AVF, contrast media extravasation	Microcoil

M: male; F: female; ANCA: antineutrophil cytoplasmic antibody.

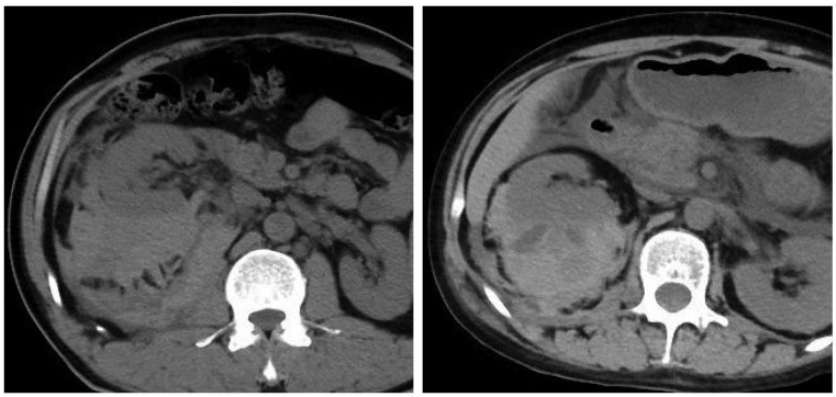

Figure 1. Computed tomography scan shows a perirenal hematoma after percutaneous renal biopsy.

A gelatin sponge was used as supplementary embolization for arteries that could be superselected from normal renal arteries. The endpoint of embolization was total obliteration of the target vessel. After treatment, posterior-anterior and oblique angiography was performed again for evaluating the homeostatic effects.

Follow-up procedure

After the interventional procedure, all of the patients entered a follow-up program with continuous monitoring of vital signs for 24 hours. Relief of symptoms was recorded, and hemoglobin and serum creatinine levels were measured on days 1 and 7 after embolization therapy.

Statistical analysis

The paired t-test was used to analyze differences in mean creatinine and hemoglobin values before and after embolization. Statistical analysis was performed using SPSS version 20 (IBM, Chicago, IL, USA).

Results

We studied 22 men and 21 women (mean age: 44.5.± 14.0 years, age range: 17–72 years). In the 43 patients, 52 branches of the renal artery were found to have an abnormal appearance. Angiography clearly showed typical signs related to bleeding complications. These findings included a pseudoaneurysm in 10 cases arteriovenous fistula in eight cases, extravasation of contrast media in 16 cases, arteriovenous fistula combined with contrast media extravasation in five cases, and pseudoaneurysm combined with arteriovenous fistula in four cases (Figure 2). Embolic material was a microcoil alone or a microcoil followed by a gelatin sponge (Table 1). Successful embolization was achieved in 42 patients by one therapy session and one patient required two therapy sessions. The patient who required two times of embolization was diagnosed with ANCA-associated vasculitis. In 29 patients with severe back pain, symptoms gradually improved 2 to 5 days after embolization. All cases of hematuria disappeared from 2 to 7 days after the operation. One patient with hypovolemic shock recovered immediately with steady vital signs after the embolization treatment. Thirty-one patients with original impaired renal function underwent hemodialysis after the operation.

In two patients, there were no abnormalities related to the renal artery. The bleeding site was finally confirmed to be a branch of

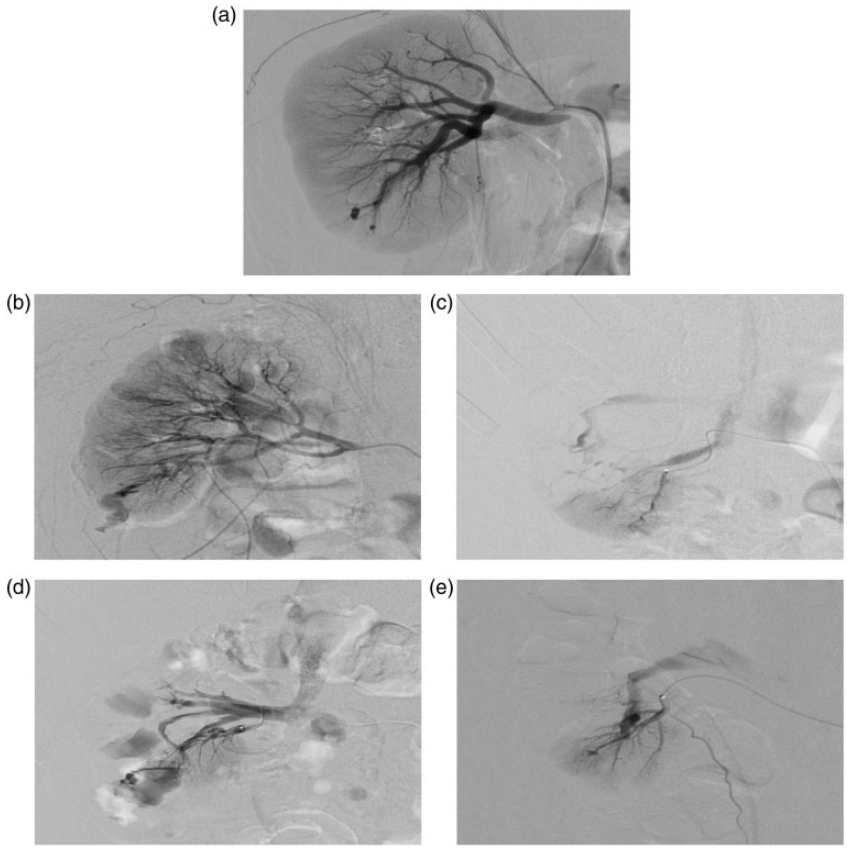

Figure 2. Different types of renal hemorrhage. (a) Pseudoaneurysm; (b) contrast media extravasation; (c) arteriovenous fistula; (d) arteriovenous fistula and contrast media extravasation; (e) arteriovenous fistula and pseudoaneurysm.

the lumbar artery and iliolumbar artery by angiography for the lumbar artery (Figure 3). These patients were successfully treated by intra-arterial embolization.

Mean serum creatinine levels were 397.8 μmol/L before embolization (median: 389.0, range: 121.0–728.0 , standard deviation: 163.7 μmol/L, 95% confidence interval: 347.4–448.1), 398.5 μmol/L 1 day after embolization (median: 380.0, range: 110.0–723.0, standard deviation: 162.4 μmol/L, 95% confidence interval: 348.5–448.5), and 395.6 μmol/L 1 week after embolization (median: 375.0, range: 100.0–721.0, standard deviation: 162.7 μmol/L, 95% confidence interval: 345.6.8–445.7). Mean creatinine values 1 day and 1 week after embolization were not significantly different compared with before embolization (95% confidence interval: −4.9–3.4 and −0.92–5.2, respectively) (Figure 4a).

Mean hemoglobin values were 72.2 g/L before embolization (median: 70.0, range: 49.0–101.0, standard deviation: 12.6 g/L, 95% confidence interval: 68.3–76.1), 93.4 g/L 1 day after embolization (median: 90.0, range: 61.0–121, standard deviation: 12.5 g/L, 95% confidence interval: 89.5–97.2), and 118.7 g/L 1 week after embolization (median: 120.0, range: 89.0–142.0,

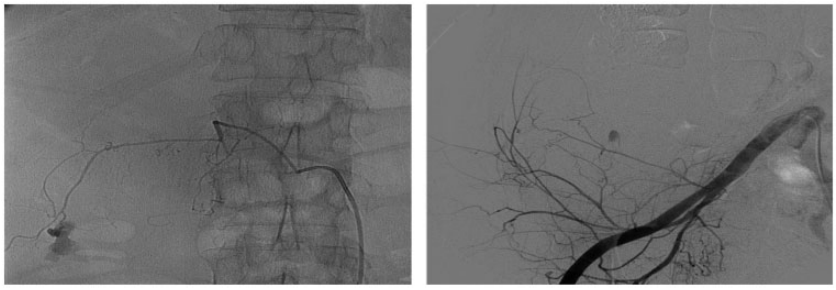

Figure 3. Hemorrhage of the lumbar artery.

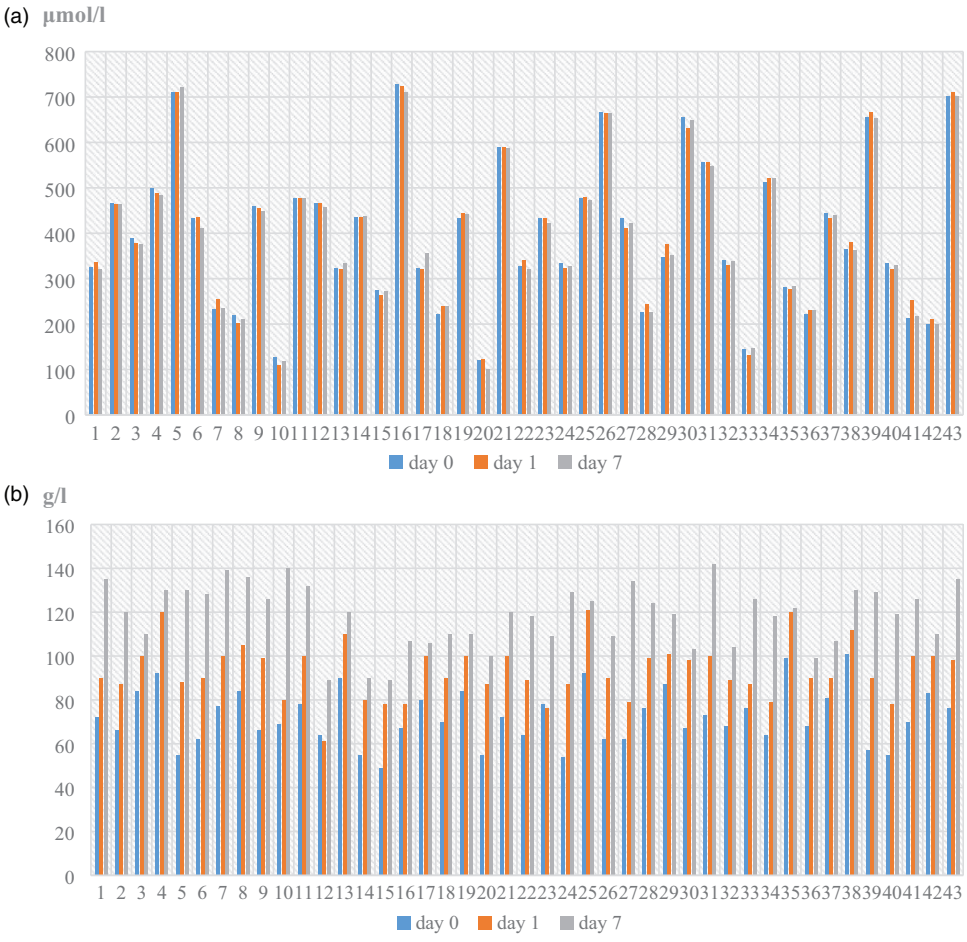

Figure 4. (a) Differences in mean creatinine values before and 1 day and 1 week after embolization ($P = 0.677$: day 1 versus day 0; $P = 0.369$: day 7 versus day 0). (b) Differences in mean hemoglobin values before and 1 day and 1 week after embolization ($P < 0.001$: day 1 vs day 0 and day 7 versus day 0). Day 0: the day before embolization; day 1: 1 day after embolization; day 7: 1 week after embolization.

standard deviation: 14.1 g/L, 95% confidence interval: 114.4–123.0). Mean hemoglobin values were significantly higher at 1 day and 1 week after embolization compared with before embolization ($P < 0.001$, 95% confidence interval: −23.8 to −18.5; $P < 0.001$, 95% confidence interval: −51.5 to −41.5, respectively) (Figure 4b).

Discussion

Some studies on post-biopsy bleeding complications that used real-time ultrasound guidance and focused on complications showed that the incidence of complications was 7.5% to 58.6%.[8–10] In our center, only severe bleeding complications needed to be treated by embolization. The definition of a complication in our center is a large hematoma, decreased blood pressure, and extended hospitalization, similar to other studies.[1,2]

Because of considerable loss of parenchyma, surgical approaches are no longer the first choice in most circumstances of renal vascular injury.[11] Otherwise, there is no need for general anesthesia in interventional therapy. Interventional treatment can locate abnormal blood vessels in a timely manner and achieve occlusion without losing normal renal parenchyma. Therefore, interventional therapy has become the first choice for treatment of iatrogenic renal vascular injury.[12–15]

Angiographic manifestations of renal vascular injury include pseudoaneurysm, renal arteriovenous fistula, and contrast media extravasation.[13] All of these manifestations were found in our study. There were no abnormalities related to the renal artery in one patient. The bleeding site was finally confirmed to be a branch of the lumbar artery and iliolumbar artery in this patient. To the best of our knowledge, lumbar or iliolumbar artery hemorrhage rarely occurs after renal biopsy. Only a few reports have described a similar phenomenon of lumbar artery or iliolumbar artery hemorrhage.[16,17]

Materials that are used in renal artery embolism, such as microcoils, polyvinyl alcohol (PVA) particles, a gelatin sponge, and tissue glue, are widely recognized, and can be selected according to the type of disease and personal habits. The microcoil is suitable for different diameters of arteries. The cages on the coils are easy to induce thrombosis and achieve complete embolism. Studies have shown that use of coil embolization has little effect on renal function.[18] Gelatin sponge particles are large and embolized arteries can be recanalized, and thus this method is relatively safe. Therefore, gelatin sponge particles can be used as a supplementary embolization after coil embolism. PVA particles are small in diameter and are a permanent embolic material. PVA particles should not be used for a separate embolism to prevent them from entering a larger arteriovenous fistula directly.[19] Our experience in treating renal artery embolization suggests the following: (1) angiography should be comprehensive and the lumbar or iliolumbar artery should not be neglected if necessary; (2) to define the site of bleeding, multi-angle angiography should be performed; (3) preservation of normal renal parenchyma is important; (4) the dosage of contrast medium should be reduced during the operation to prevent deterioration of renal function.

In our study, successful embolization was achieved in all patients, but one patient experienced two times of embolization. The pathological diagnosis of this patient was ANCA-associated vasculitis. Contrast agent extravasation sign was found in the lower pole of the right kidney in the first angiography. We used a microcoil and gelatin sponge to embolize the target artery and no bleeding signs were observed. The patient developed signs of decreased blood pressure and hemoglobin on the

second day. We performed a second angiography and found contrast agent extravasation sign in another artery. We used a microcoil and gelatin sponge to embolize the target artery again. The patient's blood pressure was stable after the operation and the hemoglobin level was improved. The patient did not experience re-bleeding. We considered that the body's self-protection mechanism led to renal artery contraction during bleeding. When the first angiography was performed, vascular damage of one artery was smaller than that in the other arteries and the renal artery was contracted. Therefore, there was no sign of bleeding. After the first angiography, a larger area of vascular damage was blocked. Therefore, blood pressure was increased and the mechanism of vasoconstriction weakened. Signs of bleeding occurred in vascular damage of the smaller artery (Figure 5).

Some studies have reported renal function after renal embolization. Loffroy et al.[6] documented a stable glomerular

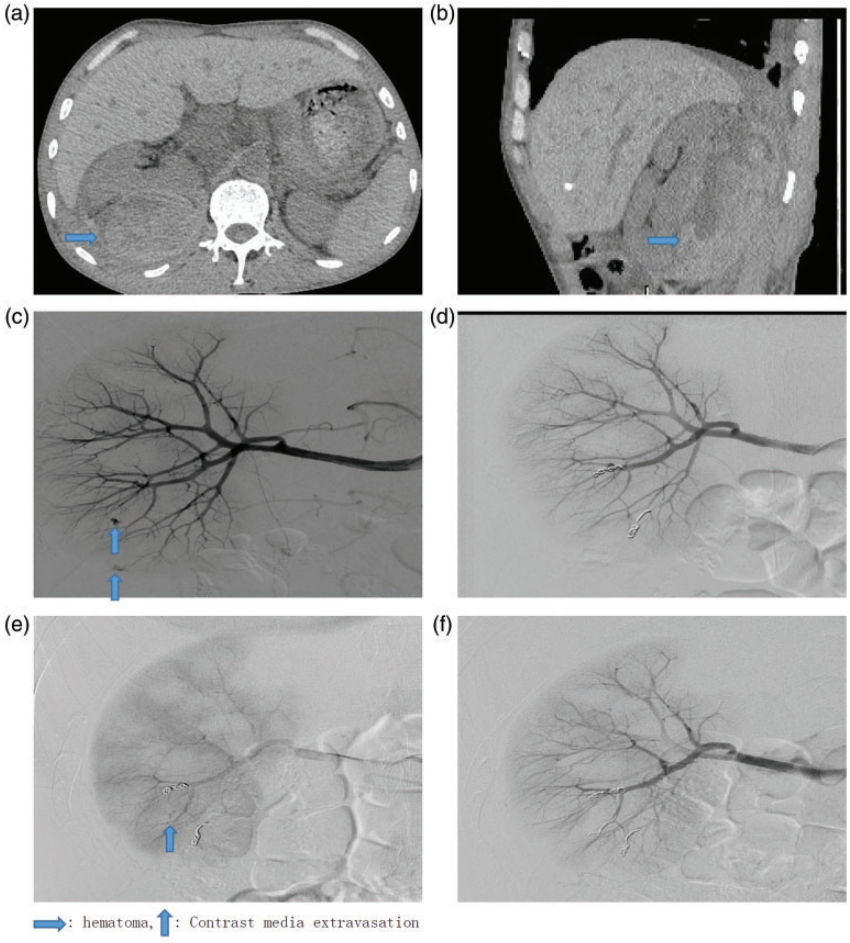

Figure 5. (a) A computed tomography scan shows a hematoma. (b) The hematoma fills the posterior renal space. (c) Contrast media extravasation in the first angiography. (d) Renal angiography after the first embolization. (e) Contrast media extravasation in the second angiography. (f) Renal angiography after the second embolization.

filtration rate in six patients after embolization and improvement in four patients. Maleux et al.[20] studied 13 patients with vascular lesions in renal allografts and found that renal function improved in nine patients. In our study, 31 patients (serum creatinine level >300 μmol/L) underwent hemodialysis after the operation because of poor renal function. Serum creatinine levels were not significantly altered before and after embolization. Because our patients had poor initial renal function, we considered that stable renal function was a good result. The patients' hemoglobin values were significantly increased 1 day and 1 week after embolization compared with before embolization. This finding indicated that embolization was safe and effective.

The incidence of complications of renal artery embolization is relatively low. Complications include post-embolization syndrome, infection, and renal dysfunction.[21] Post-embolization syndrome is characterized by fever and low back pain. After symptomatic treatment, this condition can be improved without special treatment. Patients with a risk of infection should be provided antibiotic prophylaxis after the operation. Patients with poor renal function should be provided hemodialysis after the operation. In our study, there were no obvious complications in any of the patients and 31 patients with poor renal function received hemodialysis.

Conclusion

This study shows that superselective renal artery embolization is a safe and effective treatment for post-biopsy bleeding complications. This technique offers maximal preservation of the renal parenchyma and protection of renal function. Other arteries should not be neglected if renal arteriography shows no signs of hemorrhage.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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