Alwarraky et al. Egyptian Journal of Radiology and Nuclear Medicine (2020) 51:205
https://doi.org/10.1186/s43055-020-00328-6

Egyptian Journal of Radiology and Nuclear Medicine

RESEARCH Open Access

Clinical outcome and safety of selective renal artery embolization using permanent occlusive agents for acute renal bleeding

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Abstract

Background: To evaluate how far is selective renal artery embolization (RAE) using permanent agents effective in treating acute renal artery bleeding. We retrospectively reviewed the medical records of patients (n = 45) with renal bleeding who were managed by selective RAE using coils, N-butyl-cyanoacrylate glue (NBCA glue), and polyvinyl alcohol (PVA). Data retrieved included the cause, number, and type of the bleeding lesions as well as the results of the embolization for 1 year after RAE. Clinical success was the primary outcome while re-bleeding and complications were the secondary outcomes.

Results: There were 55 bleeding lesions detected by angiography in the included 45 patients. Coils were used in 23/45 patients (51.1%), NBCA glue in 15/45 patients (33.3%), and PVA in 7 patients (15.6%). Bleeding could be controlled with embolization in a single session in 41/45 patients with primary clinical success 91.1%. Four patients needed re-embolization sessions to control bleeding and only one patient was controlled, giving secondary clinical success of 92.3%. Three patients failed to respond to embolization and nephrectomy was done. Iatrogenic dissection of the segmental branch was seen in one patient. Post embolization syndrome was seen in 14/45 patients (31.1%). Non-target embolization was seen in 2 patients: one during treatment with NBCA glue and the other with PVA. No other complications were recorded. No significant differences between clinical success among coil, NBCA glue, and PVA subgroups ($P > 0.05$).

Conclusion: Selective RAE using permanent agents is effective in controlling renal bleeding and no significant difference among coil, NBCA glue, and PVA.

Keywords: Renal bleeding, Embolization, Hematuria, Permanent, Coils, Glue

Background

Acute bleeding of renal origin could be iatrogenic, traumatic, neoplastic, or spontaneous with or without apparent underlying pathology. The clinical forms of bleeding may appear as frank hematuria or peri-renal hematomas with hemoglobin drop. Most of these bleeding states are self-limiting and conservative treatments are usually sufficient [1]. However, in massive bleeding or continuous hematuria, conservative treatment is mostly ineffective and is associated with a high recurrence rate. Hence, these states require therapy to control the bleeding either by open surgery or by selective RAE [2].

Complete nephrectomy, the commonly used emergency surgery, may involve several surgical injuries, post-operative complications, and risk of aggressive removal of functioning renal tissue with loss of renal reserve [3].

RAE was enrolled in 1964 as a line of treatment and since then with modifications over the time to perform super-selective RAE with minimal tissue loss [4]. Generally, the results of RAE depend—in part—on the type of the embolic agents. Various embolic agents are used. Among them are temporary agents like gel foam, thrombine, and collage

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granules. Permanent agents involve coils, NBCA-glue, PVA particles, and microvascular plug (MVP). The clinical outcome regarding the stoppage of bleeding or the recurrence usually depends on the type of the embolic material used [5, 6].

During the few last decades, numerous studies have been published that analyzed the indications and outcomes of RAE for the treatment in patients with renal bleeding. However, there is a lack of data regarding the specific results for various types of embolic agents [7–9].

We aimed in this study to evaluate the clinical outcome and safety of permanent embolic agents used in RAE for acute renal bleeding.

Methods

Study design and patients information

We retrospectively reviewed the medical records of all consecutive adult patients (n = 64) who underwent RAE for the treatment of refractory renal bleeding in our hospital between 2014 and 2019. The clinical and radiological data were retrieved for the patients. Nineteen patients were excluded (eight patients were excluded because of using gel foam as a temporary embolic agent, four patients because of use of the combination of more than one type of the embolic agent; PVA and coils one patient, and NBCA-glue with coil in one patient, and the last seven patients because of the unavailability of the follow-up data). Finally, 45 adult patients (mean age ± SD was 39.6 ± 4.4 years) were included in our study and informing consent of participant was not necessary as our study is retrospective.

The indications for RAE were (1) gross renal bleeding that persisted for more than 72 h, mandating repeated blood transfusion in 22 patients, (2) continuous hematuria necessitating blood transfusing in 14 patients, and (3) significant peri-renal bleeding with hematuria in 9 patients.

For diagnosis, all patients had ultrasound before interventions. Twenty-nine patients underwent digital subtraction angiography as the imaging modality to diagnose bleeding while in 16 patients; CT and CT angiography were the modality of diagnosis prior to angiography. The decision of RAE was taken when angiography detected [1] free extravasation, [2] aneurysm or pseudoaneurysm (PA), [3] arteriocalyceal fistula (ACF), and [4] tumor vasculatures.

Technique of selective renal artery embolization

All procedures were done in the angiography suite (Allura Xper FD20; Philips Healthcare; Philips). Transfemoral artery approach was used and a 5-Fr catheter was inserted. Diagnostic aortography was needed only in 5 patients to identify the origin of the renal arteries and was performed with a 5-Fr pigtail catheter. In the remaining patients, Cobra (Imager II, Boston Scientific, USA) or Sos-omni (Soft-vu, Angio-dynamics, Queensbury, New York, USA.) catheter was advanced over a 0.035-inch guide-wire for selective renal artery catheterization. After diagnostic selective renal arteriography, we used a 4-Fr catheter for lesions at or near a segmental branch while a micro-catheter system for lesions at a sub-segmental branch. In 5 patients, arterial lesion could be reached using a 4-Fr catheter. In the remaining 40 patients, we used a 2.7-Fr microcatheter (Progreat Terumo Corporation, Tokyo, Japan) because of arterial tortuosity with acute angulations as well as the distal site of the lesion and routinely for delivery of NBCA glue to prevent catheter gluing to the artery and in cases with micro-coils.

Embolic agents were delivered either inside the lesion directly or as near as possible to the lesion in the segmental feeding artery of the lesion via the catheter. Embolic agents included detachable vascular micro-coils (detachable fibered coils-0.018 Interlock^{TM}-18 Occlusion System, Boston Scientific) in 23/45 patients (Figs. 1, 2). Medical NBCA glue was used in 15/45 patients. NBCA glue was prepared manually by mixing iodized oil (Lipidol, Andre Guerbe Lab France) with 1-2 ml of N-butyl-cyanoacrylate (Histoacryl® skin adhesive 0.5 ml; B. Braun Aesculap, Tokyo, Japan) at 1:2 ratio producing a 66% mixture in case of rapid polymerization when catheter was intra-lesional (Fig. 3). When the catheter is in the segmental artery and slow polymerization is needed, the mixture was obtained at 1:4 ratio (Figs. 4, 5, 6). Seven patients were managed using PVA sized 100-300 μm and 300-500 μm (Merit Medical, Bearing sPVA Embolization Particles) (Figs. 7, 8).

Cessations of bleeding and complete obliteration of the lesion on post-embolization angiogram were the indicators that the procedure was completed.

Data collection

The angiographic findings regarding the type of lesion, site, and number were retrieved. The pre- and post-embolization data and results of the procedure were recorded as well. The complications and bleeding recurrence that occurred during the first year after embolization were extracted from patient's charts.

Study outcomes and definitions

The primary outcome in the present study was the clinical success that is defined as resolution of gross hematuria without recurrence of hematuria in the first month after embolization, no recurrent hemoglobin drop with no subsequent need for blood transfusion, and no need for renal surgery. It was defined as "primary" if success occurred after the first session and defined as "overall" if after the second session of embolization. The secondary outcomes included technical success, recurrence of bleeding, and complications. Complete stop of the renal bleeding on angiography was

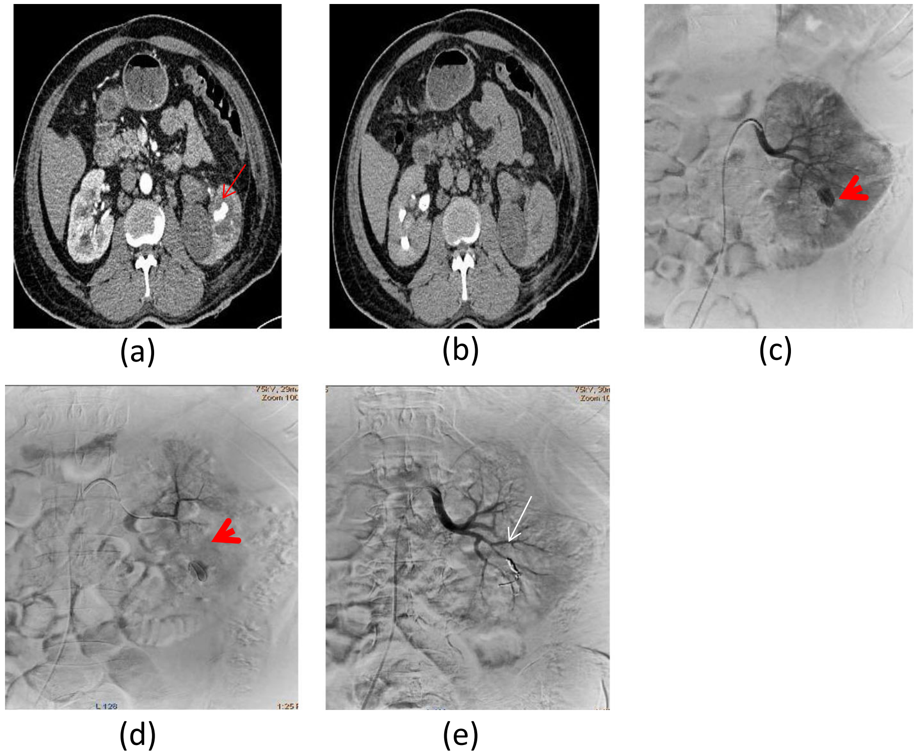

Fig. 1 Pre-embolization CT (**a**, **b**) of a 63-year-old man who presented with bleeding after PCNL showing aneurysmal extravasation (arrow) in the left kidney. Angiography revealed a pseudoaneurysm at the lower zone of the kidney (arrow head) (**c**, **d**). After super-selective catheterization with Progreat microcatheter, a micro-coil was inserted. The post-embolization DSA (**e**) showed obliteration of the aneurysmal sac with its sub-segmental feeder by the coil (white arrow) (**e**)

marked as technical success. Recurrence of bleeding was defined as re-bleeding that occurs during the first year after procedure. Technical complications considered were non-target embolization, puncture site bleeding, and iatrogenic vascular damage. Medical complications included post-embolization syndrome (back pain, fever not due to other cause and nausea), renal or peri-renal abscess, arterial hypertension, and disturbed renal functions.

Statistical analysis

Data analysis was conducted using the SPSS v.24 software (SPSS Inc., Chicago, IL, USA). Continuous variables are presented as mean ± SD. Normal distribution of the data was checked by the Kolmogorov-Smirnov test. If normally distributed, Student's t test was used to compare the means of the outcomes. The paired t test was used to compare permeabilization and postembolization values. Otherwise, the corresponding non-parametric tests were used. P value < 0.05 was considered statistically significant in all these tests.

Results

Etiology of bleeding and angiographic lesion characteristics

Table 1 shows causes of acute renal bleeding and the number of cases with different abnormalities on renal arteriography. Thirty-nine were secondary to traumatic injury (35 iatrogenic and 3 secondary to penetrating trauma and one blunt trauma). Of the iatrogenic trauma, there were 15 from PCN, 7 biopsies, 8 percutaneous nephrolithotomy (PCNL), and 5 operative. Six patients had non-traumatic bleeding; four patients had renal angiomylipoma while 2 patients had AVMs causing this spontaneous intermittent bleeding. Before embolization, all patients underwent US imaging information about the site and flow pattern of the lesion and 16 patients were investigated by CT that gave information about the site and type of the bleeding vessel. Both US and CT helped in assessing the condition of the kidneys.

Fifty-five angiographic lesions were detected in the 45 patients. In patients with renal trauma (39 patients), angiography discovered 49 bleeding lesions. In one patient with blunt trauma, giant pseudoaneurysm measuring 10 cm was recorded and it was filled from a main lobar artery. We used the microcatheter system to go inside the aneurismal cavity and filled with 18 ml NBCA glue. In non-trauma patients (6 patients), angiography showed two AVMs in 2 patients and 4 tumors in the other 4 patients as a main cause of recurrent hematuria. The types of arterial origin of lesions, the type of embolic agents, and treatment sessions are seen in Table 2.

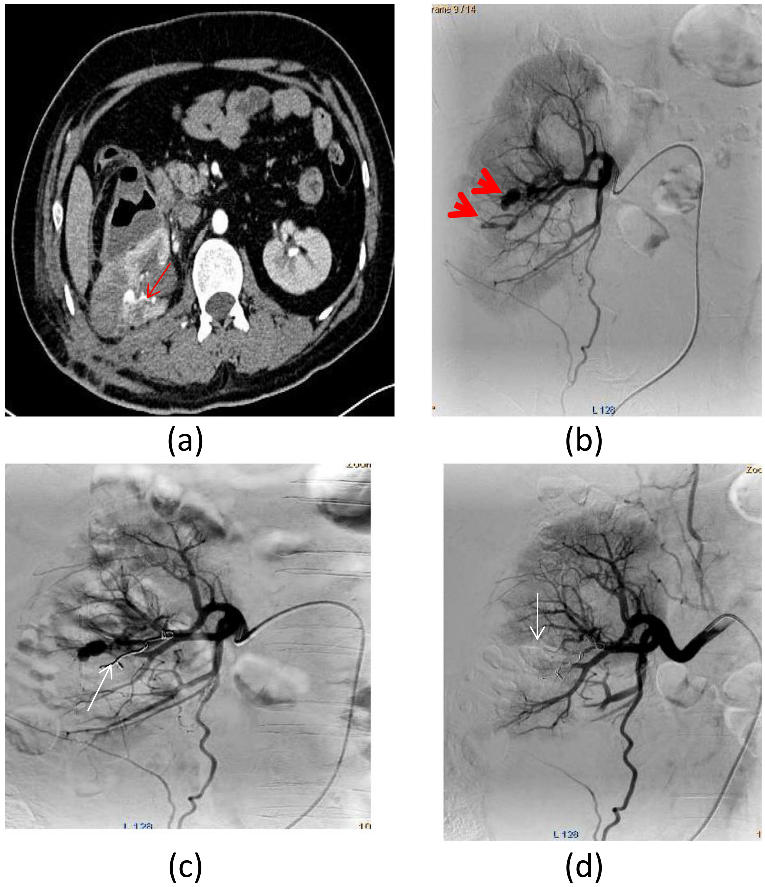

Fig. 2 Pre-embolization CT image (**a**) of a 45-year-old man who presented with bleeding after biopsy showing contrast extravasation in the right kidney (arrow). Pre-embolization DSA (**b**) revealed two pseudoaneurysmal lesions at the middle zone of the right kidney (arrow head) (**b**). After super-selective catheterization with a microcatheter, two micro-coils were inserted. Postembolization DSA (**c**, **d**) showed no filling of the pseudoaneurysms

Clinical success

Table 3 shows the clinical outcome and complications in studied patients. Technical success was achieved in 100% of patients. Clinical success was achieved in 41/45 patients from the first session reporting primary clinical success of 91.1%. One patient showed a partial response as bleeding persisted after embolization. Medical treatments in the form of hemostatics failed to control the bleeding for a week after embolization. This patient was subjected to another session of embolization, and the diagnostic angiography showed leaking around the previously implanted undersized coil in the pseudoaneurysm. The feeding artery of the aneurysm was re-packed by another coil sized 0.018 to ensure complete packing. Overall, the total number of patients with clinical success after the second session is 42/45 (93.3%). Three patients did not respond to the second session embolization. In these patients, bleeding persisted as these lesions were multiple. Those patients were subjected to nephrectomy. For the subgroup of coils (n = 23), the clinical success was achieved in 21/23 patients reporting primary clinical success of 91.3%. On the other hand, or the subgroup of NBCA glue (n = 15), the clinical success was achieved in 14/15 patients reporting primary clinical success of 93.3% while for the PVA subgroup (n = 7), all patients were controlled with a clinical success rate of 100%. We reported no significant differences regarding re-bleeding among subgroups of analysis ($P > 0.05$).

Regarding the recurrence of bleeding, none of our patients experienced re-bleeding for 1 year except one having an AVM. Re-bleeding occurred after 6 months of the embolization. For this patient, we occluded the proximal segment of the AVM because of the rapid polymerization of NBCA glue with rapid thrombosis. Diagnostic angiography for this patient showed multiple collaterals that supplied the AVM. RAE was unsuccessful and this patient underwent nephrectomy.

Complications

For technical complications, non-target embolization was seen in 2/45 patients (4.4%); one during treatment with NBCA-GLUE; and one patient with PVA. No extra-

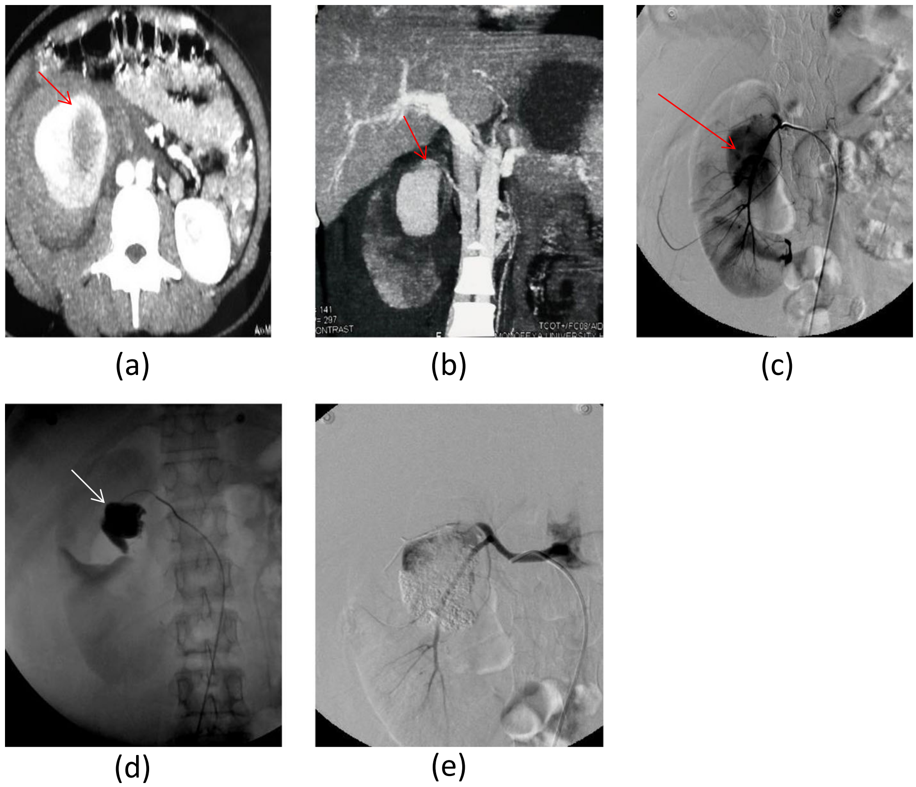

Fig. 3 A 38-year-old man had persistent massive hematuria due to a closed contusion of the right kidney in a car accident. Renal artery CTA (**a**, **b**) shows a giant pseudoaneurysm in the upper pole of the right kidney (red arrow). Angiography with the Cobra catheter (**c**) shows the pseudoaneurysm in the middle zone of the right kidney with leaking bleeding and there is contrast extravasation (long red arrow). NBCA glue was injected by microcatheter to fill the aneurysm forming thrombus ball (white arrow). Post-embolization angiography (**e**) shows occlusion of the pseudoaneurysmal sac and leak. The surrounding kidney tissues appear normal

renal or extensive renal branch embolization occurred. One patient (2.2%) suffered iatrogenic dissection of the segmental branch due to prolonged and extensive manipulations. Regarding medical complications, post-embolization syndrome was seen in 14/45 patients. Seven of them were in group of NBCA glue representing 50% of NBCA-glue patients. Post-embolization syndrome was mild in 12 patients. In the remaining two patients, the syndrome was severe as this occurred in the 2 patients with non-target embolization. Other complications such as peri-renal or renal abscess, decreased renal functions or arterial hypertension were not detected in any of the patients.

Discussion

Acute renal bleeding is a common emergency in urology. It can be due to a number of factors such as closed or open renal trauma. Commonly, iatrogenic renal vascular injuries represent 50% of renal vascular lesions and can occur during renal biopsies, PCNL, or PCN [7–10]. Renal tumors, such as renal angiomyolipoma or renal cell carcinoma and renal arteriovenous malformations, are also important causes of acute renal bleeding. Bleeding from these causes might be in the form of aneurysm, pseudoaneurysm (PA), extravasation, AVF, ACF, or perinephric hematoma [4, 5]. In our study, trauma represented 86.6% of our patients. Most of them were iatrogenic.

Diagnosis of cases and accurate detection of lesions depended on CT and US but still angiography is the best modality above with the highest accuracy in detecting the bleeding and its cause [11]. Angiography is surely diagnostic but can be therapeutic also at the same session [12, 13]. In this study, 16 patients were diagnosed with CT and the remaining 29 patients were evaluated with angiography on the first imaging modality because they needed emergency RAE. CT with its CT angiographic assessment provided an accurate description of the bleeding lesions in the kidney that facilitates interventions.

The angiographic picture of bleeding varies based on the severity and cause of the acute renal bleeding. In the study of Wang et al., they found contrast extravasation as a most common finding representing 49.4% of cases (41/83) while traumatic AVF in 14.4%, renal pseudoaneurysm in 8/83 patients (9.6%) [14]. However, the study of Ząbkowski et al. reported the pseudoaneurysms as the

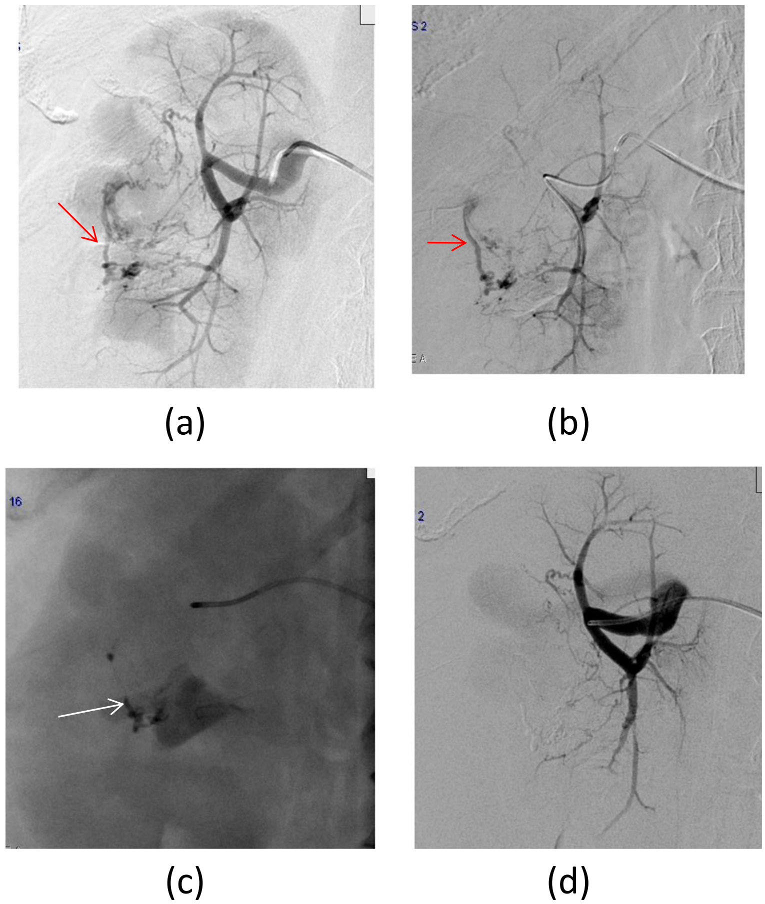

Fig. 4 A 72-year-old woman had continuous hematuria of with the CT diagnosis of right large AVM. Renal angiography with the Cobra catheter (**a**, **b**) shows the multiple serpiginous abnormal arteries with the ectatic wall in the right kidney (red arrow). NBCA glue was injected by microcatheter to fill the segmental artery that feeds the abnormal vessels (white arrow). Post-embolization angiography (**d**) shows disappearance of these vessels. The surrounding kidney tissues appear normal

most common finding [15]. In our study, pseudoaneurysms were the most common picture seen where bleeding was discovered as pseudoaneurysms in 35/55 lesions (63.6%) and as free extravasation 11/55 lesions (20%) that is running with Ząbkowski et al.

It is essential to mention that the clinical response of RAE depends on the type of the embolic agent and the adequacy of the embolization process. When selecting an embolic agent, several factors should be taken into consideration. These factors are the lesions site, size, and flow of pattern of vessels to be occluded, the availability of embolic agents, the comprehension of the radiologist who will perform the procedure, the speed and reliability of delivery, the duration of the occlusive effect, and the avoidance of non-target embolization [15, 16]. In our study, we used permanent occlusive agent, namely, the coils, NBCA glue, and PVA particles to avoid recanalization of the lesion and so, bleeding recurrence will be less.

Regarding the clinical success, our study reported a primary clinical success rate of 91.1% after the first session while the overall rate after the second session was 93.3%. This agreed with Limtrakul et al. who reported clinical success of 91.5% for their 94 patients treated with RAE [17]. Moreover, Du et al. reported clinical success of 100% of RAE compared to conservative therapy that was 73.6% in their cases of bleeding after PCNL [18]. Regarding treatment failure, RAE failed to control bleeding in 3 cases of our patients. This ran with Wang et al. who reported 4/81 (4.8%) cases of failure. The majority of their patients (3/4) were post-severe renal trauma. In our study, all failed patients were post-traumatic with either multiple injuries. For those patients, nephrectomies were done. In our study, one patient got recurrence of bleeding after 6 months of embolization of his AVM due to incomplete nidus obliteration.

Specifically, as for the coil sub-group, we successfully used coils in 23 patients representing (51.1%). All coils

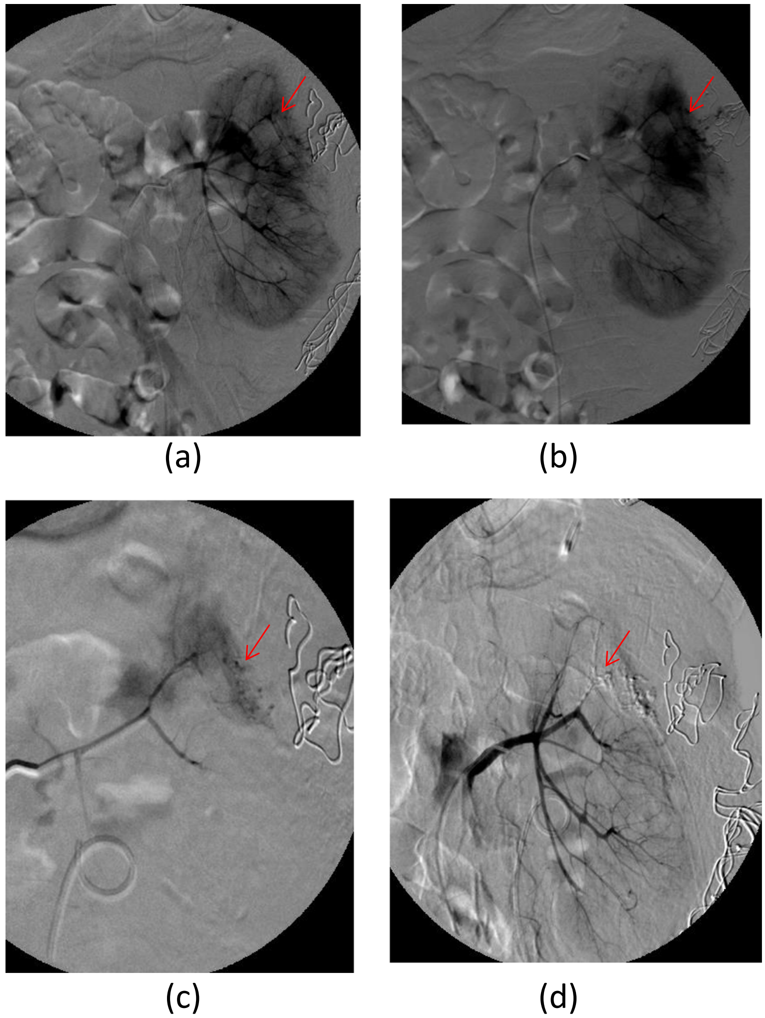

Fig. 5 A 14-year-old boy presented with persistent hematuria and perirenal hematoma after surgery for left renal trauma. Angiography with a Cobra catheter (**a**, **b**) and microcatheter (**c**) reveal contrast extravasation in the upper segmental branch of the left renal artery. The bleeding artery is successfully occluded by NBCA glue. Angiography with the Cobra catheter after embolization (**d**) showed that all bleeding arteries have been completely occluded. Normal renal arteries and the renal parenchyma are visible

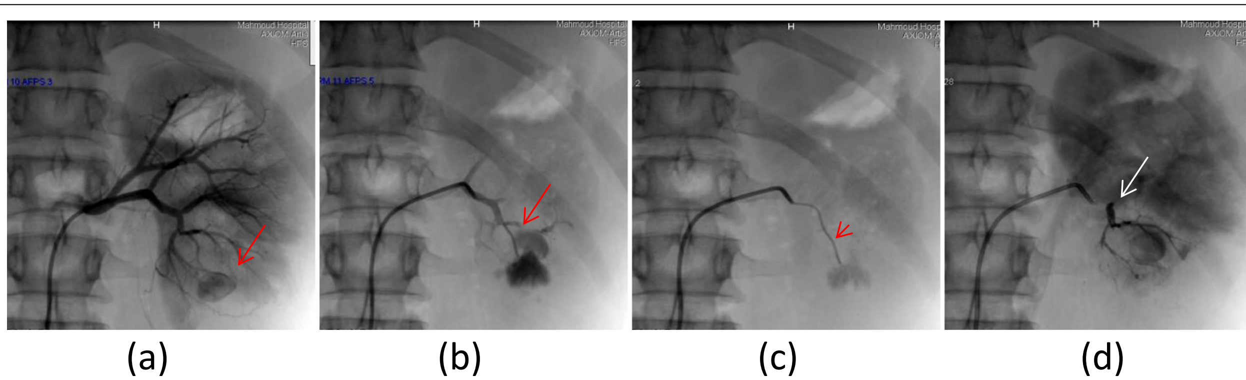

Fig. 6 A 28-year-old man had persistent massive hematuria due to a closed contusion of the left kidney in a car accident. Renal artery angiography with the Cobra catheter (**a**) shows the pseudoaneurysm in the lower zone of the left kidney (red arrow). Micro-catheter angiography was done keeping the catheter inside the aneurysmal sac (**c**) (arrow head). NBCA glue was injected by microcatheter to fill the aneurysm but spilled over the segmental branch (white arrow) (**d**)

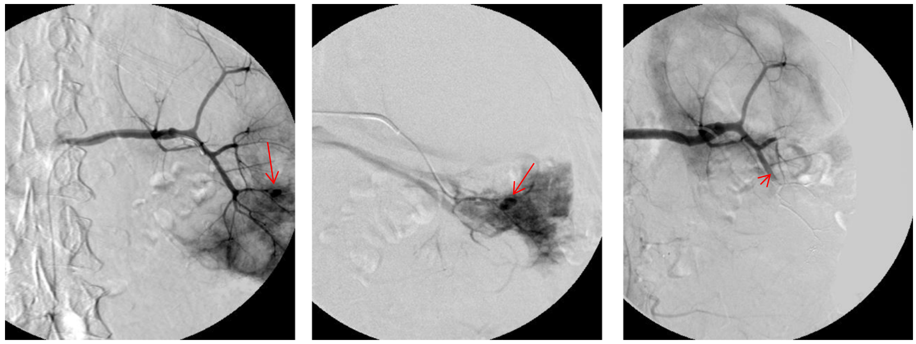

Fig. 7 A 28-year-old man had persistent massive hematuria due to a biopsy from the left kidney. Renal artery angiography with the Cobra catheter at the origin (**a**) shows the pseudoaneurysm in the lower zone of the left kidney (red arrow). Microcatheter angiography defines the segmental branch filling the aneurysm (**b**). PVA was injected through the microcatheter with obliteration of the aneurysm and the segmental branch (arrow head) (**c**)

were of detachable delivery technique and fibered surface benefiting of its advantage of controlled and accurate positioning as well as strong occlusive effects. The main disadvantage of using coils is that more than one coil is usually needed for proper occlusion increasing the cost and time of the procedure or additional embolic may be added [19]. Haochen et al. used pushable coils to treat bleeding after biopsy. In all patients, they used additional gel foam to efficiently occlude the lesion [17]. In our study, we found that detachable fibered coils are effective as we did not use additional agents. This may be due to the longer length of the detachable coil compared to pushable. We used two coils in one patient when total occlusion could not be achieved. One important complication is the coil mal-position that occurred in one of our patients with no clinical significant event.

Yamakado et al. [16] and Parildar et al. [19] reported the use of NBCA glue in renal arterial bleeding. Moreover, Contasdemir et al. [20] reported five cases while Mavili et al. [21] reported 4 cases. Both concluded that using NBCA glue provides permanent and accurate embolization in a cost-effective manner. The use of NBCA glue is preferred due to its low viscosity for easy injection through small or tortuous catheters and it provides quick and stable thrombosis with cost-effective privilege. In this study, NBCA glue was successfully used in 15 patients. The results of our study coincide with the results of these authors mentioned above. Despite its advantages, using liquid embolic agent that can cause unpredictable embolization is a major concern which was observed in one patient. A common effect that may occur after embolization is reflux. It can occur due to either using larger volume of NBCA glue or due to rapid non-intermittent injection of the glue. A test injection is usually performed to avoid this incident. In our study, we always use microcatheter to prevent gluing of the

Fig. 8 A 38-year-old man had persistent hematuria due to an angiomylipoma of the right kidney. Renal artery angiography with the Cobra catheter at the origin (**a**) shows the tumor in the middle zone (red arrow). Microcatheter angiography defines the segmental branch feeding the tumor (**b**). PVA was injected through the microcatheter with obliteration of the tumor bed as seen in the post-embolization micro-catheter angiography. Main renal angiography showed disappearance of the tumor with sparing the renal arterial tree (white arrow) (**d**)

Table 1 Causes of acute renal bleeding and the number of lesions with different abnormalities on renal arteriography

Etiology bleeding	*N* of patients	Angiographic abnormalities					Total of lesions
		Pseudoaneurysm	Free extravasation	ACF	Tumor vessels	AVM	
PCN	15	14	1				15
Biopsies	7	6	3	1			10
PCNL	8	7	1				8
Open surgery	5	4		1			5
Penetrating trauma	3	3	4	1			8
Blunt trauma	1	1	2				3
Angiomylipoma	4				4		4
AVM	2					2	2
Total of patients	45	35	11	3	4	2	55

catheter tip to the vessel wall and to prevent inadvertent embolization during retrieval of the microcatheter.

PVA is bio-compatible and inert that provides fast occlusion. It is accepted as permanent embolic material and classified as spherical and non-spherical. PVA particles were used in many studies. These particles occlude variable-sized arteries according to their size range [22–24]. In our study, we used PVA 100-300 μc to occlude subsegmental branches of traumatic bleeding. Large vessels were incompletely occluded as the particles become embedded in the walls [22, 23]. PVA control during injections is easy but reflux is common and occurred in one of seven studied cases. We used PVA in the tumor to occlude the intra-tumor vasculatures as well using 100-300 and 300-500 μc particles. Finally, PVA controlled the bleeding well in all our patients.

Post-embolization syndrome was the most common complication in our study, reported in 14 patients (31.1%). It was mild in 12 cases, and we attributed this to the use of co-axial technique with micro-catheterization of the bleeding arterial branches. Therefore, tissue loss was limited to that caused by the original trauma itself [22]. Only two patients developed severe post-embolization syndrome. In these patients, non-target embolization of a main segment branch from PVA reflux and spillage of NBCA-glue into its lumen. There was one patient having dissection. These complications ran well with those of other studies [20, 21].

Our study has some limitations. The most important limitation is the retrospective design of the study. The second is the med term evaluation and so, the durability of such embolization is limited by 1 year only. The third limitation is the small number of subgroups compared to needed in sample size. The last limitation is the non-randomization of the studied subgroups. In the future, we need a controlled randomized study to compare efficacy of each embolic agent.

Conclusion

Selective RAE using permanent agents is safe and effective in controlling renal artery bleeding. It should be considered before nephrectomy for minimizing the morbidity and preserving renal tissue. No significant difference between coil, PVA, and NBCA glue.

Table 2 Origin of bleeding and treatment parameters in the studied patients

Origin of bleeding lesions in the patients (*n*) (%)	
Lower group of segmental arteries	**35 (77.8%)**
Middle group of segmental arteries	6 (13.3%)
Upper group of segmental arteries	4 (8.9 %)
Type of embolic agent used in the patients (*n*) (%)	
Coil	23 (51.1%)
NBCA glue	15 (33.3%)
PVA	7 (15.6%)
Treatment sessions for patients (*n*)	
One session of embolization	45
Two sessions of embolization	4

Table 3 Clinical outcome and complications in studied patients

Clinical outcome (*n*) (%)	
Primary clinical success	**41 (91.1%)**
Overall clinical success	**42 (93.3)**
Clinical failure	6.7
One year recurrence of bleeding	1 (2.2%)
Treatment complications *n* (%)	
Post-embolization syndrome; pain, fever, and vomiting	14 (31.1)
Non-target embolization	2 (4.4)
Reflux from PVA	1 (2.2)
Reflux from NBCA glue	1 (2.2)
Dissection	1 (2.2)
Disturbed renal functions	0

Abbreviations

RAE: Renal artery embolization; PCNL: Percutaneous nephrolithotomy; PCN: Percutaneous nephrostomy; ACF: Arterio-calyceal fistula; NBCA: N-butyl-cyanoacrylate; PVA: Polyvinyl alcohol; AVM: Arterio-venous malformation; PA: Pseudoaneurysm

Acknowledgements

We acknowledged Dr. Einas Maged; Lecturer of community medicine, National Liver Institute for helping at the statistical analysis of the study.

Authors' contributions

MSA put the conception and design of the study, wrote the protocol, and was the radiologist who performed all renal artery embolization procedures using all embolic agents mentioned in the manuscript. He contributed in reviewing medical records, collecting and tabulating data, and selecting figures of the study. He also contributed in manuscript writing and approved the draft for submission. MMA contributed in the clinical preparation, decision of embolization, and clinical follow-up after embolization. He reviewed medical records and collected and analyzed data with manuscript drafting and approved the draft. He was the one who did nephrectomy to patients with failed embolization. ME contributed in the clinical preparation, decision of embolization, and clinical follow-up after embolization. He reviewed medical records and collected and analyzed data with manuscript drafting and approved the draft. Finally and collectively, all authors have read and approved the manuscript.

Funding

No funding was received for this study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the National Liver Institute at Menoufia University in Egypt NLI IRB number 00213/2020 (name of IRB; NLI IRB 00003413).

Not applicable as the study was retrospective.

Consent for publication

Being a retrospective study, patients' consent to publish the data contained within this study has been waived by the ethical committee.

Competing interests

The authors or author's institutions have no conflicts of interest which includes financial or personal relationships that inappropriately influence their actions.

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Received: 17 July 2020 Accepted: 24 September 2020
Published online: 08 October 2020

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