Management of Non-neoplastic Renal Hemorrhage by Transarterial Embolization

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OBJECTIVES To assess the role of transarterial embolization (TAE) and critically appraise its feasibility and efficacy in the management of non-neoplastic renal hemorrhage. Percutaneous TAE is an effective method for the control of hemorrhage, irrespective of the cause. Injury to the renal artery or its branch, after trauma or during open or percutaneous urologic procedures, can be accurately diagnosed using angiography and treated by percutaneous embolization techniques. Because the technique and technology have evolved, it is now possible to perform highly selective embolization of the injured vessel while preserving vascularity of the rest of the renal parenchyma.

METHODS The medical records of all patients who underwent angioembolization for hemorrhagic urologic emergencies at our institute from January 1996 to December 2007 were reviewed.

RESULTS A total of 41 patients, aged 7-72 years, underwent TAE because of hemorrhage after percutaneous nephrolithotomy (n = 27), open pyelolithotomy (n = 3), renal biopsy (n = 8), and spontaneous occurrence (n = 3). All patients had a normal coagulation profile before surgery. A total of 35 patients (85.3%) underwent successful embolization and none required a postprocedural blood transfusion. Of those with postpercutaneous nephrolithotomy bleeding, angioembolization failed in 6 patients. Of these, only 2 required nephrectomy to save the patient's life. No serious procedure-related complications occurred.

CONCLUSIONS TAE is a minimally invasive, safe, simple, and highly effective modality, in expert hands, for the management of postprocedural renal bleeding. This option should be considered early in the management of these cases because it is not only a life-saving, but ultimately a kidney-sparing, procedure. UROLOGY 74: 522–527, 2009. © 2009 Elsevier Inc.

Percutaneous transarterial embolization (TAE) is now a well-established endovascular treatment of life-threatening hemorrhagic urologic emergencies.[1]

Traumatic injury to the renal vasculature is a well-recognized and most worrisome complication of a multitude of renal procedures, including renal biopsy, percutaneous nephrostomy, percutaneous nephrolithotomy (PCNL), and open procedures.

The most common causes of postprocedural renal hemorrhage are arteriovenous fistulas and pseudoaneurysms.[2] The treatment of choice for traumatic renal arterial injury that does not resolve spontaneously is transarterial embolization.[3-5] Angiography is the definitive test to diagnose arterial injury resulting from these procedures. Angiography is superior to surgical exploration as both a diagnostic and a therapeutic modality.[6] TAE has all the advantages of a minimally invasive procedure, including rapid recovery, short hospital stay, and early resumption of physical activities.[7]

MATERIAL AND METHODS

Patients

We analyzed the medical records of all the patients who had undergone transarterial embolization from January 1996 to December 2007 at Muljibhai Patel Urological Hospital, Nadiad, India. All procedures were performed by our interventional nephrologist, in close consultation with the treating urologists, on an emergency basis (after conservative measures failed to control life-threatening hemorrhage). The data were compiled on data extraction sheets and included the following variables: age, sex, clinical presentation, presence of concurrent disease, blood pressure and heart rate, hemoglobin concentration, requirement of pre-embolization blood transfusion, underlying pathologic finding, timing of embolization since their first presentation, embolization agents, selective or nonselective embolization, postembolization transfusion requirement and complications, hospital stay, and the outcome, including the appearances of the kidneys on imaging studies and blood pressure. The procedure was considered successful if postembolization angiography showed complete occlusion of the feeding vessel.

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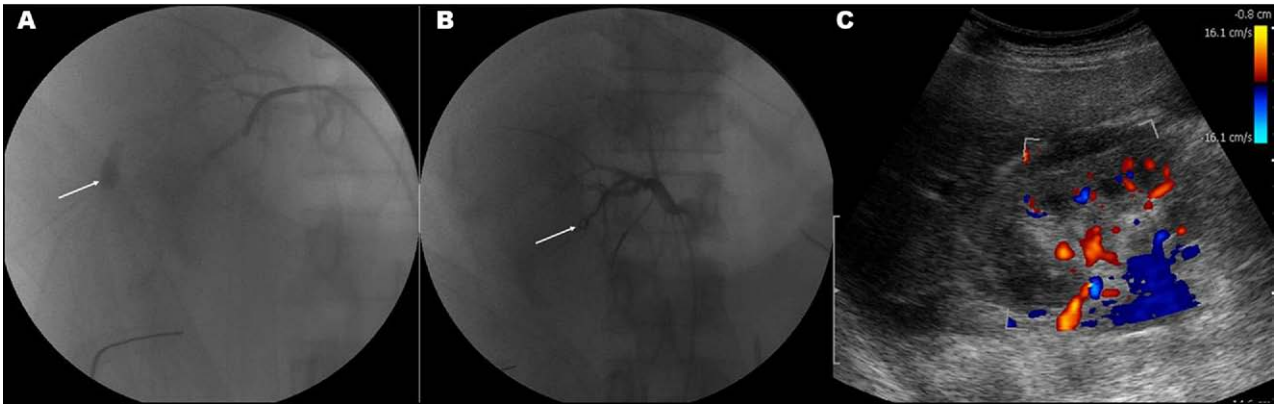

Figure 1. (A) Angiogram showing right upper polar arteriovenous fistula (AVF, arrow) in 40-year-old woman referred to us with bleeding after bilateral simultaneous percutaneous nephrolithotomy. **(B)** Postsuperselective embolization angiogram from same patient showing complete occlusion of offending vessel with metallic coil (arrow). **(C)** Doppler ultrasound image, on follow-up, of same patient, showing good vascularity.

Technique

Angiography is usually performed using the right femoral approach. A 7F sheath was used as an introducer. This sheath provides access to a wide range of catheters, which might be needed for embolization. Initial flush aortography was performed through a 5F multiple-hole pigtail catheter, which shows the main renal arteries on either side or accessory ones, if present. Sometimes, the site of bleeding can be seen on the initial flush aortogram.

Selective renal angiography usually shows the lesion (pseudoaneurysm, arteriovenous fistula [Fig. 1A]). The catheter was advanced further subselectively into the branch of the renal artery feeding the lesion. Additional lateral or oblique and magnification views can be helpful in delineating the exact location of the arterial injury. The catheter tip was placed as close as possible to the injured renal artery branch. "Road mapping" is useful to catheterize small and peripheral branches. Check angiography should be performed to ensure the right catheter position before any intervention is performed. Metallic coils, which are permanent embolic material, were then deployed, depending on the size of the vessel to be occluded (Fig. 1B). The size and number of coils is dependent on the size of the vessel to be embolized. The size should be slightly larger than the vessel to achieve total embolization. Intermittent check angiography can be done with hand injections after deployment of each coil to look for the degree of occlusion and any inadvertent nontarget embolization. It also checks the catheter position for the subsequent coiling. This can be combined with injection of a gelatin sponge if satisfactory occlusion is not achieved. Check angiography is again performed at this stage to determine the degree of occlusion. After ensuring adequate occlusion, the visceral catheter was placed in the main renal artery and postembolization angiography was performed to show the occlusion of the feeding vessel with nonvisualization of the lesion and a small avascular segment distal to the occluded branch. It will also demonstrate the patency of the rest of the vessels.

RESULTS

A total of 41 patients underwent TAE for postprocedural (n = 38) and spontaneous (n = 3) genitourinary hemorrhage, uncontrolled by other measures, from January 1996 to December 2007. Table 1 summarizes the patient characteristics and procedure results. Of these 41 patients (34 men and 7 women), 27 had post-PCNL bleeding, 3 had bleeding after pyelolithotomy, and 8 patients had undergone renal biopsy. In 3 patients, no obvious predisposing factor (spontaneous) for the bleeding was found. Of the 41 patients, 18 had bleeding from the right kidney and 23 from the left. The mean serum creatinine at presentation was 1.3 mg/dL (range 0.7-4.1). This excluded patients who had undergone renal biopsy for evaluation of chronic renal insufficiency and obviously had a high serum creatinine. The mean interval between the first presentation and embolization was 13 hours (range 45 minutes to 76 hours). A mean of 4.6 U (range 0-19) of blood was transfused. All these patients underwent angiography. Of the 41 patients, 18 had an arteriovenous fistula, 17 had pseudoaneurysms, and in 6 no lesion was found. Angiography disclosed an upper polar bleeding site in 11 patients, a mid-polar site in 7, and a lower polar site in 17. One patient had bleeding from the segmental vein. Metallic coils were used in 8 procedures, a gelatin sponge in 9, and both agents in 18 patients. Autologous blood clots were also used in 2 patients, in addition to a gelatin sponge. Two patients required 2 procedures because of technical difficulties. Both of them had a successful outcome after the second procedure. No patient required transfusion after successful embolization. No serious procedure-related complications occurred.

Patients with successful embolization were followed up at 1 and 3 months, 1 year, and then annually. All patients underwent renal ultrasonography and Doppler ultrasonography to assess the renal dimensions and vascularity (Fig. 1C), in addition to renal biochemistry, at each follow-up visit. The mean follow-up was 26 months (range 1 month to 12 years). All 27 patients (excluding 8 patients in the renal biopsy group) showed normal renal vascularity and normal serum creatinine levels on follow-up. No patient had new-onset or worsening of hypertension.

Of the 41 patients, 27 required TAE for post-PCNL bleeding. Of these, 19 were referred from elsewhere and only 8 were from our institute (of the 3859 PCNLs done

Table 1. Patient characteristics and procedure results

Patients (n)	41
Age (y)	
Mean	31
Range	7-72
Sex (n)	
Male	34 (82.9)
Female	7 (17.1)
Side (n)	
Right	18 (43.9)
Left	23 (56.1)
Indications for TAE (n)	
Post-PCNL	27 (65.8)
Postpyelolithotomy	3 (8.6)
Renal biopsy	8 (19.5)
Spontaneous	3 (8.6)
Concurrent medical illnesses	
Hypertension (excluding renal biopsy group)	12/33 (36.3)
Diabetes mellitus	17/41 (41.5)
Ischemic heart disease	2/41 (10.11)
Hemoglobin at presentation (g%)	
Mean	7.3
Range	6.1-9.8
Serum creatinine at presentation (mg/dL)	
Renal biopsy group	
Mean	2.9
Range	2.3-7.4
In other 3 groups	
Mean	1.3
Range	0.7-4.1
Interval between first presentation and embolization (h)	
Mean	13
Range	45 min to 76 h
Preprocedure blood transfusion (U)	
Mean	4.6
Range	0-19
Angiographic findings (n)	
Arteriovenous fistula	18 (43.9)
Pseudoaneurysm	17 (41.5)
No lesion	6 (14.6)
Bleeding site (n = 35)	
Upper pole	11 (31.4)
Mid-pole	7 (20)
Lower pole	17 (48.6)
Embolic material (n = 35)	
Metallic coils alone	8 (23)
Gelatin sponge alone	7 (20)
Gelatin sponge + metallic coils	18 (51.4)
Gelatin sponge + autologous blood clots	2 (5.7)

TAE = transarterial embolization; PCNL = percutaneous nephrolithotomy.
Data in parentheses are percentages.

at our institute during the study period), an incidence of 0.21% (Table 2). In 21 of 27 patients, successful embolization of the offending lesion was achieved. Of the remaining 6 patients, 2 required nephroscopy and cauterization of the bleeding point, 2 required exploration of the tract, and 2 required nephrectomy to save their life. In 2 of these patients, on exploration of the tract, the bleeding vessel could be identified and controlled using hemostatic sutures. Both of these patients did not have any fresh hemorrhage after exploration. Of the 2 patients, 1 required nephrectomy and 1 had a solitary functioning right kidney. He was referred to us with intractable hemorrhage after right PCNL. He underwent right superselective embolization of the mid-polar arteriovenous fistula; however, bleeding continued, and repeat angiography did not reveal any bleeding point. He underwent nephroscopy and clot evacuation. For persistent intractable hemorrhage, he required total right renal embolization and later nephrectomy to save his life. Histopathologic examination of the nephrectomy specimen showed features consistent with advanced renal damage, with multiple clots in the pelvicaliceal system. This patient underwent successful renal allograft transplantation.

Table 2. Incidence of postembolization syndrome

Symptom	n (%)
Flank pain alone	5 (12.2)
Fever alone	4 (9.7)
Nausea/vomiting alone	3 (7.3)
Flank pain and fever	9 (22)
Fever and raised white blood cell count	2 (4.9)
Flank pain, fever, nausea/vomiting	1 (2.4)
Flank pain, fever, nausea/vomiting, raised white blood cell count	1 (2.4)
Paralytic ileus	1 (2.4)

COMMENT

Although the incidence is very small, 1%-3% in various series,[8-13] postprocedural genitourinary hemorrhage is a troublesome urologic emergency. It requires prompt management to save the kidney, as well as the patient's life. If the expertise is available and routine maneuvers fail to control the bleeding, TAE of the offending vessel is a valid option and should be instituted early in the treatment of these patients. This procedure has been used successfully for managing a variety of benign and malignant urologic conditions for the past 30 years.[14-17]

Currently, TAE has become the mainstream treatment. The aim of this treatment is to embolize the bleeding vessels selectively while sparing the normal renal tissue. In the setting of acute hemorrhage, TAE provides immediate access to locate the precise site of bleeding while simultaneously allowing for occlusion of the bleeding vessel.

Somani et al.[18] had reported successful application of this procedure in 13 patients (of 14 patients treated) to control bleeding due to trauma, iatrogenic injury, and spontaneous urologic hemorrhages. One patient, in whom embolization failed, required emergency nephrectomy. The histopathologic examination showed renal cell carcinoma. Their work reiterated the feasibility and effectiveness of angioembolization in hemorrhagic urologic emergencies, especially the significant reduction in blood transfusion requirements.

The recent work of Richstone et al.[13] demonstrated complete resolution of bleeding with clinical stabilization in 95% of their patients (54/57). The remaining 3 required open exploration because of continued bleeding. They concluded that in 95% of cases, angiography revealed a demonstrable and treatable etiology (they identified pseudoaneurysm in 53% of their patients, contrast extravasation from a lacerated renal vessel in 25%, arteriovenous fistula in another 25%, renal arterial dissection in 2 patients, hypervascular area, a vascular "cut-off" sign, and a fistula between an arterial branch and the percutaneous tract), with a high rate of efficacy. They strongly recommended the first-line use of angiography for intractable renal hemorrhage.

In 5.3% of their patients, no demonstrable angiographic findings were present to account for renal hemorrhage. In the present series, angiography failed to demonstrate any lesion in 6 patients (14.6%). Venous injuries are often underdiagnosed by angiography and could also explain those cases without demonstrable findings. One patient who had bleeding from a segmental vein in the present series, for reasons unknown, did not have bleeding after angiography. Possibly, hemorrhages of a venous origin are usually self-limiting and respond well to conservative management.

TAE is not without its side effects and potential complications. Postinfarction syndrome is characterized by flank pain, fever, an elevated white blood cell count, nausea, vomiting, and paralytic ileus.[19] The pain, which can be severe and might require either parenteral narcotics or an epidural analgesic to control, generally begins 30-60 minutes after completion of embolization and can persist for 24-48 hours. The white blood cell count will increase to 15 000-20 000/μL, frequently with a left shift. A temperature of 40°C (104°F), along with nausea, vomiting, and ileus, will persist for $\geq$72 hours. Ninety percent of patients will experience this syndrome to varying degrees, and its severity might, in part, be related to the thrombotic agent used. In our series, 26 of 41 patients (63.4%) experienced these symptoms to varying degrees (Table 2). However, no correlation could be established between the embolization material used and the occurrence of this syndrome. These symptoms were self-limiting and did not require any specific measures. Somani et al.,[20] described this syndrome in 50% of their patients. The main concerns of embolization are the adverse effects that can result from devascularization of a portion of the renal parenchyma, with subsequent loss of its function. This issue has been very scientifically addressed by Mohsen et al.[21] in their study of long-term follow-up after superselective TAE. They demonstrated a significant improvement in the split renal uptake and renographic clearance on dimercaptosuccinic acid and mercaptotriglycylglycine scans.

We defined "success" as cessation of bleeding with selective embolization of the offending vessel and normal vascularity of the remaining kidney. In the present study, 35 patients (85.4%) underwent successful angioembolization. None of these patients had any major postprocedural complications, and none required postprocedural blood transfusions. These findings confirm the role of TAE in the treatment of these patients. A problem-based approach for the management of intractable postprocedural renal hemorrhage has been proposed (Fig. 2).

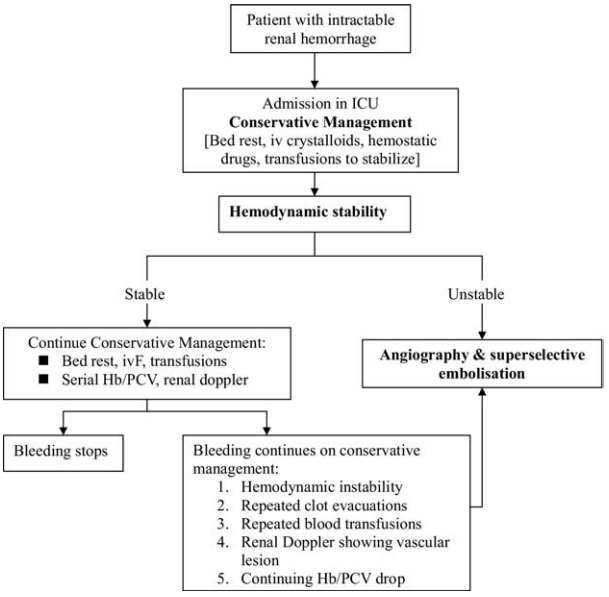

Figure 2. Algorithm for management of renal hemorrhage.

CONCLUSIONS

Our study has further clarified and defined the role of this minimally invasive nephron-sparing procedure in the management of life-threatening genitourinary hemorrhage. Except for this procedure, the bleeding in all cases would have required surgical exploration to control the hemorrhage.

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EDITORIAL COMMENT

The authors report a single-institution series of percutaneous transarterial embolization (TAE) in the management of nonneoplastic renal hemorrhage. In their series, they review 41 patients who had undergone TAE for postprocedural (92.7%) and spontaneous (7.3%) bleeding refractory to conservative management. Of the 41 patients, 35 (85.4%) were successfully treated with endovascular embolization and 6 required nephroscopy, open tract exploration, or nephrectomy for definitive treatment.

Angiography has gained acceptance as a less-invasive diagnostic and therapeutic alternative to open surgery for control of life-threatening hemorrhage. Although this has been acknowledged by most urologists as standard practice,[1] the authors should be commended for their rigorous follow-up with serum chemistry profiles and Doppler ultrasonography. Additional experience is needed to identify the prognostic factors associated with endovascular failure and progression to more invasive surgery for hemorrhage control.

The utility of endovascular techniques in the treatment of both benign and malignant urologic conditions continues to expand. Recent studies have focused on the use of intraoperative transarterial occlusion of the renal artery to reduce blood loss in high-risk patients undergoing complex percutaneous renal surgery,[2] as well as selective arterial prostatic embolization in patients with refractory hematuria of prostatic origin.[3] Transarterial delivery of chemotherapeutic agents is currently being explored in animal studies and prospective trials as both a primary and an adjuvant treatment modality in patients with genitourinary malignancies.[4,5] As efforts continue to shift toward the development of minimally invasive techniques, the role of endovascular interventions in the management of urologic disease will continue to evolve.

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REPLY

We would like to thank the editorial board for their positive reception of our work.

With the advent of smaller vascular catheters and improved imaging techniques, percutaneous transcatheter embolization has become a valuable adjunct for the treatment of patients with various genitourinary pathologic conditions.

Although this procedure is quite efficacious in expert hands, in arresting hemorrhage, failures can occur and require surgical intervention. The reported success rates of this procedure in various series,[1,2] including the present one, have ranged from 85% to 92%. It would be of great interest to identify the prognostic factors, if any, associated with endovascular failure and progression to more invasive surgery for hemorrhage control in this cohort of patients.

A close review of our 2 patients, who required nephrectomy, revealed a few noteworthy findings. Both of these patients had staghorn calculi and required ≥3 percutaneous tracts. The stone bulk (size) and number of punctures could be predictors for the occurrence of severe hemorrhage after percutaneous stone removal in various series; however, how much these factors are able to predict for endovascular failure is worth studying in larger series. Srivastava et al.[1] postulated that with an increase in stone bulk, requiring multiple tracts and treatment stages, there was an obvious increase in the torque applied within the pelvicaliceal system, which could in turn lead to an increased incidence of injury to the renal parenchyma and vasculature.

An important ubiquitous finding in our 2 patients was the presence of an arteriovenous fistula measuring >6 mm on renal Doppler ultrasonography. This was in remarkable contrast to the average 3.76-mm size lesion in patients who underwent successful embolization. The significance of this finding is dif-