Section: Radiodiagnosis

Original Research Article

TRANSARTERIAL EMBOLIZATION IN THE MANAGEMENT OF REFRACTORY HEMATURIA: A SINGLE-CENTER EXPERIENCE

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ABSTRACT

Background: Refractory hematuria is a challenging clinical condition that may result from malignant, traumatic, or vascular etiologies and can lead to significant morbidity when conservative management fails. Transarterial embolization (TAE) has emerged as a minimally invasive alternative for achieving effective hemorrhage control. This study aimed to evaluate the efficacy and safety of TAE in the management of refractory hematuria. **Materials and Methods:** This prospective observational study included 31 patients with refractory hematuria secondary to malignant, traumatic, or vascular etiologies who underwent TAE at a tertiary care center between 2020 and 2022. Demographic, clinical, angiographic, procedural, and outcome data were collected. Technical success was defined as angiographic cessation of bleeding, and clinical success as resolution of hematuria without additional intervention. **Results:** Among the 31 patients, 24 (77.4%) were males and 7 (22.6%) were females. Renal tumors were the most common etiology (32%), followed by carcinoma bladder (25.8%) and carcinoma prostate (25.8%). Renal arterial branches were the most frequently embolized vessels (44.8%). Technical success was achieved in 30/31 patients (96.7%), while clinical success was observed in 27/31 patients (87.1%). Mean hemoglobin increased from 7.0 g/dL pre-procedure to 11.4 g/dL post-procedure. Post-embolization syndrome occurred in 3 patients (10%) and groin hematoma in 1 patient (3%), with no major ischemic complications or procedure-related mortality. **Conclusion:** TAE is a safe and effective minimally invasive treatment for refractory hematuria, achieving high technical and clinical success rates, improving hemoglobin levels, and demonstrating a low complication profile. It represents a valuable therapeutic option when conventional management is unsuccessful.

INTRODUCTION

Hematuria is a common urological presentation that may range from microscopic blood loss to severe, life-threatening hemorrhage requiring urgent intervention. While many cases can be managed successfully with conservative treatment, a subset of patients develop refractory hematuria that persists despite medical management, bladder irrigation, endoscopic procedures, or other conventional measures. Persistent bleeding can result in significant morbidity, including anemia, repeated blood transfusions, prolonged hospitalization, and deterioration in quality of life. In severe cases, uncontrolled hematuria may become a medical emergency requiring prompt and effective treatment.[1,2]

Refractory hematuria can arise from a variety of underlying conditions. Malignancies of the kidney, bladder, and prostate are among the most common causes, although vascular abnormalities such as renal artery pseudoaneurysms, arteriovenous fistulas, traumatic injuries, and transplant-related vascular complications may also contribute.[2,3] Management of these patients is often challenging because the underlying pathology, extent of bleeding, and overall clinical status vary considerably. Surgical intervention may not always be feasible, particularly in elderly patients or those with significant comorbidities, highlighting the need for less invasive therapeutic alternatives.[4,5]

Transarterial embolization (TAE) has emerged as an important minimally invasive technique for the management of refractory hematuria. The procedure

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involves selective catheterization of the bleeding vessel followed by targeted occlusion using embolic materials such as coils, polyvinyl alcohol particles, gelfoam, or liquid embolic agents. By directly addressing the source of bleeding while preserving surrounding tissue, TAE offers the advantages of rapid hemorrhage control, reduced procedural morbidity, shorter recovery time, and avoidance of major surgery. Advances in angiographic imaging, microcatheter technology, and embolic materials have further improved the precision and safety of this procedure.[3,4,6,7]

Several studies have demonstrated favorable outcomes with TAE in controlling hematuria caused by both malignant and non-malignant conditions. Clinical success rates of approximately 91% with low complication rates have been reported in patients with refractory hematuria of prostatic origin.[1] Evidence from single-center experiences and systematic reviews has further highlighted the effectiveness of embolization in achieving durable bleeding control in cancer-related bladder hemorrhage.[4] Successful bilateral super-selective embolization of vesical arteries using polyviny,[1] alcohol particles has also been reported in patients with advanced bladder and prostate cancers.[3] Recent studies have additionally demonstrated favorable outcomes with prostatic artery embolization and the use of novel embolic agents in selected patient populations.[5-9]

Despite these encouraging results, data from single-center experiences remain valuable because patient populations, etiologies, embolization techniques, and embolic materials often vary across institutions. Such studies provide important real-world evidence regarding the effectiveness and safety of the procedure in routine clinical practice. Furthermore, limited data are available from Indian centers evaluating TAE across a broad spectrum of etiologies causing refractory hematuria.[10]

In view of the growing role of endovascular therapy in the management of severe urinary tract bleeding, the present study was undertaken to evaluate the efficacy and safety of TAE in patients with refractory hematuria treated at a tertiary care center. The study aimed to evaluate the efficacy and safety of TAE in the management of refractory hematuria.

MATERIALS AND METHODS

This prospective observational study was conducted at Government Stanley Medical College, Chennai, between 2020 and 2022, after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to the procedure.

Study Population and Sampling: The study included 31 consecutive patients with persistent hematuria who were referred for endovascular embolization during the study period. A census sampling method was employed, and all eligible patients undergoing embolization were enrolled.

Inclusion and Exclusion Criteria

Patients with refractory hematuria secondary to malignant, traumatic, or vascular etiologies who underwent TAE were included in the study. Patients in whom embolization could not be performed or those with incomplete clinical records were excluded.

Methods

Detailed clinical evaluation and relevant laboratory investigations were performed prior to embolization. Demographic variables including age and sex, underlying etiology of hematuria, angiographic findings, embolized vascular territories, embolic materials used, hemoglobin levels, procedural outcomes, and complications were recorded. Pre- and post-procedure hemoglobin levels were assessed. Patients were clinically followed after embolization to evaluate resolution of hematuria, changes in hemoglobin levels, and procedure-related complications. Clinical, laboratory, and imaging data were prospectively collected and supplemented by review of hospital records and imaging archives when required.

TAE Procedure

All procedures were performed under digital subtraction angiography through transfemoral arterial access. After placement of a vascular sheath, selective angiography was performed to identify the bleeding source or abnormal vascular lesion. Selective and superselective catheterization techniques were employed using appropriate catheters and microcatheters to access the target vessels. Embolization was performed using coils, polyvinyl alcohol (PVA) particles, gelfoam, n-butyl cyanoacrylate (NBCA) glue, or a combination of these agents, depending on the vascular anatomy and underlying pathology. Embolization was continued until angiographic cessation of bleeding or complete occlusion of the abnormal vascular lesion was achieved.

Outcome Measures

Technical success was defined as angiographic cessation of bleeding or complete occlusion of the abnormal vascular lesion at the end of the procedure. Clinical success was defined as resolution of hematuria without the need for additional intervention. Procedure-related complications and changes in hemoglobin levels were also assessed.

Statistical Analysis

Data were entered and analyzed using descriptive statistics. Continuous variables were expressed as mean, while categorical variables were presented as frequencies and percentages.

RESULTS

A total of 31 patients with refractory hematuria were included, comprising 24 (77.4%) males and 7 (22.6%) females. The majority of patients were aged 51–70 years (58%). Renal tumors were the most

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common etiology (32%), followed by carcinoma bladder (25.8%) and carcinoma prostate (25.8%). [Table 1]

Table 1: Demographic Profile and Etiology of Refractory Hematuria

Variable	Category	Number of Patients (%)
Total Patients	Total patients	31
Demographics	Male	24 (77.4%)
	Female	7 (22.6%)
	Age group 51–70 years	18 (58%)
Etiology	Renal tumors	10 (32%)
	Carcinoma bladder	8 (25.8%)
	Carcinoma prostate	8 (25.8%)
	Renal artery pseudoaneurysm	2 (6.4%)
	Renal AV fistula	1 (3.2%)
	Renal trauma	1 (3.2%)
	Transplant renal injury	1 (3.2%)

Renal arterial branches were the most frequently embolized vascular territory (44.8%), followed by bilateral vesical arteries (19.2%) and bilateral internal iliac arteries (19.2%). Coils with gelfoam were most commonly used embolic agents (35.2%), followed by gelfoam with PVA particles (25.6%) and coils alone (22.4%). [Table 2]

Table 2: Embolized Vascular Territories and Embolic Materials Used

Variable	Category	Number of Patients (%)
Vascular Territory	Renal arterial branches	14 (44.8%)
	Bilateral vesical arteries	6 (19.2%)
	Bilateral internal iliac arteries	6 (19.2%)
	Prostatic arteries	4 (12.8%)
	Lumbar artery	1 (3.2%)
Embolic Agent	Coils + gelfoam	11 (35.2%)
	Gelfoam + PVA particles	8 (25.6%)
	Coils alone	7 (22.4%)
	NBCA glue	3 (9.6%)
	PVA particles alone	2 (6.4%)

Technical success was achieved in 30 of 31 patients (96.7%), while clinical success was observed in 27 patients (87.1%). Mean hemoglobin increased from 7.0 g/dL before embolization to 11.4 g/dL after the procedure. Post-embolization syndrome occurred in 3 patients (10%) and groin hematoma in 1 patient (3%), with no major ischemic complications or procedure-related mortality. [Table 3]

Table 3: Procedural Outcomes and Complications

Variable	Category	Value
Outcome Parameter	Technical success	30/31 (96.7%)
	Clinical success	27/31 (87.1%)
	Mean pre-procedure hemoglobin	7.0 g/dL
	Mean post-procedure hemoglobin	11.4 g/dL
Complication	Post-embolization syndrome	3 (10%)
	Groin hematoma	1 (3%)
	Major ischemic complications	0
	Procedure-related mortality	0

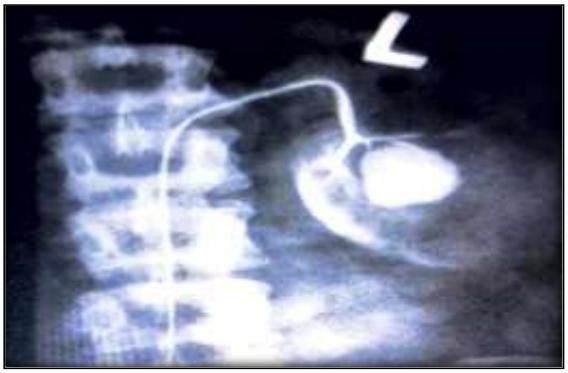

Figure 1: Selective renal angiogram demonstrating a renal pseudoaneurysm with active contrast extravasation in a patient presenting with refractory hematuria

Figure 2: Post-embolization angiogram demonstrating complete occlusion of the pseudoaneurysm following superselective coil embolization with preservation of adjacent renal parenchymal perfusion.

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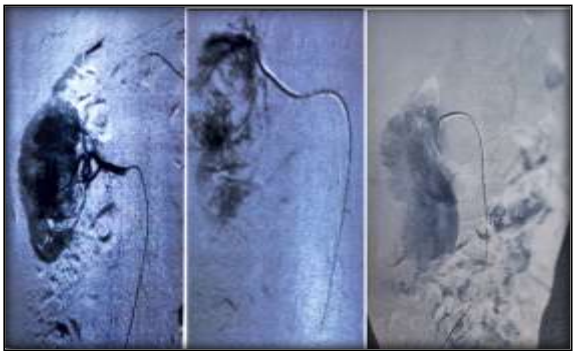

Figure 3: Angio shows supply from right 2nd and 4th lumbar artery to renal mass appearing as parenchymal blush

Figure 1: Post embolization with PVA particles and gel foam

DISCUSSION

Refractory hematuria is a challenging clinical condition that may result from malignant, traumatic, or vascular etiologies and often requires urgent intervention when conservative measures fail. The present study aimed to evaluate the efficacy and safety of TAE in the management of refractory hematuria. Overall, TAE achieved high technical and clinical success rates, improved hemoglobin levels, and was associated with a low incidence of minor complications without any major ischemic events or procedure-related mortality.

In our study, refractory hematuria predominantly affected older male patients and was mainly associated with urological malignancies. Similar findings were reported by CH Oh et al., who evaluated 22 patients undergoing TAE for malignant hematuria, including 20 males and 2 females with a mean age of 71.8 years.[11] Likewise, Hekimoglu et al. reported a cohort of 12 male patients with a mean age of 72.6 years, all presenting with bladder carcinoma.[2] Wright et al. demonstrated that TAE effectively controlled hematuria and other tumour-related symptoms with an acceptable adverse event profile.[12] These findings suggest that refractory hematuria requiring embolization is most commonly encountered in elderly men with underlying urological malignancies.

In the present study, renal arterial branches were the most frequently embolized vascular territory, and a range of embolic agents was used according to lesion characteristics. Alarayedh et al. treated patients with bladder and prostate cancers using 300–500 μm PVA particles, targeting bilateral superior and inferior vesical arteries in nearly all cases.[3] Similarly, Hekimoglu et al. performed 17 selective embolization procedures in 12 patients, including bilateral embolization in 5 cases, using microspherical particles and microcoils to embolize branches of the internal iliac artery.[2] Hayashi et al. demonstrated high technical success in 18 patients with renal arteriovenous malformations using individualized embolization techniques, achieving 83% complete occlusion and 17% marked regression without major adverse events.[13] These studies support the need for individualized embolization strategies based on vascular anatomy and underlying pathology.

Our findings demonstrated high technical and clinical success with a favorable safety profile. Choi et al. reported a technical success rate of 100% in 27 embolization procedures, with clinical improvement of hematuria in 86.4% of patients. Hekimoglu et al. achieved complete bleeding control in 75% of patients during follow-up and reported no major complications. In addition to effective bleeding control, improvement in hemoglobin levels has also been documented in previous studies. Hekimoglu et al. reported a significant increase in mean hemoglobin from 7.55 g/dL to 9.77 g/dL one month after embolization, while Alarayedh et al. observed an increase from 9.6 ± 1.7 g/dL at the time of the procedure to 10.6 ± 1.5 g/dL at one-month follow-up.[2,3] These findings are consistent with the hematological recovery observed following successful hemorrhage control. A systematic review by Dehvari et al. further demonstrated technical success rates ranging from 89% to 100% and immediate hemostatic control rates between 67% and 100%, with predominantly minor adverse events.[14] In patients with vascular lesions, Morita et al. reported a primary technical success rate of 98.8% and a secondary success rate of 100% following embolization of renal artery pseudoaneurysms and arteriovenous fistulas, with no recurrence of bleeding during long-term follow-up.[15] These findings reinforce the effectiveness and safety of TAE in the management of refractory hematuria.

Our findings suggest that TAE is an effective and safe treatment for refractory hematuria, achieving high hemorrhage control rates, improving hemoglobin levels, and causing only minor complications. These findings support its use as a valuable minimally invasive option when conservative management is unsuccessful.

Limitations

The relatively small sample size and inclusion of patients with diverse underlying etiologies may limit

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the broader applicability of the findings. In addition, long-term follow-up data were not available for all patients, restricting assessment of sustained clinical outcomes and recurrence following embolization.

CONCLUSION

TAE is a safe and effective minimally invasive treatment for refractory hematuria arising from diverse etiologies. The procedure achieves high technical and clinical success rates, improves hemoglobin levels, and is associated with a low incidence of minor complications. These findings support its role as a valuable therapeutic option when conventional management fails.

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