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Prostate Artery Embolization in Patients above Eighty Years Old: Clinical Efficacy and Safety

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Abstract

Objectives Prostate artery embolization (PAE) has been established as an effective treatment option for benign prostate hyperplasia or hematuria of prostatic origin. We aim to confirm the effectiveness and safety of PAE in elderly patients aged ≥ 80 years old.

Materials and Methods Between January 2014 and August 2020, PAE was attempted on 54 elderly patients with lower urinary tract symptoms (LUTS) or prostatic hematuria who were unfit for surgical treatment or opted for PAE. Outcome parameters (International Prostate Symptom Score [IPSS], quality of life [QoL] score, International Index of Erectile Function score (IIEF), maximal urinary flow rate, postvoid residual, and prostate volume) were collected and analyzed at baseline, 6 months, 1, 2, and 3 years.

Results The mean patient age was 85.29 years (range: 80–98). Technical success was achieved in 50 patients (92.6%). Mean IPSS improved from 18 at baseline to 7.7, 8.5, 8.6, and 9.1 at 6 months, 1, 2, and 3 years. Mean QoL improved from 4.9 at baseline to 2.8, 1.7, and 1.5 at 6 months, 1, and 2 years. Mean prostate volume reduced from a baseline of 152.7 to 123.5 mL within 6 months and 120.5 mL after 7 months of PAE. Urinary catheter removal was successful in 13 out of 19 patients with urinary retention. PAE succeeded in stopping bleeding in 16 out of 17 patients with prostate-induced hematuria.

Conclusion PAE is a feasible low-risk treatment for LUTS with or without urinary retention or prostatic hematuria in elderly patients.

Keywords

- benign prostate hyperplasia
- urinary retention
- prostate-induced hematuria
- prostate artery embolization
- lower urinary tract symptoms

Introduction

Elderly frail patients may be poor anesthetic candidates and are usually unsuitable for surgical treatments due to multiple underlying comorbidities.[1] Transurethral resection of the prostate (TURP) is still the gold-standard surgical procedure for benign prostate hyperplasia (BPH) treatment in most patients whose symptoms do not improve with medical

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treatment. However, it has a high morbidity rate.[2,3] Compared with TURP, the embolization of prostatic arteries offers a lesser hospital stay (1-day procedure), a lower level of overall morbidity risk, and a shorter recovery time.[4,5] Prostatic artery embolization (PAE) is a minimally invasive procedure done with local anesthesia in most cases. Transcatheter embolization of the prostate was introduced to control the postoperative or cancer-induced prostate bleeding.[6–8] The selective PAE was first described in 2000 for hematuria and BPH.[9] Since then, several studies have shown the promising clinical outcome of PAE performed for symptomatic BPH.[10–13] The present single-center study aims to explore the outcome of PAE in the management of BPH and refractory hematuria of prostatic origin (RHOPA) in elderly men (aged $\geq$ 80 years old).

Materials and Methods

Patient Population

From January 2014 to January 2020, we attempted PAE on 54 elderly patients aged $\geq$ 80 years with LUTS or prostate-related hematuria. The patients were clinically reviewed by consultant urologists who assessed their conditions, discussed different treatment options, and referred them for magnetic resonance imaging (MRI) prostate and CT angiography (CTA) on pelvic arteries. If the patient agreed, and CTA showed amiable prostate arteries for embolization, the decision was made to perform PAE in a multidisciplinary team meeting (MDM).

Procedure

The whole procedure was planned with CTA to ensure more straightforward navigation and catheterization and reduce procedural time and radiation exposure. A manual drawing of each internal iliac artery branching configuration was sketched to directly correlate with the real-time digital subtraction angiography (DSA). Femoral access was performed.

A 4-French Brite tip sheath (Cordis, High Wycombe, UK), C2 and Rim catheters (Cordis, High Wycombe, UK), and 2-French Progreat microcatheters (Terumo UK, Bagshot, UK) over 0.014" Fathom microwire (Boston Scientific, Hemel Hempstead, UK) were used to access prostate arteries bilaterally. A 2.4-French SwiftNinja Steerable microcatheter (Merit Medical, Galway, Ireland) was used for acutely angled prostatic artery ostia to facilitate cannulation. If prostatic artery access was difficult owing to aortoiliac arterial disease or tortuosity, bilateral femoral access was tried. Prostatic arteries were embolized with polyvinyl alcohol particles (PVA) Cook Medical, Limerick, Eire, Ireland. PVA 100 (90–180µ) particles were injected proximally, and PVA 200 (180–300µ) particles were injected distally when distal advancement of the microcatheter was possible (PErFecTED technique).

Postembolization prostatic artery coiling was performed in patients whose future reintervention is unlikely or who receive anticoagulant therapy to maximize the embolization effect and assure arterial occlusion. Anastomoses with prostatic arteries were also protected from nontarget embolization with coil deployment if they were unavoidable.

For elective PAE procedures, the patients were discharged on the same day after 4 hours of follow-up. The premedications included 160 mg intravenous (IV) gentamicin, 100 mg diclofenac per rectum, and 1 gm IV paracetamol. At home, the patient received a 1-week course of 500 mg ciprofloxacin twice daily and 400 mg ibuprofen four times a day.

Data Collection

Before the procedure, the values of the International Prostate Symptom Score (IPSS), quality of life (QoL), International Index of Erectile Function score, maximal urinary flow rate (Qmax), and postvoid residual (PVR) were recorded. Then, they were clinically followed up in 6 months, 1 year, 2, and 3 years post-PAE. Changes in prostate size were also collected by comparing post-PAE mean prostate volume change from the preprocedural volume in MRI.

The collected data were examined by SPSS version 23 and explored through descriptive statistics and paired *t*-test for identifying significance. The correlation was estimated through the Pearson's test. Alpha level of 0.05 was selected as the level of significance. Patients who failed to meet the follow-up duration were excluded from the corresponding analysis.

Patients' Characteristics

A total of 54 patients aged $\geq$ 80 years old were referred for prostate artery embolization between January 2014 and August 2020. The mean patient age was 85.29 years (range: 80–98, standard deviation = 4.29), with seven patients aged $\geq$ 90 years old. Seventeen patients complained of LUTS, 20 were catheter-dependent due to urinary retention, and 17 presented with prostate-induced hematuria.

In 30 patients, prostate surgery was contraindicated or unfavorable due to multiple comorbidities and low risk or metastatic prostate cancer. Eighteen patients had a high risk for thromboembolism (atrial fibrillation, pulmonary embolism, ischemic heart disease, coronary stents, etc.) on long-term anticoagulant/antiplatelet therapy, while one patient had chronic myelomonocytic leukemia with platelets count of $15,000 \times 10^9$/L. The other 24 patients opted for PAE or had a previous prostate operation in view with the minimally invasive technique and less hospital stay.

Results

Technical Outcomes, Dose Analysis, and Complications

Technical success (unilateral or bilateral embolization) was accomplished in 14 out of 17 patients with LUTS, 19 out of 20 catheter-dependent patients, and all prostate-related hematuria patients.[14] Forty patients had bilateral PAE, while ten patients had unilateral PAE. Reasons for unilateral embolization were either failure to access the other prostate artery or decision to do unilateral PAE only for a patient with unilateral holmium laser enucleation of the prostate (HoLEP) and low estimated glomerular filtration rate, a patient with unilateral prostate artery in CTA, which supplied both prostate lobes in

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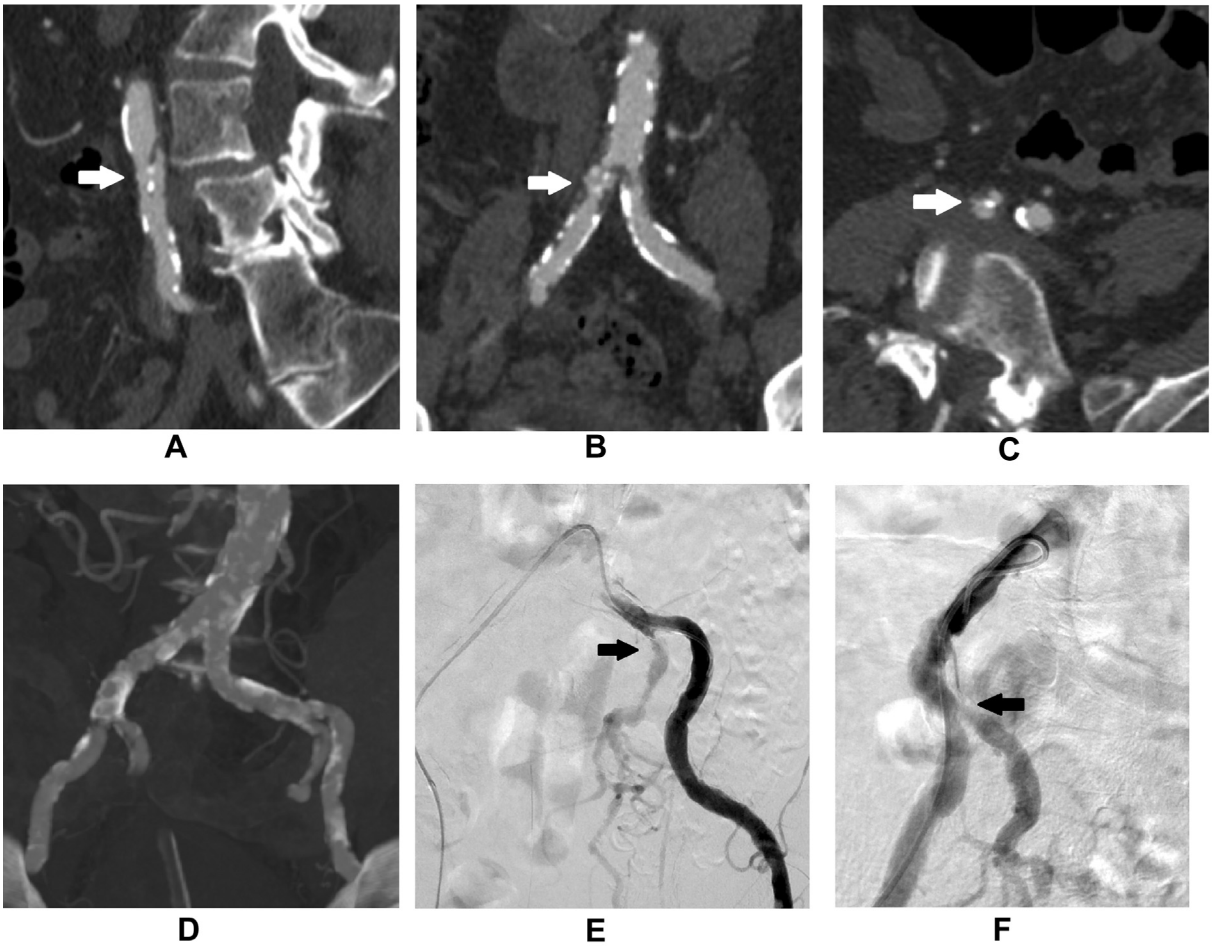

Fig. 1 (A–C) An 88-year-old patient on anticoagulants for coronary stenting with a 21-month history of urinary retention prior to prostate artery embolization (PAE). Computed tomographic angiography (CTA) shows dissected stenosed right common iliac artery (white arrows). Left groin access and left PAE was only done in view of the patient's high international normalized ratio (INR). (D) CTA in an 86-year-old patient with a 1-year history of urinary retention reveals diseased, calcified aortoiliac arteries with stenosed internal iliac arteries. Bilateral groin puncture and up and over access to both internal iliac artery (E, F) was done as access failed with forming Waltman loop or with USL 2 catheter due to severe calcifications and stenosis of iliac arteries and internal iliac arteries (black arrows). Both patients had successful trial without catheter in the first month post-PAE.

angiography, and a patient with extremely diseased and dissected contralateral common iliac artery with high international normalized ratio (►**Fig. 1A–C**).

The PAE was unfeasible in four patients due to extensive atheromatous disease, prostate arteries osteal stenosis, or occlusion. However, the failed procedures were done early before the availability of smaller 2 French and steerable microcatheters. Preprocedure CTA predicted the difficult anatomy in those patients who were consented to the high failure rate. CT findings were very small prostate artery calibers, stenotic or occluded prostate artery origins (two cases, ►**Fig. 2**), and nonvisualized prostate arteries with atheromatous vascular disease. Three of them had successful HoLEP operations after 1, 3, and 12 months. The fourth patient is still awaiting HoLEP and being attempted after aortic valve implantation surgery, which was further delayed because of the coronavirus disease 2019 (COVID-19) pandemic.

Bilateral groin puncture was done in four patients to gain stable access to prostatic arteries on each side. In the other 50 patients, PAE was accomplished with unilateral groin puncture. Patients with significant aortoiliac disease in CTA consented to bilateral groin access. Three patients had severe aortoiliac tortuosity, and ipsilateral catheterization of internal iliac artery was performed using USL 2 catheter, rim catheter, or C2 catheter (Cordis, United States) (►**Fig. 3**). The fourth patient had severely diseased (calcified and stenosed) iliac arteries, which could not accommodate a Waltman loop or USL 2 catheter. Therefore, bilateral access with up and over catheterization was performed (►**Fig. 1D–F**). Bilateral postembolization prostate artery coiling was done in 12 patients (24%); 9 of them had prostate-induced hematuria. Coil embolization was performed in elderly patients who were unlikely to undergo a repeated PAE in the future, patients with an MDM decision to intervene surgically if PAE clinically failed, patients with hematuria on lifelong anticoagulants to ensure occlusion, and patients with difficult access prostate artery for whom repeated prostate artery recatheterization will be challenging.

Eleven prostate arteries' pelvic anastomotic branches were coil-embolized in eight patients (16%): four vesical, four penile, and three rectal anastomoses. A suprapubic

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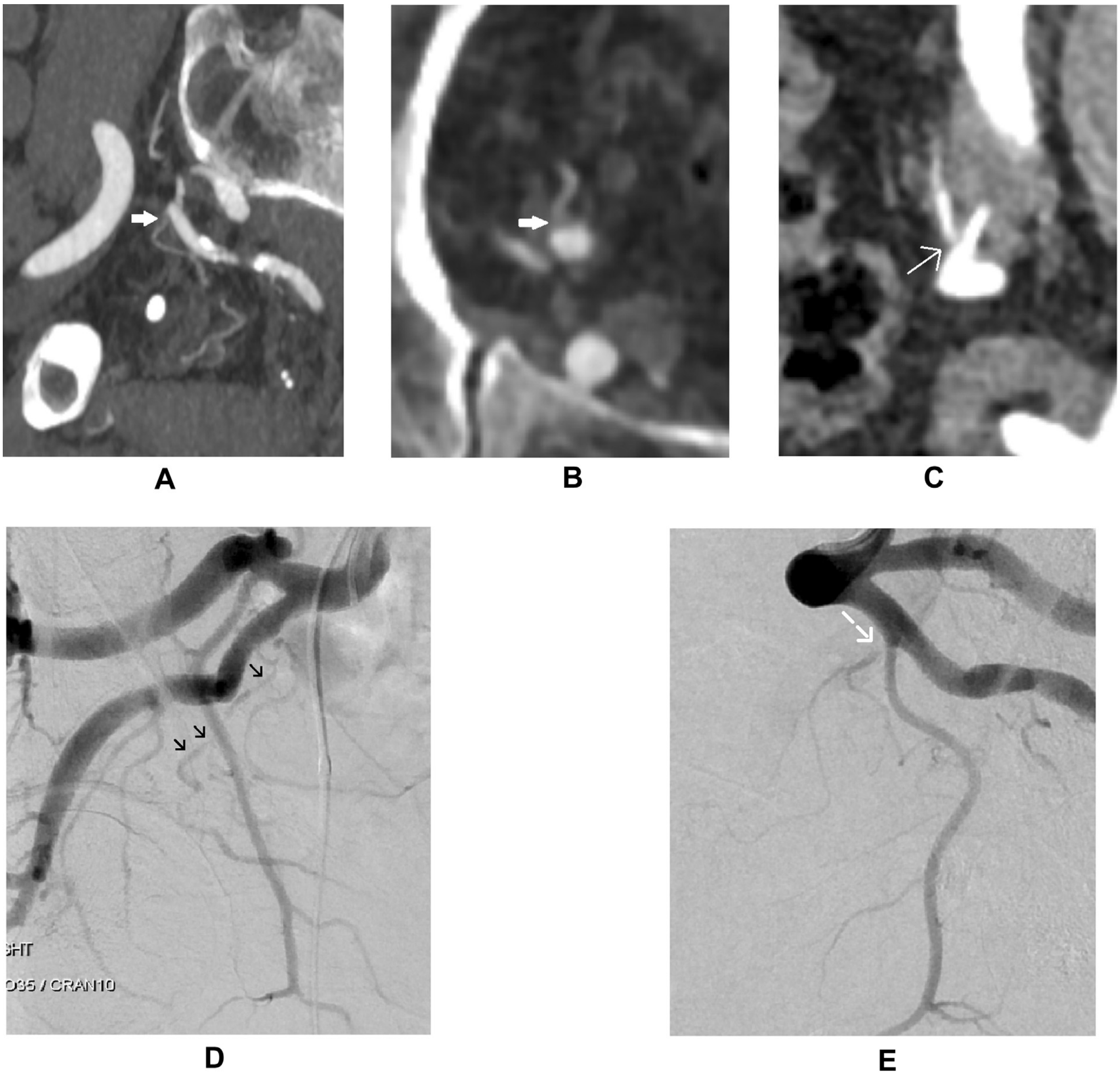

Fig. 2 An 81-year-old patient with lower urinary tract symptoms. (**A, B**) Computed tomographic angiography (CTA) of prostate arteries (PA) shows right PA origin focal occlusion by noncalcific plaque (white arrow). (**C**) CTA shows focal superior vesical artery (SVA) origin stenosis/occlusion (thin white arrow), which gives a PA branch. (**D**) Right internal iliac artery (IIA) angiogram reveals small diseased right PA with origin from the gluteal–pudendal trunk (thin black arrows). (**E**) Left IIA angiogram shows occluded SVA origin, which could not be cannulated (dashed white arrow).

catheter (SPC) was inserted in the same setting in six patients with urinary retention. An SPC was planned in patients with chronic retention on long-term catheters and would less likely have a successful trial without catheter (TWOC), patients with transurethral catheter exchange problems (bleeding—pain—infections), or patients who could not tolerate transurethral catheters. In all PAE procedures, no intra- or postprocedural complications were encountered. Thirteen patients died in the follow-up period with no procedure-related mortality: seven patients in the hematuria group, four patients in the urinary retention group, and two patients in the BPH group.

The mean fluoroscopy time was 38 minutes (range: 4.54–130.50 minutes). The mean dose area product (DAP) was 7831.59 μG.m^2 (range: 901.10–19394.07 μG.m^2), while the mean skin dose was 740.4 mGy (range: 76–1653 mGy). Doses were automatically estimated.

Clinical Outcomes

In patients with LUTS and successful PAE (14/17), a paired *t*-test showed significant improvement of mean IPSS from 18 before the procedure to 9.1 at 3 years (►**Fig. 4**). The paired *t*-test demonstrated improvement in the mean QoL score from 4.9 prior to PAE to 1.5 in 2 years (►**Fig. 5**). Moreover, the mean International Index of Erectile Function score showed a mild increase through a 2-year follow-up from 11.9 before PAE to 16 in 2 years post-PAE (►**Table 1**).

The mean % reduction of IPSS in 1 year was higher in patients with high baseline IPSS (IPSS $\geq$ 20, 7 patients) compared with those with low baseline IPSS (IPSS $<$ 20, 6

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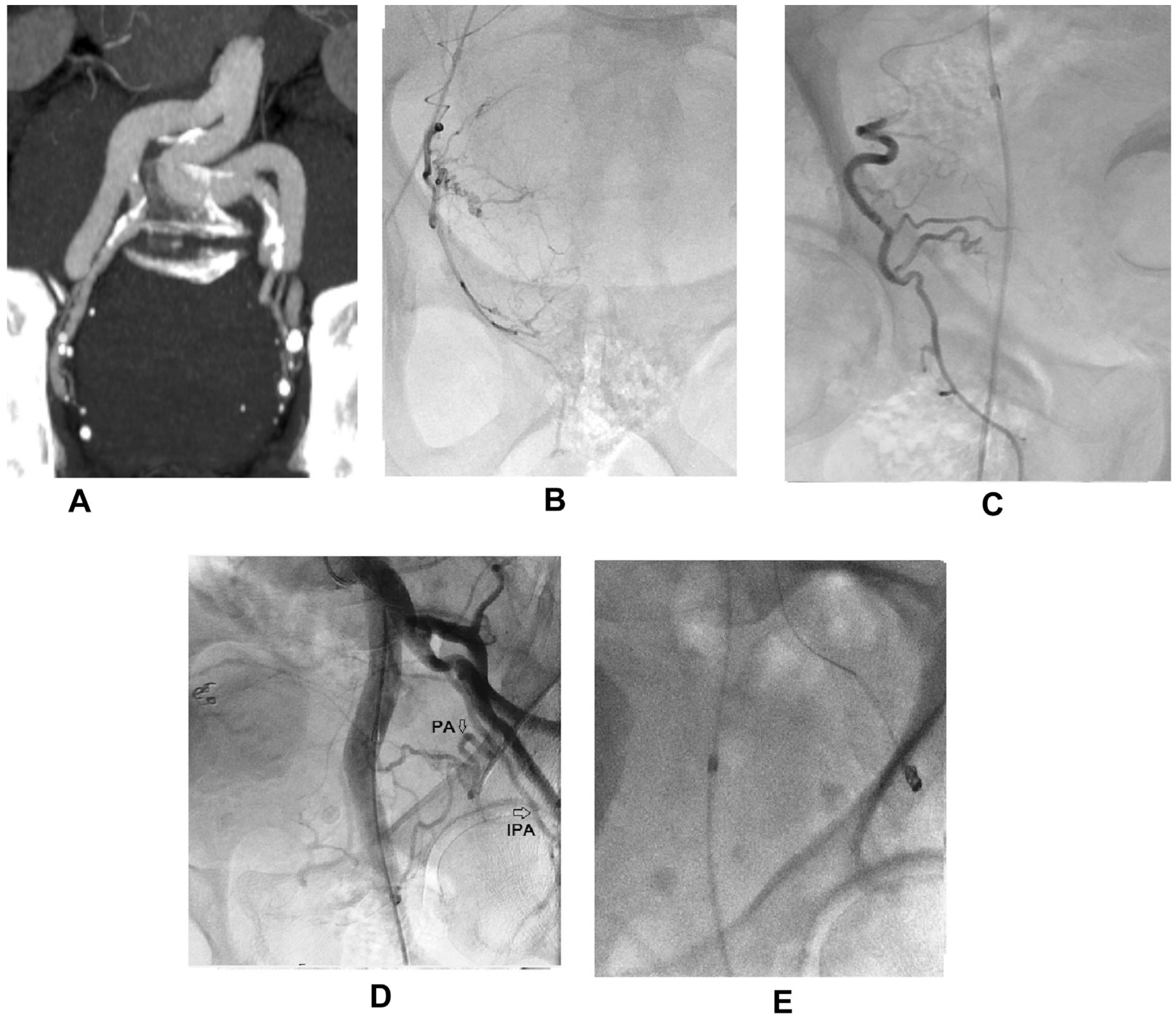

Fig. 3 An 80-year-old patient with chronic urinary retention for 10 months. (**A**) Computed tomographic angiography shows marked tortuous aortoiliac arteries with both internal iliac arteries calcifications. (**B**) Super-selective catheterization of the right prostatic artery (PA) was done. Digital subtraction angiography (DSA) shows hemiprostatic gland blush with an accessory internal pudendal branch, which could not be coil-protected or avoided by positioning the microcatheter more distally, so PA was slowly embolized with polyvinyl alcohol particles (PVA)-200. (**C**) Postembolization angiogram demonstrates the lack of prostatic gland blush with a preserved flow in the accessory internal pudendal artery (IPA) branch. (**D**) Left groin puncture and rim catheter were used to cope with the aortoiliac tortuosity. DSA from the left internal iliac artery shows the left PA arising from the IPA. (**E**) The left PA was super-selectively catheterized and "Embolized" with PVA-200 particles. Both PAs were coiled postembolization.

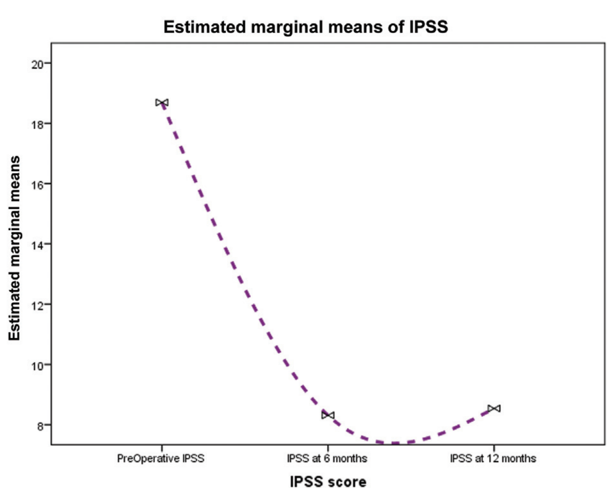

Fig. 4 Mean International Prostate Symptom Score (IPSS) at baseline, 6 and 12 months postprostate artery embolization.

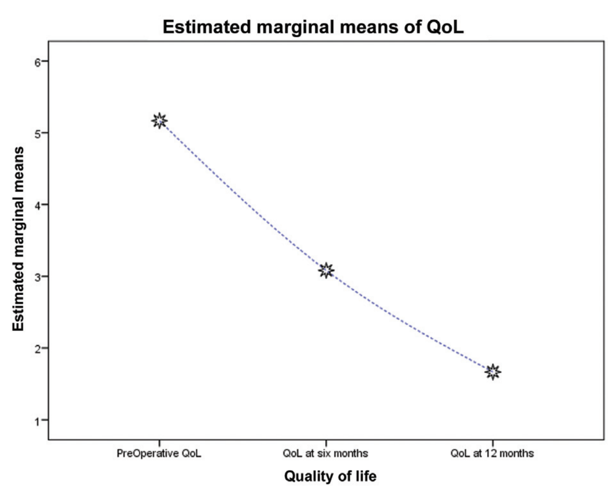

Fig. 5 Mean quality of life at baseline, 6 and 12 months postprostate artery embolization.

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Table 1 Changes of mean IPSS, QoL, IIEF scores before and after PAE (*r* = range, *n* = number of patients)

Mean IPSS				
–	Pre-PAE	18 r = 2–28	(*n* = 14)	
–	6 m	7.7 r = 0–17	(*n* = 14)	$p < 0.0001$
–	Y	8.5 r = 2–16	(*n* = 13)	$p < 0.0001$
–	2 y	8.6 r = 2–17	(*n* = 9)	$p = 0.003$
–	3 y	9.1 r= 3–19	(*n* = 8)	$p = 0.011$
Mean QoL				
–	Pre-PAE	4.9 r = 2–6	(*n* = 14)	
–	6 m	2.8 r = 0–5	(*n* = 14)	$p < 0.0001$
–	Y	1.7 r = 0–3	(*n* = 12)	$p < 0.0001$
–	2 y	1.5 r = 0–4	(*n* = 8)	$p < 0.0001$
Mean IIEF				
–	Pre-PAE	11.9 r = 2–21	(*n* = 9)	
–	Y	13.8 r = 5–25	(*n* = 8)	
–	2 y	16 r = 10–20	(*n* = 4)	

Abbreviations: IIEF, International Index of Erectile Function; IPSS, International Prostate Symptom Score; PAE, prostate artery embolization; QoL, quality of life.

Table 2 Mean % reduction of IPSS in 1 year

	Preoperative IPSS change 1 year ≥ 50%		Total
	No	Yes	
Preoperative IPSS ≥ 20	2	**5**	7 (53.8%)
Preoperative IPSS < 20	4	2	6 (46.2%)
Total	6 (46.2%)	7 (53.8%)	13

Abbreviation: IPSS, International Prostate Symptom Score.

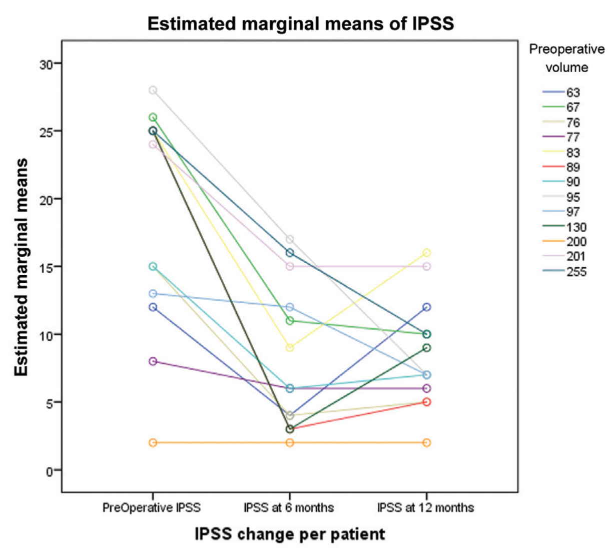

Fig. 6 International Prostate Symptom Score (IPSS) change per patient.

patients). Five patients with high baseline IPSS (71.4%) scored ≥ 50% reduction in IPSS in 1 year (Pearson $p = 0.170$, ►**Table 2**, ►**Fig. 6**). The Qmax improved from 12.48 mL/s pre-PAE to 14.35 mL/s in 2 years. A mean pre-embolization PVR of 111.5 mL declined to 89.4 mL in 2 years, and the mean prostate-specific antigen (PSA) level dropped from 6.64 ng/mL to half in 6 months before scoring 5.67 ng/mL in 2 years (►**Fig. 7**).

PAE was successful in 19 out of 20 patients with a chronic UB catheter for urinary retention. Thirteen patients of them had a successful catheter removal within 3 months post-PAE, and 1 patient after 9 months (73.7%) who had his first TWOC appointment after 9 months due to COVID-19 clinic cancellations. One patient of the successful TWOC group underwent HoLEP after 2-year of PAE, and two patients passed away 1 year after the procedure. Of the five patients who failed to pass the TWOC, two patients had the onset of urinary retention directly after meningitis and subdural hematoma. The rest were catheter-dependent for over 2 years before PAE.

A total of 17 patients received PAE for hematuria. Four of them had metastatic prostate cancer. PAE resulted in clinical success in 16 out of 17 patients with immediate stoppage of bleeding and voiding clear urine. The follow-up cystoscopy in the clinically failed patient showed no bleeding from the prostatic urethra or the bladder. The contrast-enhanced CT abdomen and pelvis revealed a small right renal transitional cell carcinoma, which was the source of bleeding. Five patients were discharged within 24 hours following PAE, while other patients remained hospitalized to control other comorbidities or for social or palliative care, with a mean overall hospital stay of 5.3 days. Five patients of this group passed away within 1-year post-PAE.

In 26 patients, prostate volume was measured preoperatively and during follow-up. Mean prostate volume

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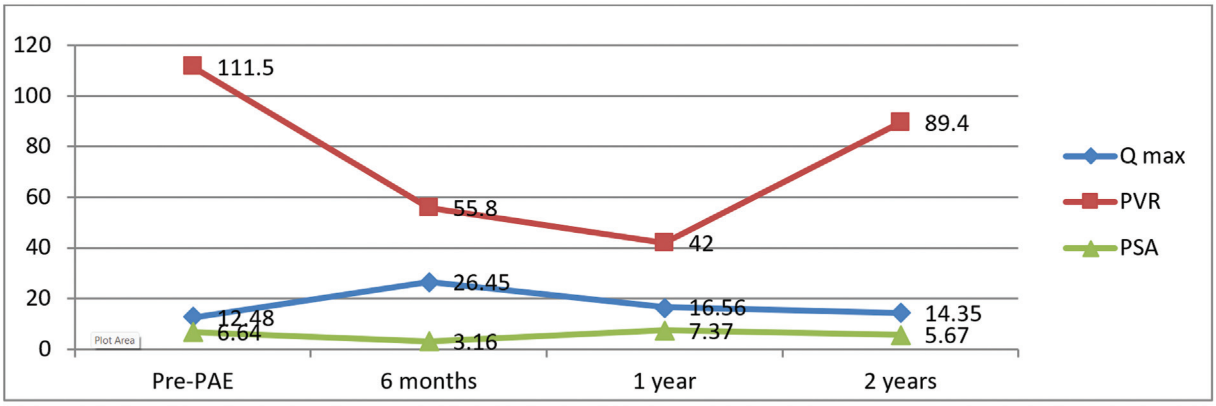

Fig. 7 Changes of mean maximal urinary flow rate (Qmax), postvoid residual (PVR), and prostate-specific antigen (PSA) levels.

measured prior to embolization was 152.7 ± 96.7 mL. It demonstrated a significant decline to 123.5 ± 77 mL (mean reduction: 18.45%, $p < 0.0001$) within 6 months (mean: 3.6 months, range: 2–6 months) postembolization. On follow-up, imaging was performed from 7 to 23 months postembolization (mean: 13.7 months, range: 9–23 months). The mean prostate volume measured 120.5 ± 76.8 mL ($p = 0.002$), representing a decrease of 18.13% in mean prostate size compared with the baseline prostate size. The largest prostate size to embolize, measuring a volume of 650 mL, was performed in an 80-year-old patient presented with BPH complicated with hematuria. The patient was not included in the prostate volume analysis due to the lack of post-PAE volume follow-up; however, satisfactory technical and clinical outcome was achieved with the stoppage of hematuria. The patient was discharged within 24 hours postprocedure (►**Fig. 8**).

Discussion

Technical Considerations

Prostate artery embolization is a challenging procedure due to the small and variant prostate arterial anatomy.[15] In elderly frail patients, catheterizing the prostate arteries may be more challenging with a higher possibility of underlying arterial occlusion, dissection, tortuosity, or aneurysm formation.[16] Here comes the importance of preprocedural planning with CTA in this age group to help anticipate arterial difficulties and choose the best suitable groin puncture side and catheters/microcatheters.[17] We recorded a 92.6% technical success rate that was lower than some studies, which were performed on younger age groups.[14,18,19]

The fluoroscopy time was not high compared with other studies.[11] Moreover, the DAP was lower than other studies, indicating comparative technical feasibility and low radiation exposure in the elderly population.[14,20–23] The leading cause behind this was the efficient preplanning and the use of minimal DSA and fluoroscopy.

Coil-embolization of prostate arteries after particle-embolization was performed to reduce the clinical recurrence by reducing the arterial recanalization. Since the primary pattern of revascularization was reported to be from main prostate arteries, a more effective embolization with an additional embolic agent was suggested to reduce recanalization.[24,25] Coil embolization as an adjunct embolic agent has recently been reported as technically feasible with no adverse events.[26]

Clinical Considerations

The present study proves the safety and efficacy of PAE in elderly frail individuals. PAE offers good clinical results with minimal intervention, perioperative morbidity, and hospital stay. It helps reduce the psychological impact or depression directly correlated with longer hospital stays or surgical operations.[27] The symptom improvement is similar to that presented in other studies.[19,28,29] However, one of the limitations was that the follow-up period was limited to 2 to 3 years postprocedure due to more difficulty patients' attendance to follow-up clinics in view of increased age, multiple comorbidities, and patients' death ($n = 13$).

TURP is considered a "high risk of bleeding" procedure that, in high-risk patients, requires discontinuation of anticoagulant or antiplatelet therapy.[30] Such high-risk patients usually have their surgery postponed. Therefore, PAE provided a safe treatment alternative for high-risk patients on anticoagulants.

PAE allowed catheter removal in 73.7% of patients. An SPC was inserted in the same PAE procedure setting whenever indicated. Insertion of SPC facilitates bladder training and volume recording toward catheter removal. It also reduces the risk of infection or bleeding. An SPC is better tolerated than a transurethral catheter in elderly patients with more prevalent urethral ulcers from frequent catheter exchange. It also helps them perform basic daily living skills.

PAE controlled hematuria in 16 patients. Although PAE was initially done on patients with hematuria,[9] it is vital to exclude other causes of hematuria before assuming that it is of prostatic origin. In our study, hematuria persisted in

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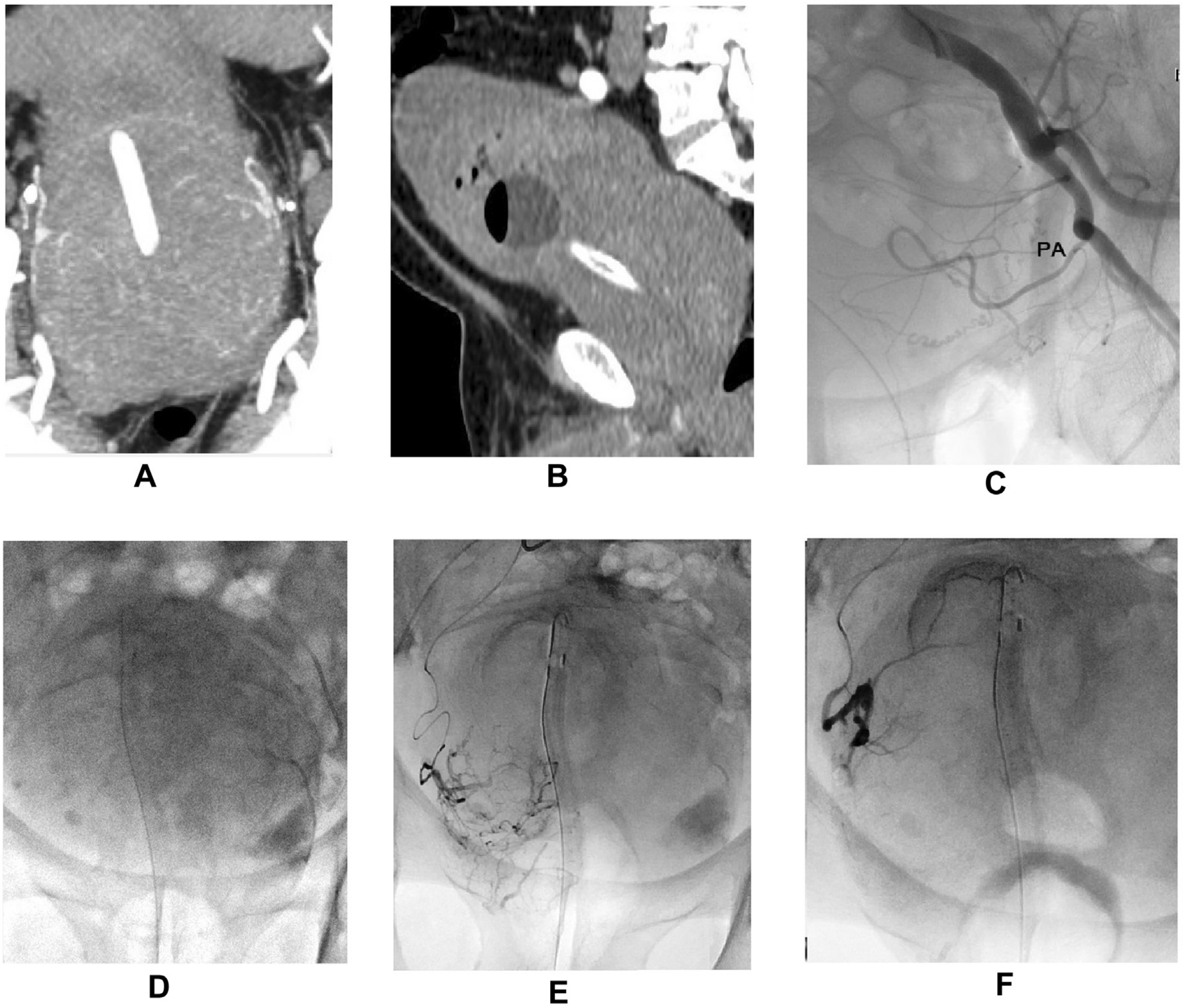

Fig. 8 An 80-year-old patient referred with benign prostate hyperplasia-induced prostate hematuria. (**A, B**) Computed tomographic angiography demonstrates the hugely enlarged, 650 mL, hypervascularized prostate with a bladder catheter and hyperdense bladder contents indicating blood clots. (**C, D**) Super-selective catheterization of the left prostate artery (PA) was performed, and embolization was achieved with PVA-100/200 particles. Super-selective catheterization of the right prostate artery was performed, and embolization of the peripheral (**E**) and central (**F**) branches was performed with PVA-100/200 particles.

one patient and proved to be caused by small bleeding renal pelvis transitional cell carcinoma and not of prostatic origin.

Conclusion

PAE in elderly patients with LUTS, urinary retention, and prostatic hematuria is an effective, minimally invasive alternative treatment to surgery. The safety and feasibility of the procedure allow a reliable curative treatment option for nonanesthetic candidates or those who fear surgical operations with related comorbidities.

Ethical Consideration

The study was conducted following the approval of the research ethics board at Guy's and St Thomas' Hospitals, London, United Kingdom. Informed consent was obtained from all participants in the study, and all procedures were approved by the research ethics board.

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Conflict of Interest

None declared.

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