# Quality of Life and Clinical Symptom Improvement Support Prostatic Artery Embolization for Patients with Acute Urinary Retention Caused by Benign Prostatic Hyperplasia

**Article** *in* Journal of vascular and interventional radiology: JVIR · February 2013

DOI: 10.1016/j.jvir.2012.12.019 · Source: PubMed



Francisco Carnevale
University of São Paulo


Joaquim Mauricio Da Motta Leal Filho
University of São Paulo


Ronaldo Hueb Baroni
Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, Ho…


Antonio S Z Marcelino
Hospital Sirio Libanes

# Quality of Life and Clinical Symptom Improvement Support Prostatic Artery Embolization for Patients with Acute Urinary Retention Caused by Benign Prostatic Hyperplasia

Francisco C. Carnevale, MD, PhD, Joaquim M. da Motta-Leal-Filho, MD, Alberto A. Antunes, MD, PhD, Ronaldo H. Baroni, MD, PhD, Antonio S.Z. Marcelino, MD, PhD, Luciana M.O. Cerri, MD, PhD, Eduardo M. Yoshinaga, MD, Giovanni G. Cerri, MD, PhD, and Miguel Srougi, MD, PhD

## ABSTRACT

**Purpose:** To show that prostatic artery embolization (PAE) improves quality of life (QoL) and lower urinary tract symptoms in patients with acute urinary retention caused by benign prostatic hyperplasia (BPH).

**Materials and Methods:** This was a single-center prospective study of PAE in 11 patients with BPH managed with indwelling urinary catheters. International Prostate Symptom Score (IPSS), ultrasound, magnetic resonance (MR) imaging, QoL, and urodynamic tests were used to assess outcomes. Prostate size ranged from 30 to 90 g, and embolizations were performed with 300–500-µm Embosphere microspheres.

**Results:** The rate of technical success (ie, bilateral PAE) was 75%, and the rate of clinical success (ie, catheter removal and symptom improvement) was 91% (10 of 11 patients). Postembolization syndrome manifested as mild pain in the perineum, retropubic area, and/or urethra. Ten of 11 patients urinated spontaneously after Foley catheter removal 4–25 days after PAE (mean, 12.1 d). No major complications were observed. Follow-up ranged from 19 to 48 months. In an asymptomatic patient, a discrete area of hypoperfusion suggesting small ischemia of the bladder was observed on 30-day MR imaging follow-up, but the bladder was normal on 90-day MR imaging. After 1 year, mean prostate volume reduction was greater than 30%, symptoms were mild (mean IPSS, 2.8 ± 2.1; $P = .04$), no erectile dysfunction was observed, and QoL improved significantly (mean, 0.4 ± 0.5; $P = .001$) using the paired t test.

**Conclusions:** Patients with severe symptoms and acute urinary retention caused by BPH can be treated safely by PAE, which improves clinical symptoms and QoL.

## ABBREVIATIONS

BPH = benign prostatic hyperplasia, DSA = digital subtraction angiography, IIEF = International Index of Erectile Function, IPSS = International Prostate Symptom Score, PAE = prostatic artery embolization, $P_{det}$ = detrusor pressure, PVR = postvoid residual volume, $Q_{max}$ = maximum urinary flow, QoL = quality of life, TURP = transurethral resection of the prostate

Benign prostatic hyperplasia (BPH) is age-related, and, if left untreated or not effectively treated, can lead to acute urinary retention, incontinence, and urinary tract infections, progressing in severity with age (1–6).

Treatment options for patients include watchful waiting or medical, minimally invasive, or surgical therapies (5). Although transurethral resection of the prostate (TURP) remains the gold standard for invasive therapy, TURP is associated with erectile dysfunction in 10% of patients and ejaculatory disorders in 50%–65% of patients (7). In TURP and laser TURP, ejaculatory disorder remains the primary

From the Department of Radiology (F.C.C., J.M.d.M.-L.-F., R.H.B., A.S.Z.M., L.M.O.C., G.G.C.) and Division of Urology, (A.A.A., E.M.Y., M.S.), University of Sao Paulo Medical School, Rua Teodoro Sampaio, 352/17, Sao Paulo 05406-000, Brazil. Received September 12, 2012; final revision received and accepted December 18, 2012. **Address correspondence to** F.C.C.; E-mail: fcarnevale@uol.com.br

From the 2012 SIR Annual Meeting.

None of the authors have identified a conflict of interest.



*J Vasc Interv Radiol 2013; XX:*■■■–■■■

http://dx.doi.org/10.1016/j.jvir.2012.12.019

side effect, and is attributed to damage of nerve bundles adjacent to the prostatic capsule (7–10).

For more than 30 years, embolization of hypogastric arterial branches has been used to control severe prostatic hemorrhage caused by BPH or cancer, with successful results (11,12). Some authors have described initial results with PAE to assess the efficacy, durability, and adverse event rates in patients with enlarged prostate symptoms (13–15).

In the present study, we report the results of a prospective study of PAE with microspheres as a primary treatment in 11 patients with acute urinary retention who were managed with indwelling urinary catheters as a result of BPH. Patients were followed up for a minimum of 19 months, with the initial two patients followed up for 4 years.

## MATERIALS AND METHODS

A single-center prospective study of PAE was conducted in 11 patients managed with indwelling urinary catheters during a mean of 10.9 months (range, 1.5–42 mo) as a result of BPH, who underwent PAE between June 2008 and November 2011. After approval by the urology and radiology departments in 2008, the institutional review board approved the study protocol (no. 0136/09) and patients signed informed consent for PAE as an alternative treatment.

Eleven patients on the waiting list for TURP, who had been previously treated with selective α-blockers without success, were enrolled in the study. All patients stopped medication 1 month before PAE. Prostate size ranged from 30 to 90 g. Mean patient age was 68.5 years (range, 59–78 y). Before intervention, a urologist performed digital rectal examination and prostate biopsy if indicated. Demographic and urologic examination data are reported in **Table 1**. In preparation for the PAE procedure, the indwelling catheter was removed and urodynamic tests were performed to establish baseline measurements. Prostate-specific antigen (PSA) level, transrectal ultrasound (US), and magnetic resonance (MR) imaging baselines were established for each patient. The medical team assessed symptom severity and erectile function by using the International Prostate Symptom Score (IPSS; evaluated as mild, moderate, or severe) and the International Index of Erectile Function (IIEF; evaluated as severe, moderate, mild-to-moderate, mild and no dysfunction), respectively. To assess baseline quality of life (QoL), patients answered the question, "If you were to spend the rest of your life with your urinary condition just the way it is now, how would you feel about that?" Possible answers ranged from "terrible" to "delighted" (5). Patients with malignancy or any other cause of voiding dysfunction were excluded from the study.

**Table 1**. Patient Demographic and BPH-related Symptoms (N = 11)

| Characteristic | Value |
|---|---|
| Age (y) | 68.5 ± 5.2 |
| LUTS duration (mo) | 22.9 ± 36.5 |
| Mean catheter indwell (mo) | 10.9 ± 11.2 |
| DRE prostate volume (g) | 61.8 ± 15.4 |
| Mean PSA (ng/mL) | 9.8 ± 5.1 |
| Hematuria | 4 (36.4) |
| Arterial hypertension | 6 (54.5) |
| Coronary disease | 1 (9.1) |
| Diabetes mellitus | 1 (9.1) |

Values presented as means ± standard deviation where applicable. Values in parentheses are percentages.
BPH = benign prostatic hyperplasia, DRE = digital rectal examination, LUTS = lower urinary tract symptom, PSA = prostate-specific antigen.

After the PAE procedure, US and MR imaging were used for evaluation of effectiveness at 1, 3, 6, and 12 months, and every year thereafter. The interval between MR imaging and US was less than 1 week. IPSS, IIEF, and responses to the QoL questionnaires were reevaluated through the last follow-up appointment.

### Imaging

Prostate volume was measured by standard transrectal US (Applio; Toshiba, Tustin, California) by the same two radiologists. Prostate vascularization was visualized by Doppler assessment and the use of a sonicated contrast agent (Definity; Bristol Myers Squibb, Billerica, Massachusetts) injected as a bolus through the antecubital vein in a dose of 1 mL, followed by 10 mL of saline solution. The residual urine volume was assessed by transabdominal US. The MR imaging protocol for all examinations was the same, and a 1.5-T magnet was used with a phased-array 12-channel body coil (GE Healthcare, Milwaukee, Wisconsin). Because of technical issues, we used fat-suppression for the preembolization but not the postembolization studies. We also performed two axial sequences for the study of the pelvis. Gadolinium chelate (Magnevist; Bayer-Schering, Berlin, Germany) was injected through an antecubital vein in a dose of 0.2 mL/kg at a rate of 2 mL/s with the use of an automated bolus injection system. Prostate measurements (cephalocaudal, transverse, and anteroposterior) were obtained, and volume was calculated by the ellipse formula.

### PAE Technique

To provide good orientation to the prostate site and related structures in the pelvis, we filled a Foley balloon in the bladder of each patient with contrast medium (mixture of 10 mL of 50% iodinated contrast medium plus 50% normal saline solution). Patients underwent angiography and embolization in the interventional radiology suite (FD20 digital subtraction angiography [DSA] unit; Philips, Best, The Netherlands) with nonionic contrast medium (iodixanol 320 mgI/mL; Visipaque; GE Healthcare). A 400-mg intravenous dose of ciprofloxacin was given before the procedure, followed by 500 mg orally twice per day for 7 days after PAE. Patients also received nonopioid analgesic and nonsteroidal antiinflammatory medication after embolization if necessary. Intervention was performed under local anesthesia through the right transfemoral approach. Initial pelvic angiography was performed to evaluate iliac vessels and prostatic arteries during arterial and late phases. Selective DSA of the right and left internal iliac arteries was performed with a 5-F Cobra-2 or vertebral catheter to assess the blood supply to the prostate.

Bilateral selective catheterization of the inferior vesical artery, superior vesical artery, obturator artery, middle rectal artery, and internal pudendal artery was then performed with use of a microcatheter (Embocath [Biosphere, Roissy, France] or Progreat 2.8 [Terumo, Tokyo, Japan]). Angiography was performed by manually injecting 3–5 mL of contrast medium to identify any blood supply to the prostate and to ensure that the tip of the microcatheter was inside or at the ostium of the prostatic arteries. When spasm occurred, nitroglycerin was used.

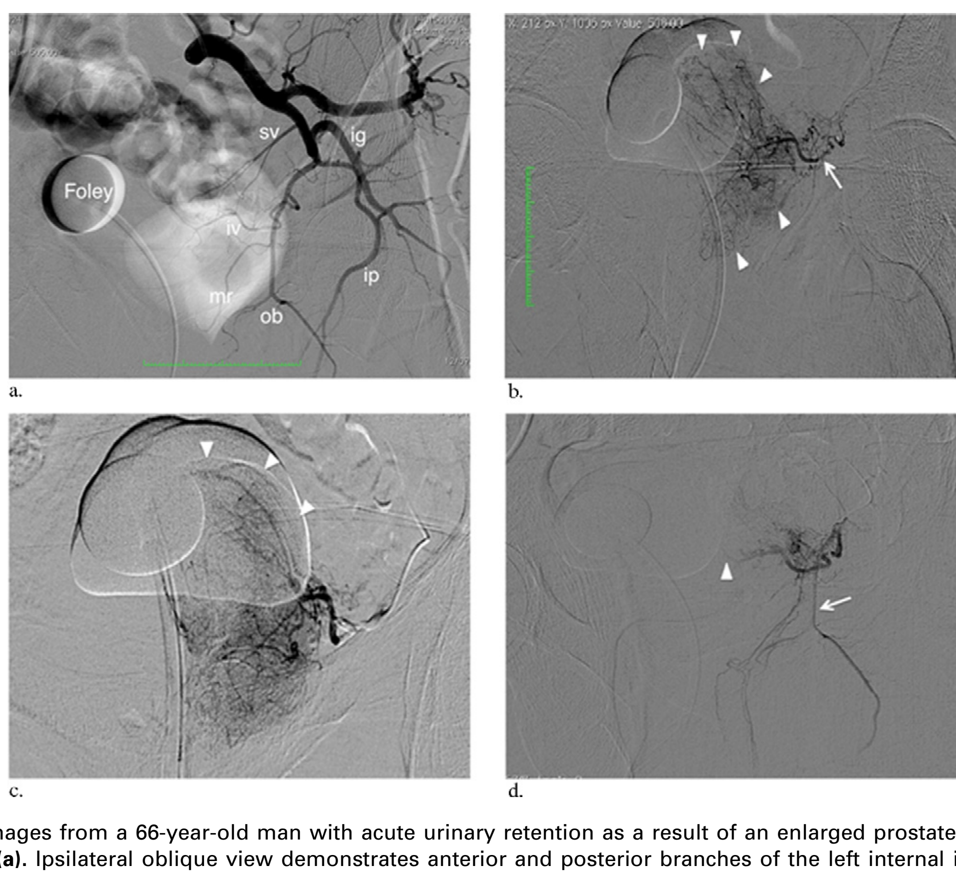
Tris-acryl microspheres (Embosphere microspheres; Biosphere) 300–500 μm in diameter were used for embolization. We diluted the 2.0-mL syringe to a total volume of 22 mL with equal amounts of contrast medium and saline solution. The microsphere mixture was slowly injected under fluoroscopic guidance. Embolization of the prostatic arteries was performed to the extent of stasis, without reflux of the mixture to undesired arteries (Fig 1). Follow-up angiography was performed manually with the microcatheter using the power injector, with the 5-F catheter at the anterior branch of the internal iliac artery to check for any further blood supply to the prostate. Embolization was then performed on the contralateral side by using the same technique.

## Statistical Analysis

Categoric variables were expressed as percentages, and continuous variables were expressed as means and standard deviations. A Student $t$ test for paired samples was used when appropriate. A $P$ value of less than .05 was considered statistically significant. All statistical analyses were performed with SPSS software (version 13.0; SPSS, Chicago, Illinois).

# RESULTS

Follow-up ranged from 19 months to 4 years (mean, 28.6 mo) for the 11 patients. One patient was lost to follow-up as a result of pancreatic cancer 17 months after




a. b. c. d.

**Figure 1.** DSA images from a 66-year-old man with acute urinary retention as a result of an enlarged prostate, with an indwelling bladder catheter. **(a).** Ipsilateral oblique view demonstrates anterior and posterior branches of the left internal iliac artery and their relationship with the Foley balloon (*ig* = inferior gluteal artery, *ip* = internal pudendal artery, *iv* = inferior vesical artery, *mr* = middle rectal artery, *ob* = obturator artery, *sv* = superior vesical artery). Rectum filled with air can be identified (white area at the projection of middle rectal artery and inferior vesical artery). **(b)** Ipsilateral oblique view showing the left prostate lobe arteries (arrowheads) after distal catheterization of the inferior vesical artery with the microcatheter (arrow). The relationship of the main prostatic artery and the Foley balloon can be identified. **(c)** Posterior/anterior view shows median lobe prostatic arteries prolapsed into the bladder (arrowheads). **(d)** Ipsilateral oblique view shows the endpoint of the left PAE: contrast medium stasis (arrowhead) after left prostatic artery embolization with contrast medium reflux to the left obturator artery (arrow). (Available in color online at *www.jvir.org*.)

PAE. Technical success (ie, bilateral PAE) was achieved in nine procedures (75%). Bilateral PAE failed twice in one patient, who was unable to void spontaneously when the indwelling urinary catheter was removed. This patient was referred to undergo TURP. Of the three patients who received unilateral embolization, one had an inferior vesical artery dissection during selective catheterization; in another, the microwire was placed into the inferior vesical artery but the microcatheter did not progress; and, in the third patient, who had asymmetric hypertrophy of the prostate, the left inferior vesical/prostatic arteries were not indentified during arteriography.

Mean fluoroscopy and procedure times were 85.9 minutes ± 49.3 and 197.5 minutes ± 84.5, respectively. No serious skin injuries or complications related to radiation exposure were observed during the first year of follow-up of medical consultation. The mean volume of contrast medium/Embosphere microsphere mixture used per procedure was 13.2 mL ± 4.2. Among nine patients who underwent bilateral PAE (one patient underwent PAE twice), the microcatheter was positioned in the prostatic arteries in eight and more proximally on one side as a result of technical difficulties with microcatheter progression in the ninth.

Adverse events were evaluated for severity based on Society of Interventional Radiology (SIR) criteria and National Cancer Institute Common Toxicity Criteria for Adverse Events (version 4.0) (16,17). There were no major complications, and patients reported no discomfort during six of the 12 procedures (50%). The others reported mild burning in the urethra and/or retropubic areas. No patients experienced fever. The first two patients stayed in the hospital for 3 days for observation and digital rectal examination by a urologist, and the others were discharged on the same day as the procedure. Patients were followed up for self-reported adverse events including discomfort during the first week after procedure. Nine patients reported very mild pain in the perineum, retropubic area, and/or urethra, which was treated with nonopioid analgesic and nonsteroidal antiinflammatory drugs. Three patients had rectal bleeding (approximately 1 tsp of blood mixed with mucus and stool), and two patients had mild diarrhea lasting 24 hours. A small inguinal hematoma at the puncture site was observed in one patient. A single patient reported one episode of hematuria, which was subsequently correlated with a focal area of hypoperfusion in the bladder neck caused by nontarget embolization that was observed at the 30-day MR imaging follow-up. The hematuria did not recur, and the bladder showed reperfusion without any intervention; it had resolved completely by 3-month follow-up imaging. One case of inferior vesical artery dissection occurred during an attempt to catheterize the artery with the microcatheter. No lower urinary tract infection was observed during follow-up. Patients' symptoms during and after intervention, adverse events, and complications related to the 12 PAE procedures are described in **Table 2**.

**Table 2**. Patients Symptoms, Adverse Events and Complications Related to PAE (N = 12)

| Finding | Incidence |
|---|---|
| Intraprocedural symptoms | 6 (50) |
| Mild perineal pain | 4 (33.3) |
| Mild retropubic pain | 1 (8.3) |
| Mild urethral and perineal pain | 1 (8.3) |
| Postprocedural symptoms | 10 (83.3) |
| Mild perineal pain | 3 (25) |
| Mild retropubic pain | 2 (16.7) |
| Mild urethral pain | 2 (16.7) |
| Mild perineal and retropubic pain | 1 (8.3) |
| Mild perineal and urethral burning | 1 (8.3) |
| Hematuria | 1 (8.3) |
| Adverse events | 3 (25) |
| Minimal rectal bleeding and diarrhea | 2 (16.7) |
| Minimal rectal bleeding | 1 (8.3) |
| Complications | 3 (25) |
| Focal hypoperfusion area in the bladder | 1 (8.3) |
| Small inguinal hematoma | 1 (8.3) |
| Inferior vesical artery dissection | 1 (8.3) |

Values in parentheses are percentages.
PAE = prostatic artery embolization.

Clinical success (ie, Foley catheter removal) was obtained in 10 patients (91%) after PAE, including the three patients who underwent unilateral PAE. Patients returned to the urologist weekly, and removal of the indwelling catheter was attempted. Ten urinated spontaneously after Foley urethral catheter removal at 4–25 days after PAE (mean, 12.1 d). A single patient underwent bilateral embolization twice after failure to urinate after Foley catheter removal by the 1-month follow-up visit after initial embolization. During the second procedure, both inferior vesical arteries were occluded, but another small prostatic branch was identified on each side and embolized by using the same technique. When removal of the Foley catheter in this same patient failed after the second bilateral embolization, he was referred to undergo TURP.

**Table 3** shows that, after 1 year, mean prostate volume reduction was greater than 30% as measured by US (31.6% ± 18.6; range, 2.6%–57.1%; $P$ = .004) and MR imaging (31.7% ± 20.9; range, 2.2%–56.8%; $P$ = .002).

Ten of 11 patients were able to void spontaneously without catheterization after PAE, with only mild symptoms. Mean IPSSs were 7.1 ± 4.5 at 1 month and 2.8 ± 2.1 at 1 year after PAE ($P$ = .04). Erectile dysfunction measured by IIEF was mild/moderate at 1-month follow-up and thereafter improved to mild to no dysfunction ($P$ = .53). QoL improved significantly after embolization, and results were sustained at 1-year follow-up ($P$ = .001). Before PAE, mean PSA level was 10.1 ng/mL ± 5.6; this increased to 85.6 ng/mL ± 70.2 at 24 hours after PAE and decreased to 3.5 ng/mL ± 2.3 at 1 month and 4.3 ng/mL ± 1.7 at 1 year ($P$ = .003). As all patients had indwelling catheters at baseline, maximum urinary flow

**Table 3**. Imaging Prostate Volume Measurements before and after PAE (n = 10)

| Imaging Method | Before PAE | 30 d | 90 d | 180 d | 365 d | *P* Value |
|---|---|---|---|---|---|---|
| MR | | | | | | |
| Weight (g) | 69.7 ± 15.6 | 51.5 ± 15.1 | 48.2 ± 14.9 | 45.1 ± 14.2 | 46.3 ± 16.3 | .002 |
| Reduction (%) | – | 25.7 ± 12.8 | 29.8 ± 16.4 | 33.8 ± 17.4 | 31.7 ± 20.9 | – |
| US | | | | | | |
| Weight (g) | 62 ± 14.7 | 44.4 ± 13.6 | 39.4 ± 6.3 | 39.4 ± 9.2 | 40.8 ± 10.6 | .004 |
| Reduction (%) | – | 27.3 ± 15.5 | 34.3 ± 12.3 | 34 ± 16.3 | 31.6 ± 18.6 | – |

PAE = prostatic artery embolization.

($Q_{max}$) was difficult to measure during urodynamic studies. Among all 10 patients who were able to have their catheters removed after embolization, $Q_{max}$ increased from an average of 4.2 mL/s ± 2.9 to 10.8 mL/s ± 4.6 ($P$ = .009), detrusor pressure ($P_{det}$) was reduced from 85.7 cm $H_2O$ ± 31.7 to 51.5 cm $H_2O$ ± 26.2 ($P$ = .007), and postvoid residual volume (PVR) decreased from 160.5 mL ± 107.8 to 60 mL ± 83.8 ($P$ = .04).

## DISCUSSION

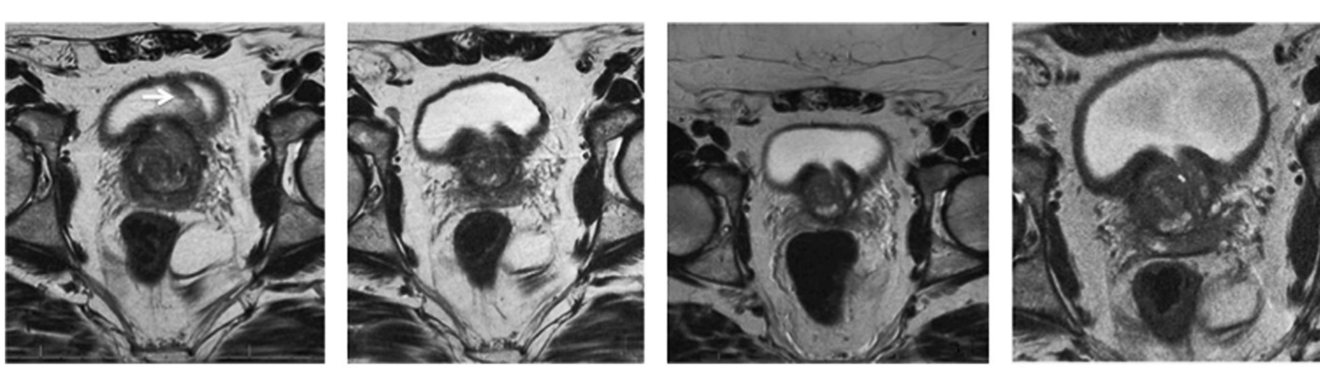
The first published case in which it was recognized that PAE could have a therapeutic affect on BPH was in 2000 by DeMeritt et al (18). Carnevale and colleagues (13,14) reported the first intentional treatment of BPH with PAE and midterm follow-up data for two patients with acute urinary retention managed with indwelling urinary catheters, confirming the efficacy of the procedure. Other authors have shown good initial results with PAE in patients with symptomatic enlarged prostates and have used computed tomographic angiography to identify the prostatic arteries (15,19).

In the present study, the most common artery supplying the prostate was the inferior vesical artery, but branches from other arteries were also found to feed the gland. For this reason, an important feature of our technique was the use of a Foley balloon catheter filled with contrast medium for better orientation and exploration of all the feeding vessels of the prostate. It provides better understanding of the prostate and related structures to avoid complications from nontarget embolization. This maneuver is also useful for patients without indwelling urinary catheters. It is also important to visualize and explore all arteries that might be supplying the prostate to achieve as complete an occlusion as possible. This method involves investigating the inferior and superior vesical, middle rectal, obturator, and internal pudendal arteries for feeder vessels to the prostate.

Bilateral inferior vesical arteries and any other prostatic branches should be embolized to achieve optimal prostate ischemia, resulting in volume reduction for better long-term results. Reasons for unilateral embolization were an inferior vesical artery dissection during selective catheterization, with tortuosity and atherosclerotic disease of the inferior vesical artery (n = 1); and no progression of the microcatheter over the microwire placed into the inferior vesical artery (n = 1). In a third patient, who had asymmetric right-sided hypertrophy of the prostate diagnosed by US and MR imaging, the left inferior vesical/prostatic arteries were not visualized after extensive investigation as a result of atherosclerotic occlusion.

Despite the learning curve resulting in long procedure time in this initial study, there were no serious skin injuries or complications related to radiation exposure observed during the follow-up period. To avoid radiation injuries, any available dose-reducing features such as low-dose fluoroscopy mode, collimators, and image-hold capabilities should be used.

Technical success was considered when bilateral inferior vesical arteries could be embolized, which was achieved in 10 of 11 patients (75%). Pisco et al (15) considered it a technical success if at least one side could be embolized



a. b. c. d.

**Figure 2.** MR images from a 71-year-old patient who underwent PAE. **(a)** At the 30-day follow-up, a focal area of hypoperfusion in the bladder neck (arrow) caused by nontarget embolization was identified. MR images show normal bladder at 90-day **(b)**, 1-year **(c)**, and 2-year **(d)** follow-up.

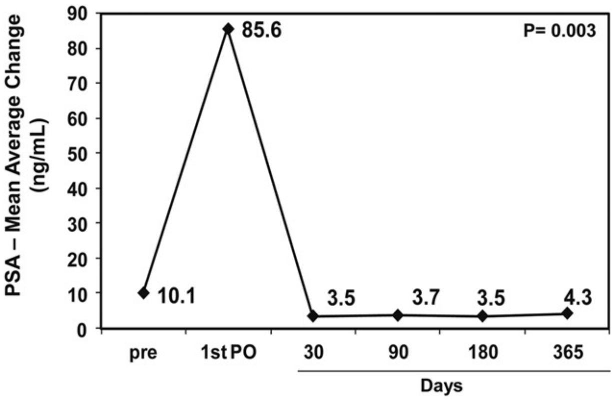



**Figure 3.** Mean PSA level of 10 patients treated with PAE was increased at baseline as a result of enlarged prostate. Prostate ischemia was confirmed by an eightfold PSA level increase 24 hours after PAE. Mean PSA level was reduced to lower than 50% of the baseline measurement at 1-month follow-up, and these values were sustained over 1 year of follow-up.

(ie, unilateral PAE), which they achieved in 14 of 15 patients (93.3%). The aim of PAE is to achieve as much prostate ischemia as possible to avoid revascularization from the contralateral prostatic arteries or accessory arteries and subsequent later gland regrowth. For that reason, bilateral PAE should be performed if possible, and any additional prostatic branches should also be embolized for greater prostate shrinkage and better long-term clinical success.

No serious complications or adverse events in the performance of PAE were observed in the present series. Similar to any other visceral embolization, we defined symptoms like nausea, vomiting, fever in the absence of infection, urethral burning, periprostatic or pelvic pain, and very small amounts of blood in the urine and/or mixed in the stool with mucus for 2–3 days as "post-PAE syndrome." Because this post-PAE syndrome is mild and the procedure is performed under local anesthesia, patients can be discharged on the day of the procedure.

The presence of a small amount of blood in the urine or mixed in the stool is likely to be the result of arterial communications between the prostate, bladder, and rectum.

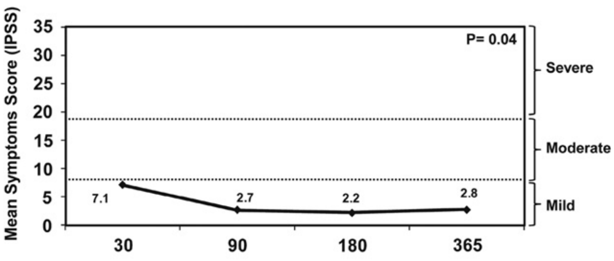



**Figure 4.** IPSS variation before and after PAE. IPPS could not be applied at baseline because patients had indwelling urinary catheters, but the patients can be considered to have had severe symptoms based on their acute urinary retention. At 30-day follow-up, patients had mild symptoms that lasted during the first year of follow-up.

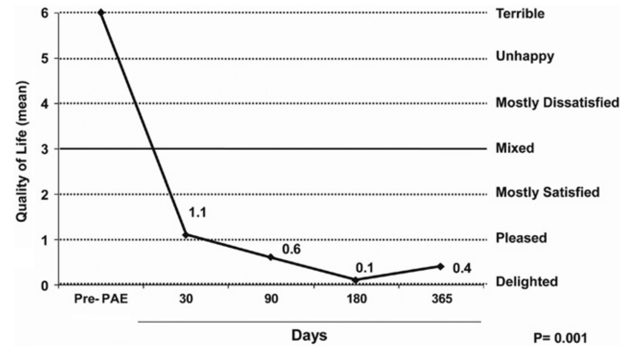



**Figure 5.** According to the QoL questionnaire before PAE, all patients had a terrible QoL. At 1 month after PAE, patients had a high degree of satisfaction with PAE, and these values were sustained over 1 year of follow-up.

None of these incidents required treatment, and all resolved spontaneously.

The only notable complication, in an asymptomatic patient, was a discrete focal area of hypoperfusion in the bladder wall observed at the 1-month MR imaging follow-up. In this embolization, selective distal positioning of the microcatheter into the prostatic arteries was not possible, and embolic agents had to be injected with the microcatheter placed at the proximal portion of the inferior vesical artery. Embolization was stopped when opacification of the contralateral inferior vesical artery was observed. At the 30-day MR imaging follow-up, a focal area of hypoperfusion in the bladder neck was identified on the left side. We determined this as an ischemic area related to nontarget embolization to the left inferior vesical artery. The patient had no other complications of bladder ischemia, and 90-day and 2-year MR imaging follow-up showed that the bladder was normal (Fig 2). Pisco et al (15) reported a major complication from untargeted bladder embolization that required treatment with partial resection. This reinforces the need to position the microcatheter tip close to the prostatic branches to achieve more effective embolization and a safer procedure.

Prostate inflammation and ischemia after embolization are reflected in a PSA increase immediately after the procedure. In the present study, we observed that, 24 hours after the procedure, PSA increased by eight times relative to the mean baseline values. One month after embolization, mean PSA level decreased to normal levels (50% of the initial mean value; $P = .003$), which was sustained over time, suggesting prostate cellular apoptosis after PAE (Fig 3).

All patients had indwelling urinary catheters as a result of acute urinary retention at baseline and after the PAE procedure. Patients in whom clinical success was achieved were able to void spontaneously after urinary catheter removal. Ten of the 11 patients showed an average of greater than 30% reduction in prostate volume after PAE as measured by US ($P = .004$) and MR imaging ($P = .002$) at 1-year follow-up. Volume decrease was most evident during the first 3 months after PAE. Mean prostate

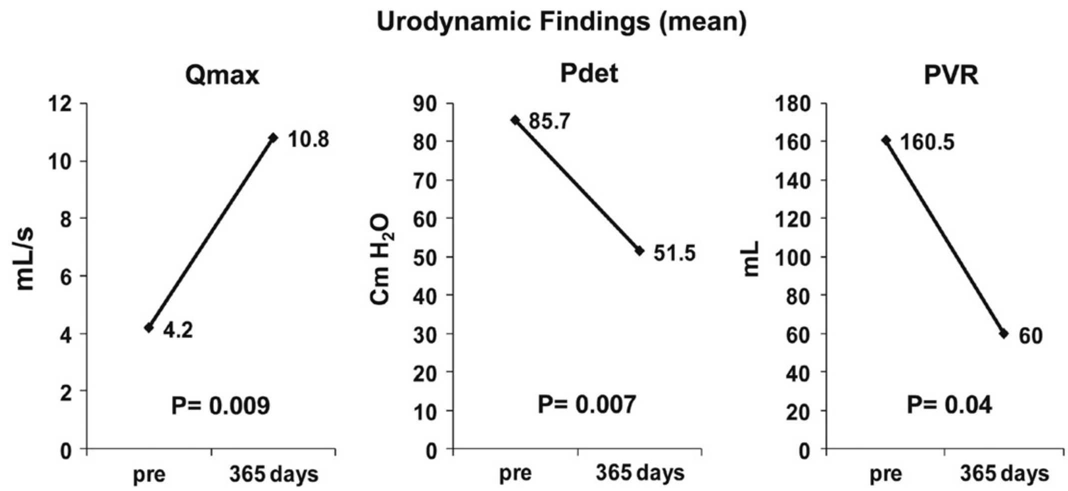



**Figure 6.** Mean urodynamic findings before and at 1 year after PAE showed improvement of $Q_{max}$, reduction of $P_{det}$, and reduction of PVR.

reduction was slightly greater than 30% at 1 year after PAE. US and MR imaging are useful methods of measurement before and after PAE, but we have observed greater variations in US results and therefore prefer MR imaging for this procedure.

Indwelling urinary catheter removal was achieved in 10 patients at a mean of 12.1 days after PAE. Patients' lower urinary tract symptoms decreased meaningfully after treatment, as measured by IPSS at 1-month follow-up. This improvement was sustained over time (Fig 4).

After a 4-year follow-up in two patients and a minimum of 19 months of follow-up in all patients, a 91% clinical success rate was achieved. Overall, QoL significantly improved for the 10 patients who underwent successful PAE (Fig 5). Clinical failure occurred in one patient (9%). This patient had a mean prostate reduction of 5% after two bilateral PAE procedures and was referred for TURP. The surgeon stated that this patient experienced a much smaller blood loss compared with historic TURP recipients. No complications were observed after TURP, and the catheter was removed successfully. In their initial experience, Pisco et al (15) observed clinical failure in 28.6% of cases at a mean follow-up of 7.9 months (range, 3–12 mo).

One-year follow-up urodynamic findings after PAE in the present study showed that maximum bladder capacity and maximum flow rates improved significantly. Bladder complacence improved, and patients showed better $Q_{max}$ with reduction of the $P_{det}$ and PVR. This means that patients were voiding better, without straining to void and with less residual urine in the bladder after voiding (Fig 6). No patient presented with erectile dysfunction after intervention. Clinical overall improvement in lower urinary tract symptoms and urodynamic data during 1 year of follow-up corroborate the high degree of satisfaction after PAE and better QoL for these patients.

Some limitations of the present study are related to the small number of patients treated at a single center with limited follow-up. Longer follow-up in all patients will bring additional information in the future. The use of a 2.8-F microcatheter with no hydrophilic microwire contributed to some technical failures and prolonged radiation time. Further investigation concerning different sizes of embolic agents and unilateral versus bilateral embolization are necessary.

Good clinical outcomes and improvements in urodynamic data, even in patients who underwent unilateral PAE, suggest that factors from PAE other than prostate reduction, such as prostate tissue change, can contribute to improving symptoms and better voiding. More research needs to be done to confirm the role of PAE in the management of patients with BPH.

In conclusion, our initial results suggest that patients with acute urinary retention caused by BPH can be treated safely by PAE, without major complications, reducing the prostate volume, with overall clinical improvement in lower urinary tract symptoms as assessed by QoL and urodynamic data. Overall, a multidisciplinary approach between urologists and interventional radiologists provides optimum continuity of care.

## REFERENCES


1. Emberton M, Andriole GL, de la Rosette J, et al. Benign prostatic hyperplasia. A progressive disease of aging men. Urology 2003; 61: 267–273.
2. Ziada A, Rosenblum M, Crawford ED. Benign prostatic hyperplasia: an overview. Urology 1999; 53:1–6.
3. McVary KT. BPH: epidemiology and comorbidities. Am J Manag Care 2006; 12(5 suppl):S122–S128.
4. Chute CG, Panser LA, Girman CJ, et al. The prevalence of prostatism: a population-based survey of urinary symptoms. J Urol 1993; 150:85–89.
5. American Urological Association. Guideline on management of benign prostatic hyperplasia. Linthicum, MD: AUA, 2010.
6. Kaplan SA. Factors in predicting failure with medical therapy for BPH. Rev Urol 2005; 7(suppl 7):S34–S39.
7. Wasson J, Reda D, Bruskewitz R, et al. A comparison of transurethral surgery with watchful waiting for moderate symptoms of benign prostatic hyperplasia. The Veterans Affairs Cooperative Study Group on Transurethral Resection of the Prostate. N Engl J Med 1995; 332:75.

8. Rassweiler J, Teber D, Kuntz R, Hofmann R. Complications of transurethral resection of the prostate (TURP)—incidence, management, and prevention. Eur Urol 2006; 50:969–979.
9. Kuntz RM, Ahyai S, Lehrich K. Transurethral holmium laser enucleation of the prostate versus transurethral electrocautery resection of the prostate: a randomized prospective trial in 200 patients. J Urol 2004; 172: 1012–1016.
10. Muzzonigro G, Milanese G, Minardi D. Safety and efficacy of transurethral resection of prostate glands up to 150 ml: a prospective comparative study with 1 year of follow-up. J Urol 2004; 172:611–615.
11. Michel F, Dubruille T, Cercueil JP. Arterial embolization for massive hematuria following transurethral prostatectomy. J Urol 2002; 168: 2550–2551.
12. Rastinehad AR, Caplin DM, Ost MC, et al. Selective arterial prostatic embolization (SAPE) for refractory hematuria of prostatic origin. Urology 2008; 71:181–184.
13. Carnevale FC, Antunes AA, da Motta-Leal-Filho JM, et al. Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: preliminary results in two patients. Cardiovasc Intervent Radiol 2010; 33:355–361.
14. Carnevale FC, da Motta-Leal-Filho JM, Antunes AA, et al. Midterm follow-up after prostate embolization in two patients with benign prostatic hyperplasia. Cardiovasc Intervent Radiol 2011; 34:1330–1333.
15. Pisco JM, Pinheiro LC, Bilhim T, et al. Prostatic arterial embolization to treat benign prostatic hyperplasia. J Vasc Interv Radiol 2011; 22:11–19.
16. Sacks D, McClenny ET, Cardella JF, Lewis CA. Society of Interventional Radiology Clinical Practice Guidelines. J Vasc Interv Radiol 2003; 14(suppl):S199–S202.
17. National Cancer Institute. Common Terminology Criteria for Adverse Events (CTCAE), version 4.0. US Department of Health and Human Services National Institute of Health Publication no. 09-5410. Bethesda, MD: NIH, 2009.
18. DeMeritt JS, Elmasri FF, Esposito MP, et al. Relief of benign prostatic hyperplasia-related bladder outlet obstruction after transarterial polyvinyl alcohol prostate embolization. J Vasc Interv Radiol 2000;11: 767–700.
19. Bilhim T, Pisco JM, Tinto HR, et al. Prostatic arterial supply: anatomic and imaging findings relevant for selective arterial embolization. J Vasc Interv Radiol 2012; 23:1403–1415.