CLINICAL STUDY

Occlusion of the Internal Iliac Artery Is Associated with Smaller Prostate and Decreased Urinary Tract Symptoms

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ABSTRACT

Purpose: To characterize the relationship of proximal internal iliac artery (IIA) occlusion or embolization on prostate volume (PV) and the presence of lower urinary tract symptoms (LUTS) or benign prostatic hyperplasia (BPH).

Materials and Methods: The study included 2 parts: Part 1 comprised 99 men $\geq$ 50 years old who underwent abdominopelvic computed tomography angiography for lower extremity claudication assessed in a retrospective cohort design; Part 2 comprised 18 patients who underwent iatrogenic IIA embolization during endovascular aneurysm repair assessed by a within-subjects approach. Prostate volume and IIA origin diameter were measured; IIA occlusion was noted. Chart review documented body mass index, LUTS, impotence, and buttock claudication.

Results: Of 99 men in Part 1, 60 had no IIA occlusion, and 39 had IIA occlusion (17 unilateral, 22 bilateral). Prostate volume differed significantly between groups (no IIA occlusion, 27.3 mL; unilateral IIA occlusion, 20.7 mL; bilateral IIA occlusion, 17.1 mL; $P = .001$). Men without IIA occlusion had more LUTS (27%) than men with IIA occlusion (10%; $P = .04$). The number of men with complaints of impotence or buttock claudication was similar in both groups (40% vs 46%; $P > .05$). Multiple regression showed that age and IIA occlusion were independent predictors of PV ($P < 0.05$), whereas body mass index was not ($P > .05$), and that IIA occlusion was the only independent predictor of LUTS/BPH ($P < .05$). Among the 18 men in Part 2, PV declined by 29% after embolization ($P = .00001$); 6 men had improvement or resolution of LUTS.

Conclusion: Proximal IIA occlusion is associated with nearly one-third reduction in PV and decreased findings of LUTS/BPH.

ABBREVIATIONS

BMI = body mass index, BPH = benign prostatic hyperplasia, EVAR = endovascular aneurysm repair, IIA = internal iliac artery, LUTS = lower urinary tract symptom(s), PAE = prostate artery embolization, PV = prostate volume

Benign prostatic hyperplasia (BPH) is widely prevalent in men > 50 years old (1) and is associated with significant disability and health care costs secondary to progressive lower urinary tract symptoms (LUTS) (2). The pathophysiology of BPH is multifactorial, likely involving not only the size of the gland but also smooth muscle tone (3). Risk factors include age, genetics, hormonal status, and metabolic factors such as obesity and exercise (4). In light of this multifactorial pathophysiology, the correlation between prostate size and the presence of LUTS has been found to be weak, although LUTS are five times more common among men with large (> 50 cm^3) prostates (3), and men with LUTS have significantly large prostates than men without LUTS (5). Furthermore, increase in prostate size over time is associated with worsening of LUTS (6). Studies documenting the clinical efficacy of prostate artery

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embolization (PAE) for BPH showed improvements in clinical outcome concomitant with roughly 30% reduction in prostate volume (PV) (7,8).

PAE has been shown to be an effective interventional radiology treatment in animal models and human subjects in other countries (7,9–12). Because PAE is not approved in the United States, study of the procedure here is limited as no prospective randomized trials or comparisons with medical and surgical therapies have been possible. Given the limited available data, the purpose of the present study was to assess the relationship of devascularization of the prostate arterial supply and the presence of LUTS/BPH and prostate size. The aim was to acquire further understanding of the relationship of reduced blood supply to the prostate, potentially stimulating further prospective trials for prostate devascularization for patients with BPH. To this end, men with and without proximal atherosclerotic and iatrogenic internal iliac artery (IIA) occlusion were studied.

MATERIALS AND METHODS

Part 1

In this institutional review board–approved, Health Insurance Portability and Accountability Act–compliant retrospective cohort study, sequential male patients who underwent abdominopelvic computed tomography (CT) angiography with runoff for evaluation of lower extremity claudication between April 2012 and February 2014 were identified. Patients $\geq$ 50 years old were included; men with prior prostate surgery, radiation, or pharmacologic therapy that could alter prostate size were excluded. Only the most recent CT examination was included for each subject; therefore, only one CT scan was assessed per patient. The IIA was selected for analysis because the arteries that supply the prostate originate from distal branches of the IIA. A retrospective cohort design was selected so that the influence of multiple possible risk factors, such as age and IIA occlusion, on multiple outcomes, including PV and the presence of LUTS, could be assessed (13).

There were 99 men included: 39 with IIA occlusion (17 unilateral and 22 bilateral) and 60 with no IIA occlusion (**Table**). Of the total 61 IIA occlusions among 39 patients, one occlusion was due to coil embolization, 18 were noted in the setting of common iliac to external iliac metallic stents, and nine were noted in the setting of a bypass graft. All other occlusions (n = 33) were due to atherosclerotic disease. Medical records were reviewed for body mass index (BMI), prostate-specific antigen levels, LUTS (hesitancy, frequency, urgency, nocturia), urologic medications, and symptoms of IIA occlusion including buttock claudication and impotence. Each patient was characterized as a definite case of LUTS/BPH after Verhamme et al (14) if the patient (*a*) reported at least one LUTS and had a reported clinical diagnosis of BPH, (*b*) had at least one LUTS and was treated with an α-blocker, or (*c*) had two or more LUTS suggestive of BPH in the absence of any other comorbidity that could explain the LUTS.

Part 2

To evaluate the effect of IIA occlusion further while removing the potential for confounding variables, a separate cohort of patients was assessed with a retrospective within-subjects design. These patients underwent CT angiography before and after endovascular aneurysm repair (EVAR) with concurrent unilateral IIA embolization between December 2012 and March 2014. Men $\geq$ 50 years old were identified by a search of the radiology picture archiving and communication system. One man who had undergone prior transurethral resection of the prostate was excluded, giving a total group size of 18 subjects. Average age at the time of EVAR was 76 years (SE 1.6). All men underwent unilateral embolization (left, five; right, 13). The CT scan performed immediately before EVAR and the next follow-up CT angiography performed at least 1 month after the intervention were evaluated. The presence of LUTS, impotence, and buttock claudication was assessed in the medical chart before and after EVAR.

Imaging and Statistical Analysis

The diameter of bilateral IIA origins was measured on axial CT images. The IIA origins also were assessed for the presence of IIA occlusion and categorized as either severely stenosed (> 90%)/occluded or patent. Prostate volume was calculated from three diameters (transverse and anteroposterior on axial images, craniocaudal on sagittal or coronal images), using the formula $PV = (4/3) * \pi * (d_1 * d_2 * d_3/8)$, where *d* represents each diameter.

One-way analysis of variance was used to assess group differences in PV, with post hoc comparisons with Bonferroni correction comparing men with unilateral IIA occlusion, bilateral IIA occlusion, and no IIA occlusion. Student *t*-tests and χ^2 tests evaluated group differences. Multiple linear and logistic regression was used to assess the impact of BMI, age, and IIA diameter on PV and on the diagnosis of definite LUTS/BPH.

RESULTS

Part 1

Among the 99 men (no IIA occlusion, 60; IIA occlusion, 39) who underwent CT angiography with runoff, one-way analysis of variance demonstrated that mean prostate size was significantly different between groups, with mean PV of 27.3 mL (SE 1.5) in men without IIA occlusion, 20.7 mL (SE 3.4) in men with unilateral IIA occlusion, and 17.1 mL (SE 1.8) in men with bilateral IIA occlusion ($F = 7.3$; $P = .001$) (**Fig 1**). Post hoc