Urology : Research And Therapeutics Journal

Special Issue Article "Benign Prostatic Hyperplasia"

Research Article

Prostatic Artery Embolization is able to improve the Prostatic Urethral Angle in Patients with Lower Urinary Tract Symptoms

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ARTICLE INFO

Received Date: May 24, 2022
Accepted Date: June 20, 2022
Published Date: June 22, 2022

KEYWORDS

Lower urinary tract symptoms
Intravesical prostatic protrusion
Prostatic artery embolization

Citation for this article: Bernard P, Bischoff P, Hanitzsch H, Schäfer A, Yu W, Pinkawa M, El-Mansouri A, Oechtering T and Kovács A. Prostatic Artery Embolization is able to improve the Prostatic Urethral Angle in Patients with Lower Urinary Tract Symptoms. Urology : Research And Therapeutics Journal. 2022; 3(1):131

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ABSTRACT

Purpose: The prostatic urethra is a bent tube, and a greater Prostatic Urethral Angle (PUA) is associated with Lower Urinary Tract Symptoms (LUTS). We investigated the effect of Prostate Artery Embolization (PAE) on PUA in men with LUTS related to Benign Prostatic Hyperplasia (BPH).

Materials and Methods: A retrospective analysis was done of 178 men treated with PAE from April14th 2015 to November 28th2018 at the MediClin Robert Janker Clinic in Bonn/Germany. International Prostate Symptom Score (IPSS), respectively International Index of Erectile Function (IIEF) were requested, further Prostate Volume (PV), Intravesical Prostatic Protrusion (IPP), and PUA were measured on MRI prior and 6 month after PAE.

Results: All investigated parameters were significantly improved 6 months after PAE, in detail IPSS was reduced from 20.6±7.4 to 10.7±6.9 ($p<0.001$), PV was reduced from 79.5±42.6cc to 60.2±38.1cc ($p<0.001$), the IPP was reduced from 12.6±6.1mm to 10.7±5.6mm ($p<0.001$), and the PUA decreased from 71.3±14.9° to 62.4±14.4° ($p<0.001$).

Conclusions: PAE is able to significantly improve all three parameters that influence LUTS, in particular PV, IPP and PUA and thus also significantly improve IPSS.

INTRODUCTION

Lower Urinary Tract Symptoms (LUTS) are usually considered a synonym for benign prostatic hyperplasia (BPH). Although BPH is very common, not all LUTS are caused by BPH. The pathophysiology of male LUTS is complex and multi factorial. There are some other prostatic anatomic factors that have been considered as potential factors affecting clinical symptoms, such as the Intravesical Prostatic Protrusion (IPP) and the prostatic urethral angle (PUA) [1]. Prostatic Artery Embolization (PAE) is an emerging minimal-invasive therapy of BPH, able to reduce the Prostatic Volume (PV) and the IPP [2-4]. Our study investigates a possible effect of PAE on PUA in patients with LUTS.

MATERIAL AND METHODS

A retrospective analysis was done of 178 men treated with PAE from April 14th 2015 to November 28th 2018 at the MediClin Robert Janker Clinic in Bonn/Germany. Patients with urologic tumors, neurogenic bladder, urinary tract infection, bladder stones, which could affect voiding, were excluded. Patients responded to the International Prostate Symptom Score (IPSS), respectively to the International Index of Erectile Function (IIEF) questionnaire. Prostate Volume (PV), IPP, and PUA were measured on MRI prior and 6 months after PAE. The IPP was measured on the midsagittal plane in T2-weighted MR-images of the prostate as the shortest perpendicular distance between the protruded end of the prostate and the bladder base on the bladder neck in the sagittal plane. The PUA was measured as the angle between the prostatic urethra and the membranous urethra in the midsagittal plane also at MRI. All PAE was carried out with calibrated spheric embolic agents with a diameter of 200 µm (Terumo Hydro Pearls®). IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA) was used for statistical analysis. p-values of <0.05 were considered statistically significant.

RESULTS

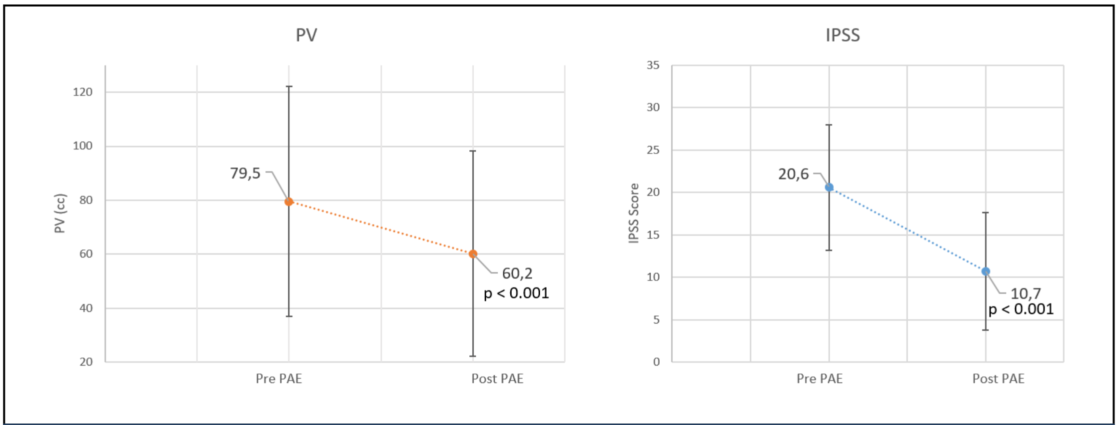

Diagram 1: Six months after the Prostate Artery Embolization (PAE) there are significant changes in the prostate and clinical symptoms. The Prostate Volume (PV) decreases significantly from 79.5cc on average to 60.2 cc on average. The clinical symptoms improve at the same time. The International Prostate Symptom Score (IPSS) drops on average from 20.6 to 10.7.

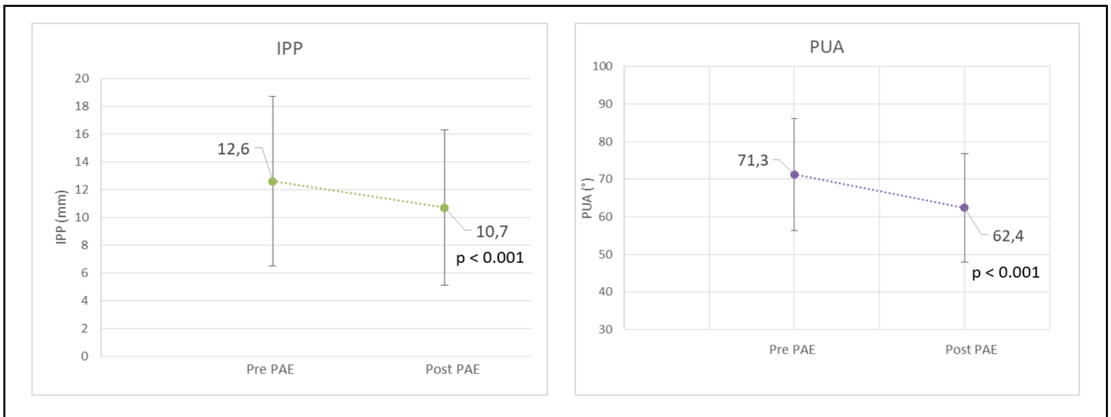

Diagram 2: Six months after the PAE the morphological characteristics of the prostate also show significant changes. The Intravesical Prostate Protrusion (IPP) decreases significantly on average from 12.6 to 10.7 cm. The bent Prostetic Urethral Angle (PUA) straightens up by 8.9° on average, from an average 71.3° to 62.4°.

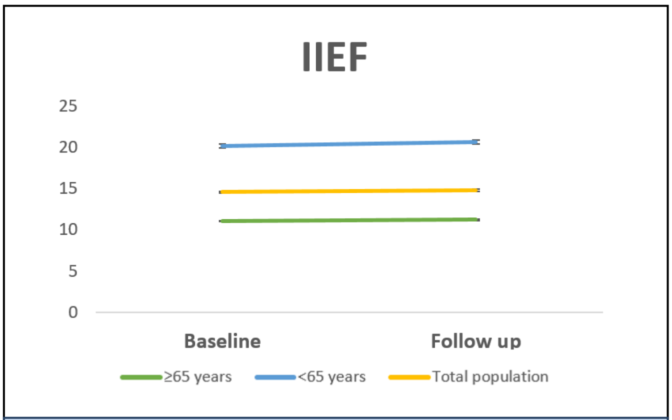

Diagram 3: Six months after the PAE Erectile function was maintained in both, younger (< 65y) and older patients (≥ 65y).

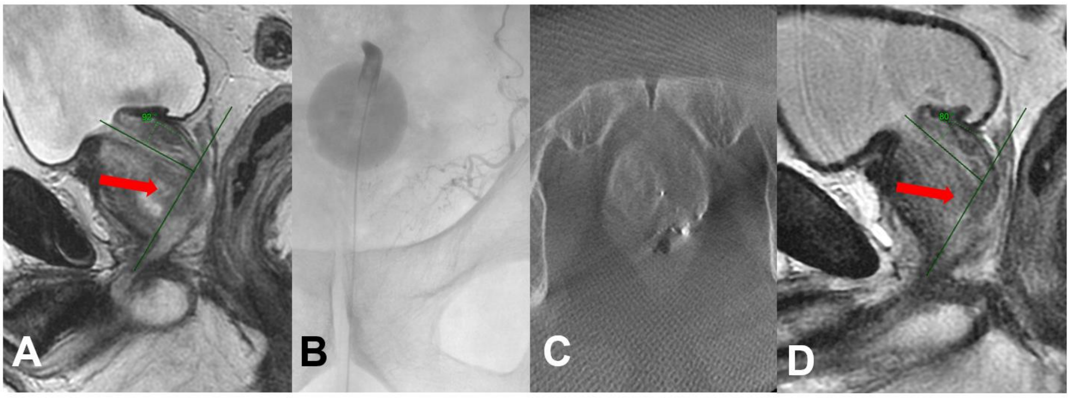

Figure 1: 63-year-old patient with pronounced LUTS (IPSS 28), severely impaired quality of life and without Impairment of Erectile Function (IIEF 24). The patient explicitly desired ejaculation-preserving therapy. A. In the pretherapeutic diagnostic MRI (sag T2w) the strongly kinked PUA (92°) is clearly visible. The red arrow marks an urodynamically unfavorably located adenoma nodule, which significantly worsens the kinking of the PUA. B. PAE is performed under fluoroscopic control. C. Selective contrast-enhanced Cone Beam Computed Tomography (CBCT) increases the safety of embolotherapy by excluding contrast outside the target region. D. 6 months after PAE, MRI shows a clear erection of the PUA to 80°, and a significant shrinkage of the adenoma nodule (red arrow).

The mean age was 65.4±7.8 years. All interventions were carried out under local anesthesia via femoral puncture from the right side. Selective cannulation of the prostatic arteries was 100% technically successful. 17% of the patients had minor side effects (adverse events Clavien-Dindo I), mostly temporary post embolization syndrome for 1-3 days, in all cases successfully treated with antipyretics and analgetics. No serious Side Adverse Events (SAE) have been reported. There have been no cases of hematoma of the groin or similar. Procedural time and fluoroscopy time were 72.4 ± 27.5 min, respectively 22.3 ± 7.9 min. Median dose-area product was 7535 μGym^2 – this equates to 19 mSv with a 0.07% additional lifetime cancer risk in a 50-60-year old man.All measured parameters could be significantly improved by the PAE. In detail, IPSS was reduced from 20.6±7.4 to 10.7±6.9 ($p<0.001$), PV was reduced from 79.5±42.6cc to 60.2±38.1cc ($p<0.001$), the IPP was reduced from 12.6±6.1mm to 10.7±5.6mm ($p<0.001$), and the PUA was decreased from 71.3±14.9° to 62.4±14.4° ($p<0.001$) (Diagrams 1,2). Erectile function was maintained after PAE in both younger (< 65y) and older patients (≥ 65y). Baseline and follow-up IIEF-scores were 20.1±8.06 and 20.6±7.72 in men younger than 65years, respectively 11.06±10.06 and 11.19±10.06 in men ≥ 65y (Diagram 3).

DISCUSSION

Our study is the first one published so far that could prove the positive effect of PAE not only on the reduction of PV and IPP but also on PUA. Traditionally, male LUTS, encompassing a variety of storage, voiding, and post-micturition symptoms has been considered a synonym for BPH because most male LUTS develop in aging men [5]. Despite its high prevalence, the pathogenesis of LUTS is still poorly understood. Only 25% to 50% of men with BPH have LUTS, and urodynamically-proven bladder outlet obstruction (BOO) is only seen in 50% of men with LUTS [6,7]. Clinically, the diagnosis of BPH and BOO is usually made based on PV > 40 mL, a maximum flow rate (Q_{max}) <10 mL/s, in combination with a high IPSS [8]. Many clinical studies have demonstrated that LUTS have poor diagnostic specificity for BOO, moreover the correlation between the PV and LUTS severity is weak [9]. Recently, a greater PUA was found to associate with LUTS [10]. An increased PUA on Transrectal Ultrasound (TRUS) corresponds to a high bladder neck on cysto-urethroscopy [11]. Although some urologists suspect that the higher bladder neck might be a causal factor of BPH, the clinical significance of PUA is not well understood. The prostatic urethra runs through the prostate from the base to the apex, making an anterior angulation of approximately 35° at the proximal part of the verumontanum between the prostatic urethra and the membranous urethra in the midsagittal plane. The anatomical hypothesis behind the PUA describes the prostatic urethra like a bent tube [1]. This bend divides the urethra into the proximal and distal portions. The greater the angle, the greater the amount of kinetic energy of the voiding urine that would be lost. PUA has a remarkable correlation with Q_{max} and IPSS in men with LUTS. As PUA increased, IPSS also increased, and urinary flow rate decreased, exhibiting an inverse relationship.

The PUA correlates with IPSS total scores ($p<0.001$), voiding symptom scores ($p<0.001$), or storage symptom scores ($p<0.005$) as well as with Q_{max} ($p<0.001$) [10]. The greater the degree of the PUA, the more severe the LUTS and lower the Q_{max} will be. Kang et al found that the mean PUA of the patients whose Q_{max} are <10 cc/sec is 45.28°, whereas that of patients whose Q_{max} is >10 cc/sec is 41.18°(p 0.016) [1]. Ku and co-workers found that PUA correlates also with the BOO-Index (BOOI) - as PUA increases, the severity of BOOI also increases. Patients with PUA>35° were more likely to have outlet obstruction than were those with PUA<35° [12]. The PUA is also inversely correlated with changes in Q_{max} and IPSS after tamsulosin treatment. Namely, the PUA might be a predictor for the treatment efficacy of α-blockers in men with LUTS [13]. An interesting collective assessed are the patients with LUTS but small PV, because a small PV suggests BPH is unlikely. In those patients only PUA was significantly associated with urinary symptom severity as well as with Qmax [1].

Imaging studies assessing the PUA have some technology-inherent limitations. However, the PUA can be measured on the sagittal view in TRUS. A limitation of TRUS might be the straightening of the PUA by the pressure from the rectal probe and falsification of the true value. Further, the prostatic urethral anatomy may be altered during voiding; because TRUS is performed while the patient is at rest, these measurements cannot reflect the PUA on voiding [11]. To evaluate the severity of BOO, pressure-flow examination is a more accurate method, although it is an unpleasant examination for the patients to undergo. In addition, an inserted catheter also straightens and falsifies the PUA. On the other hand PUA is easily assessable in MRI (T2-weighted images, sagittal view) without the use of ionizing radiation or contrast agents, and without falsifying the true value in rest. This could also be the explanation why in our collective the measured PUA values were on average higher than those measured in TRUS (71.3±14.9° in MRI vs 44.5±12.8° in TRUS) [14]. Furthermore, MRI enables also a non-invasive real-time imaging of anatomical changes during physiological voiding in men [15].

The impact of PUA on disease progression, and response to medical and minimal-invasive treatment needs to be further investigated. Measuring the IPSS-storage and IPSS-voiding subscores separately and using the IPSS-V/S ratio, further the wider application of non-invasive imaging studies could potentially stratify patients who would require a more precise patient directed treatment.

CONCLUSION

PUA should be considered as an important clinical factor in male LUTS management. PAE is currently considered a potential link between the exhausted medical management and more or less radical resection-based interventions. Our study found that PAE cannot only reduce PV and IPP, but also significantly improve PUA. These insights can provide background of future researches on LUTS in general, respectively PUA and PAE in particular.

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