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INTERVENTIONAL RADIOLOGY

TECHNICAL NOTE

Transperineal microwave thermoablation for benign prostatic hyperplasia-related lower urinary tract symptoms in an elderly patient

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ABSTRACT

Transperineal prostate microwave thermoablation (TPMT) has been established as a safe means of treating benign prostatic hyperplasia (BPH); however, its effectiveness in addressing BPH-related lower urinary tract symptoms (LUTS) remains unexplored. This case study aims to evaluate the efficacy of TPMT in LUTS attributed to BPH. An 84-year-old man with LUTS due to BPH-induced bladder outlet obstruction, unresponsive to previous medical treatments, and failed prostate artery embolization, underwent TPMT. Three coaxial needles were positioned at the midline, right, and left sides of the hypertrophic transitional zone of the prostate. Microwave energy, with parameters determined using liver data and targeted ablation area, was applied at 2,450 MHz in continuous mode. The tissue temperature was monitored using bilateral thermocouple sensors. The patient exhibited no changes in defecation rhythm, abdominal discomfort, or anorectal pain. Temporary postoperative hematuria was promptly resolved through saline irrigation within 6 hours, and hematological evaluations showed normal results. Significant clinical improvements were observed (e.g., prostate volume, prostate-specific antigen levels) accompanied by an increase in peak flow rate. Thus, TPMT appears to be a promising intervention for bladder outlet stenosis and LUTS induced by BPH.

KEYWORDS

Benign prostatic hyperplasia, microwave ablation, prostate, thermoablation, urinary tract symptoms

Benign prostatic hyperplasia (BPH) has a substantial impact on the social and clinical aspects of geriatric men, and its significance cannot be overstated. It is a prevalent disease, affecting 50% of men in their sixth decade and 90% in their ninth decade, with an annual development of symptoms in 1.5% of men. Those with a prostate size >50 cm^2 face a five-fold increased risk of experiencing clinically mild-to-severe lower urinary tract symptoms (LUTS) and a three-fold elevated risk of significant bladder outlet blockage (peak flow rate 10 mL/sec).[1] These findings indicate a correlation between prostate growth, LUTS, and blockage, particularly in men with larger prostates.

For the past 45 years, transurethral prostate removal has been the gold standard for BPH surgery.[2] However, concerns regarding sexual dysfunction, hospitalization, and cost have prompted the exploration of alternative minimally invasive therapies.[1,2]

Among the alternative methods, microwave ablation has been valuable for treating hyperplasia. When tissue is exposed to microwave radiation (900–2,450 MHz), water molecules begin to oscillate, and the temperature increases due to friction. If the increase in temperature is sufficient, proteins and enzymes start to degrade, resulting in coagulative necrosis.[3] As per the guidelines of the American Urological Association, transurethral microwave thermotherapy (TUMT) is recognized as a potential treatment for LUTS associated with BPH[4] and is widely utilized.[5] Nevertheless, TUMT is contraindicated for patients with urethral strictures, as well as those with penile or urinary sphincter devices or a history of pelvic radiation. Conversely, transperineal prostate microwave thermoablation (TPMT) presents a viable alternative for these individuals.

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TPMT offers the advantage of a shorter duration-typically approximately 5 minutes-compared with the 30 minutes or so required for TUMT. Furthermore, TPMT may lead to a reduction in the risk of sexual dysfunction, persistent irritative voiding symptoms, incontinence, urinary tract infections, and repeated acute urinary retention episodes. Despite these potential benefits, TPMT has been explored in only a limited case series, focusing on the safety and comfort assessment of the device and the impact of microwaves on prostatic tissue *in vivo*, as reported by Bartoletti et al.[1] It is noteworthy that, to the best of our knowledge, there is currently no evidence supporting or refuting the efficacy of TPMT in addressing LUTS. In this case study, TPMT was performed on an 84-year-old patient whose LUTS resulting from bladder outlet obstruction due to BPH were resistant to medical treatment and did not show any improvement after prostate embolization (PE). Surgery was also deemed unsuitable due to the patient's underlying morbidities. The results showed that TPMT was effective in addressing LUTS attributed to BPH.

The patient

An 84-year-old man was presented with LUTS resulting from bladder outlet obstruction attributed to BPH (Figure 1a, Figure 2a). . Prior treatment with α-blockers had proven ineffective. The patient's advanced age and extensive arteriosclerosis of the anterior division of the internal iliac artery resulted in the failure of PE conducted at another medical facility. He experienced severe symptoms, as indicated by an international prostate symptom score of 28. Additionally, the patient exhibited a diminished maximum urinary flow rate of 5.1 mL/sec and incomplete bladder emptying, evidenced by a post-void residual urine volume of 350 mL. Prostate volume (PV) assessment revealed significant enlargement, at 218 mL. Elevated total and free prostate-specific antigen (PSA) serum levels were noted (total PSA: 14.9 ng/mL, free PSA: 7.78 ng/mL), with a free-to-total PSA ratio of >0.2. The PSA density (total PSA/PV) was calculated as 0.068, falling below the 0.15 limit.

Given the patient's advanced age, comorbidities (diabetes mellitus, hypertension, coronary artery disease, atrial fibrillation, cerebrovascular disease), and a poor 10-year prognosis, a decision was made to forego a prostate cancer study.

Technique

The patient received a 7-day course of cefixime (400 mg/day), Ibuprofen (2 × 600 mg/day), and gastroprotective therapy. Notably, the treatment initiation occurred 12 hours before the scheduled procedure.

The patient was positioned in the dorsal lithotomy posture. For anesthesia, lidocaine (10 mL) was administered into the prostate/seminal vesicle angle and the bilateral prostate apex. The coaxial needles and microwave antenna were inserted under guidance from ultrasound (Aplio 500, with a 3.5 MHz Convex ultrasound probe; Toshiba, Japan) and computerized tomography (SOMATOM Scope; Siemens AG, Germany). Three 15-G/13.8 cm coaxial needles (TruGuide; Bard, GA, USA) were strategically placed behind the urethra at the midline, right, and left sides of the hypertrophic transitional zone of the prostate (Figure 1b).

The exposure energy and duration were calculated using liver data, measuring the targeted ablation area around the microwave antenna. The antenna's tip was positioned at a distance >1 cm from the capsule and >0.5 cm from the rectal wall and the urethra, ensuring the preservation of the rectal wall and the urethra during thermoablation. The microwave ablation device, equipped with a 16-G/20-cm microwave ablation antenna (Canyon; Nanjing, China), operated at 2,450 MHz in continuous mode. The midline of the prostate received an exposure power of 20 W for 2 minutes, and the right and left sides had exposure powers of 40 W for 3 minutes and 2 minutes, respectively.

To monitor the temperature of the periprostatic tissue around the treatment site, two interstitial thermocouple sensors were placed bilaterally just outside the prostatic capsule, using two 19-G/20-cm microwave ablation temperature probes (Canyon; Nanjing, China). Post-treatment, the patient underwent immediate magnetic resonance imaging, followed by assessments at 1- and 3-month intervals. An 18-F urethral catheter, placed before TPMT, was removed 2 weeks later.

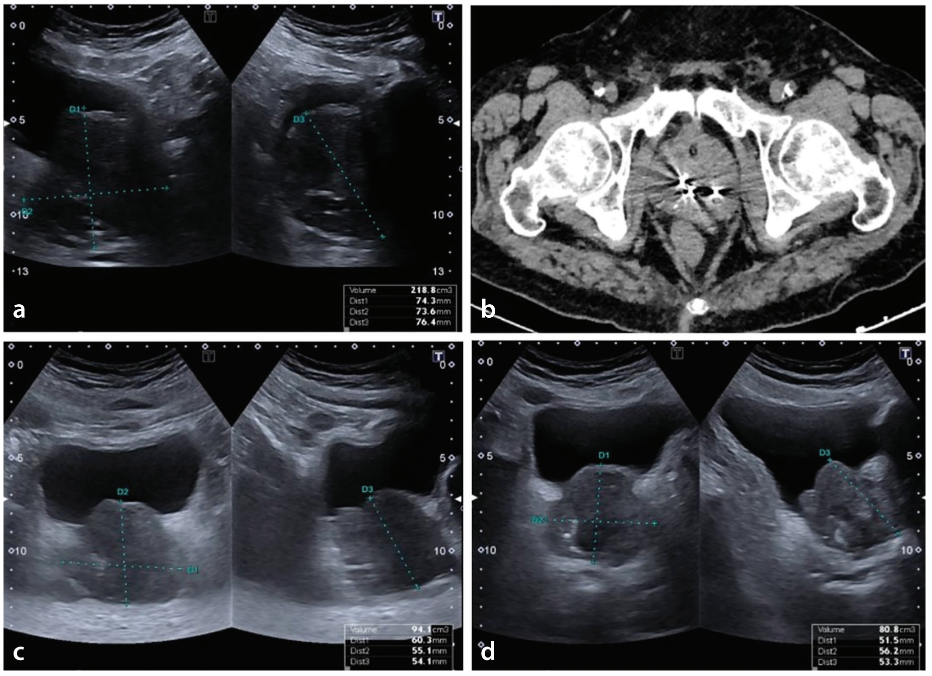

Figure 1. Ultrasound (US) image **(a)** before, computed tomography (CT) image **(b)** during, and US images **(c, d)** after the intervention. **(a)** The prostate gland was enlarged as measured on the US image before transperineal prostate microwave thermoablation (TPMT). **(b)** TPMT was performed under CT guidance. Three coaxial needles are observable in the image. The prostate gland was reduced in size after **(c)** 1 month and **(d)** 3 months post-procedure.

Main points

- Transurethral prostate resection is currently the recommended benign prostatic hyperplasia (BPH) procedure; however, mortality, sexual dysfunction, hemorrhage hospitalization, and high costs have led to less invasive options.
- BPH treatment using transperineal prostate microwave thermoablation (TPMT) is safe, but its efficacy in treating BPH-related lower urinary tract symptoms (LUTS) is unknown.
- This case study examined TPMT's effectiveness in BPH-related LUTS.
- Transperineal prostate microwave is an effective treatment method in BPH-related LUTS.

The safety and efficacy of the technique were assessed through a series of tests conducted before (within 30 days), as well as 1 and 3 months after TPMT. The assessments included blood tests, urine culture, complete urinalysis, uroflowmetry, and chest X-rays, as well as comprehensive abdominal, transperineal, and transrectal ultrasounds. These evaluations were repeated at 1 and 3 months post-TPMT to monitor any changes or developments. This study has obtained informed consent.

Results

The procedure was conducted as an outpatient procedure in a day hospital. The patient did not exhibit any abdominal discomfort, anorectal pain, or any changes in defecation rhythm following TPMT. The only transient issue observed was post-operative hematuria, which was promptly addressed through saline irrigation within 6 hours and did not require a blood transfusion. The initial PV of 218.8 mL decreased to 94.1 mL 1 month after TPMT and further to 80.8 mL 3 months after TMPT (Table 1). Subsequent hematological assessments conducted after TPMT consistently indicated normal results, while functional measures showed improvement (Table 1). The ejaculatory function was not recorded due to the limited sexual activity reported by the elderly patient. Meanwhile, a significant reduction in the prostate gland size was noted (Figure 1c, d, Figure 2b-d). The patient experienced approximately 3 weeks of dysuria following TPMT, which necessitated catheterization for 2 weeks post-procedure.

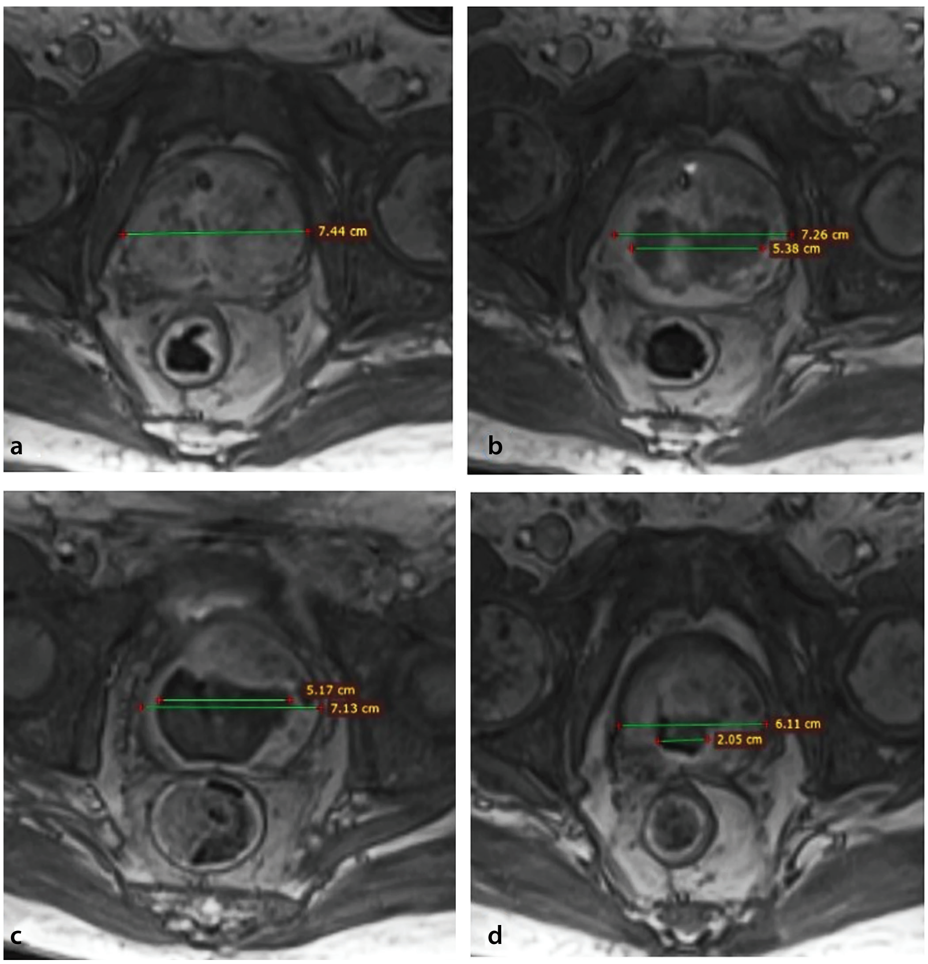

Figure 2. Contrast-enhanced T1-weighted magnetic resonance images before and after the intervention. The shrinkage of the prostate gland is observable immediately after transperineal prostate microwave thermoablation (TPMT) (transverse diameter of the prostate and the ablated zone: 7.26 and 5.38 cm) **(b)**, as well as in the follow-up controls 1 month (7.13 and 5.17 cm) **(c)** and 3 months after TPMT (6.11 and 2.05 cm) **(d)** in comparison with before TPMT condition (7.44 and 0.00 cm) **(a)**.

Discussion

We did not observe any of the clinical indications reported in the literature,[6] such as orchitis, prostatic abscess, urethral burn, urinary tract infections, or severe urinary retention. The episode of urinary incontinence lasting approximately 2 weeks may be attributed to the external urethral sphincter undergoing degeneration due to prolonged and severe BPH. We opted to retain the bladder catheter for 2 weeks to facilitate the reduction of the adenoma after consultation with the relevant urologists. Consequently, we recommend choosing a course of action for a bladder catheter on an individual basis. The occurrence of dysuria lasting approximately 3 weeks following TPMT is consistent with the patterns observed in previous minimally invasive thermal interventions for BPH.[6]

Bartoletti et al.[1] conducted open prostatectomy procedures in three groups at different intervals following TPMT. Their findings demonstrated that treating BPH with microwave thermotherapy is a safe, tolerable, and repeatable procedure, especially when employing a dedicated probe (AMICA-PROBE). The presented case further supports the versatility of using a common microwave probe. Notably, these microwave probes offer the advantage of customization for various anatomical sites. The studies targeting BPH using microwave thermoablation mostly occupy the transurethral method, which may not be suitable for some patients due to urethral

Table 1. Clinical measures related to the severity of lower urinary tract symptoms before and after the transperineal prostate microwave thermoablation procedure

	BII	IPSS	IPSS-QoL	Q_{max} (mL/sec)	PVR (mL)	Prostate size		T-PSA (ng/mL)	F-PSA (ng/mL)
						X × Y × Z (mm)	PV (mL)		
Before	11	28	6	5.1	350	74.3 × 73.6 × 76.4	218.8	14.9	7.78
After 1 month	5	15	3	7.3	150	60.3 × 55.1 × 54.1	94.1	1.32	0.56
After 3 months	2	7	1	11.5	90	51.5 × 56.2 × 53.3	80.8	1.19	0.44

BII, benign prostatic hyperplasia impact index; IPSS, international prostate symptom score; IPSS-QoL, IPSS quality of life index; Q_{max}, peak flow rate; PVR, postvoid residual volume; PV, prostate volume; PSA, prostate-specific antigen; T-PSA, total PSA; F-PSA, free PSA.

strictures or a history of radiation therapy in the pelvic region. To reliably compare the outcomes of these studies with the TPMT procedure using a common microwave probe, a further large-scale clinical study is needed. Although similar microwave ablation settings (e.g., frequency and operation mode) can be used for the treatment of both BPH and prostate cancer, further studies are still needed to optimize the duration and the power of microwave radiation in the treatment of LUTS due to BPH. Although the aged participant already reported limited sexual activity, we do not expect any significant effects on ejaculatory functions because the technique maintains the prostate capsule, urethra, and ejaculatory pathways similar to cryoablation. Nevertheless, further studies are required to confirm this.

In conclusion, the utilization of interstitial microwave ablation antennas in TPMT appears to be a promising treatment for LUTS caused by BPH. However, the need for randomized clinical studies is imperative to comprehensively assess the effectiveness and practicality of implementing TPMT in clinical settings.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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