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Renal Function Improvement after Transurethral Prostate Vaporesection with Thulium YAG Laser and Resection with High-Frequency Electrical Current

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Abstract

Introduction. Benign prostatic hyperplasia/Benign prostatic obstruction (BPH/BPO) and chronic kidney disease (CKD) are two important public health problems in elderly men, with a huge medical and social impact on rapidly aging population globally. Clinical studies have proven obstruction of the lower urinary tract, secondary to BPO as a cause of a decreased renal function and CKD development. Conversely, the reverse process of the lower urinary tract obstruction relieve should be improving the renal function. The aim of this study is to evaluate the possibility of simultaneous improvement in renal function with transurethral prostate surgery for treatment of BPO.

Methods. A randomized, study (1:1) initiated in July 2022 at the University clinic for urology in Skopje, Republic of N Macedonia, was conducted on 40 patients with BPO to compare the efficacy and safety of the two endourological transurethral surgical methods for BPO treatment: in our country the recently introduced Tm:YAG laser transurethral vaporesection of the prostate (ThuVARP) and the traditional and well-established method of transurethral resection of the prostate (TURP) by using high-frequency electric current (TURP). For evaluation two types of indicators were used, BPO related and renal function (RF) related indicators. The BPO related indicators (International Prostate Symptom Score-IPSS, maximum flow rate-Qmax, prostate volume-V, and post-void residual urine volume-PVR) were assessed preoperatively and reassessed at 6 months postoperatively. RF related indicators (serum potassium, serum creatinine, and estimated glomerular filtration rate (eGFR) evaluated with the 2021 Creatinine equation (CKD-EPI) were also assessed preoperatively and reassessed after 7-10 days, postoperatively. By comparing the pre and postoperative values within each surgical group, conclusions were drawn about the possible effect of BPO surgery on renal function improvement. Other risk factors for CKD like diabetes, hypertension, smoking, obesity, dyslipidemia and metabolic syndrome were not considered in this study.

Results. Significant improvements were observed postoperatively in all BPO related indicators in both surgical groups. In the ThuVARP group, Qmax increased from 6.06±2.1 to 16.59±6.2ml/s ($p=0.00$) and IPSS, prostate V and PVR decreased from 25±1.9 to 3.56±5 ($p=0.00$); 61.4±33.4 to 26.2±11.9 ml ($p=0.00$); and 142.8±79.1 to 7.97±11 ml ($p=0.00$), respectively. In the TURP group, Qmax increased from 7.96±3.5 to 18.14±6.6 ml/s ($p=0.00$); and IPSS, prostate V and PVR decreased from 22.89±4.4 to 6.68±5 ($p=0.00$); 61.5±16.2 to 21.13±14.4 ml ($p=0.00$); and 128.9±86.1 to 23.45±47.2 ml ($p=0.00$), respectively.

RF related indicators also presented significant improvements postoperatively. In the ThuVARP group, serum potassium and serum creatinine decreased from 4.44±0.5 to 4.17±0.4mmol/L ($p=0.019$) and 86.77±23.2 to 78.84±19.3 ($p=0.029$), respectively and eGFR increased from 83.26±18.3 to 88.63±15mL/min/1,73m² ($p=0.049$). In the TURP group, serum potassium and serum creatinine decreased from 4.32±0.3 to 4.13±0.5 mmol/L ($p=0.041$); and 78.59±12.3 to 73.44±12.0 ηmol/L ($p=0.004$), respectively and eGFR, increased from 89.05±11.8 to 93.65±10.70 mL/m in/1,73m² ($p=0.0028$).

Conclusion. Our findings suggest that prostate surgery

with consecutive relief of the lower urinary tract obstruction, regardless of the chosen method (ThuVARP or TURP) may improve the renal function and be potentially benefitial in CKD patients.

Key words: BPO, Renal function, CKD, serum creatinine, eGFR, Thulium laser, ThuVARP, TURP

Introduction

Benign prostatic hyperplasia (BPH) is the most common urologic condition in male population over the age of 50 [1]. It is a histologic term for a condition which is age dependent and has prevalence in autopsy studies increasing from around 20% in men aged 41–50 years to 50% in men aged 51-60 years and >90% in men over 80 years old. At the age of 55, about 25% of patients experience obstructive symptoms, typically with complain of a decreased strength and caliber of urinary flow, which rate increases to 50% by the age of 75 [2]. Its high prevalence presents this condition as very important medical and social issue requiring vast resources for management, especially after decades of progressive ageing in population worldwide. Its significance is clearly presented in the United Nations World Population Prospects from 2019 where by 2050, one in six people in the world will be over age 65, up from one in eleven in 2019. Often, but not necessarily, BPH leads to a certain level of urinary obstruction referred to as benign prostatic obstruction (BPO), and presents with symptoms termed as lower urinary tract symptoms (LUTS) of variable intensity. Therefore, the term BPH has been replaced with the more appropriate term BPO. LUTS in men mainly come from BPO, even though other entities like urethral stricture, prostate cancer and urinary incontinence may present with LUTS [3]. If untreated or when therapy fails, BPO could lead to serious complications such as acute or chronic urinary retention, urinary tract infection (UTI), calculosis, urine stasis, and acute or progression to chronic kidney disease (CKD). Consequently, it is very important, to promptly and properly diagnose, evaluate, follow up and if needed treat BPO [3].
CKD is another very important public health problem. It is also more prevalent in the elderly population, with approximately 50% in patients older than 70 years. It develops over months to years, with early stages often being asymptomatic [4]. BPO as the main reason for distal urinary tract obstruction, depending on its severity and length of exposure, may cause urinary stasis initially in the bladder and later in the proximal urinary tract. Urinary stasis leads to a decline in the glomerular filtration rate (GFR), and an inevitable destructive effect on nephrons in both kidneys with a consecutive decrease in renal function and development of certain level of post-renal CKD [5]. On average, 13.6% of the patients with BPO presenting to urological clinics for treatment have any stage of CKD [6]. There is a continuous controversy in the urology guidelines on whether to implement a routine screening on serum creatinine levels among men presenting with LUTS secondary to BPO for identifying patients with CKD. As of 2003, the guidelines of the American Urological Association (AUA) no longer recommend men with LUTS regularly to be screened for serum creatinine. As opposed to that, the European Association of Urology (EAU) guidelines recommend renal function evaluation if an abnormal renal function is suspected, based on the patient’s medical history and clinical examination, suggesting a possible correlation between renal function and LUTS.
With BPO as one of possible reasons for renal function impairment, it is of a great importance to evaluate whether and to what extent the reverse process of treating BPO and relieving the obstruction in the distal urinary tract with transurethral prostate surgery would improve the renal function as potential treatment of CKD.

Material and methods

A randomized (1:1) study was conducted in July 2022 at the University clinic for urology in Skopje, on 40 patients with BPO and prostate volume between 30-80ml, to compare the efficacy and safety of the two transurethral surgical methods in treating BPO. Namely, one is in our country a recently introduced method of Tm:YAG laser transurethral vaporesection of the prostate (ThuVARP), and the other is the traditional and well-established method of transurethral resection of the prostate by using high-frequency electric current (TURP). The primary endpoint was detection of renal function improvement after surgical treatment for BPO with either of the two transurethral surgical methods.
The ThuVARP method, as an energy source uses the latest and most powerful 200W Thulium YAG, 2013 nm, continuous wave laser (ROCAMED Hemera). An 800 micrometer end-firing optical core laser fiber is introduced through a 26F continuous-flow laser resectoscope (Richard Wolf, Knittlingen, Germany) with normal saline as irrigation. With precise hand movements the excessive prostate tissue at the level of the prostatic urethra is vaporesected under direct vision. The term vaporesection describes the simultaneous process of vaporization and resection of the prostate tissue and is closely related to the exclusively high vaporization capacity of the thulium laser. The resection process is controlled by the surgeon’s hand movement of the laser fiber through the prostatic tissue. The TURP method uses the similar transurethral approach, but a metal loop mounted on a resectoscope

is used to resect excessive prostate tissue with an alternating high frequency electric current as an energy source (ERBE VI0 3 electrosurgical unit).

Study inclusion criteria were: bothersome lower urinary tract symptoms or chronic urinary retention, secondary to BPO. Exclusion criteria were neurogenic lower urinary tract symptoms, prostate cancer, previous prostate or urethral surgery and prostate specific antigen (PSA) level outside the normal age-related range without prostate cancer excluded by biopsy. Patients with indwelling catheter due to an acute urinary retention were excluded from the study since considered relieved from the obstruction.

Patients were evaluated with two types of indicators: BPO related and renal function (RF) related. BPO related indicators included: 1. International Prostate Symptom Score (IPSS), provided with an IPSS questionnaire; 2. Maximum flow rate (Qmax), provided with uroflowmetry; 3. Prostate volume, (V); and 4. Post void residual urine volume (PVR), provided with transabdominal ultrasonography. The RF related indicators included: 1. serum levels of potassium; 2. serum levels of creatinine, provided by biochemistry, and 3. estimated glomerular filtration rate (eGFR) calculated with a Chronic Kidney Disease Epidemiology Collaboration equation (2021 CKD-EPI Creatinine equation) from patients' sex, age, and serum creatinine values.

The RF and BPO related indicators were assessed preoperatively and reassessed at postoperative 7-10th day and at 6 months, respectively. The eGFR was provided pre and 7-10 days postoperatively.

The preoperative and the postoperative values of the BPO and RF related indicators were compared within each surgical group. Statistical analyses were performed using Microsoft Excel t-test with paired analysis at one-tailed distribution. Indicators were expressed as mean ± standard deviation. $P<0.05$ was considered as statistically significant.

Results

Study patients were randomized (1:1) in two groups, consisted of 20 participants, labeled as ThuVARP and TURP group, based on the surgical method used. The preoperative and postoperative values of BPO and RF related indicators were compared within each group and presented in Table 1 and Table 2.

Table-1. Patients surgically treated with ThuVARP technique. BPO related indicators at baseline and 6-months after surgery. RF related indicators at baseline and 7-10 days after surgery

	ThuVARP	Mean ± SD (range)		
	No. of pts.	20		
	Age	69.37±5.1 (58-80)		
		Baseline values	***6 months***	***P- value***
BPO related indicators	IPSS	25±1.9 (21-29)	3.56±5 (0-22)	0.000
	Qmax (ml/s)	6.06±2.1 (3.5-10.6)	16.59±6.2 (5.1-34.8)	0.000
	Prostate V (ml)	61.4±33.4 (4-150)	26.2±11.9 (5.6-61)	0.000
	PVR (ml)	142.8±79.1 (10-330)	7.97±11 (0-35)	0.000
		Baseline values	***7-10 days***	***P- value***
Renal function related indicators	Potassium (mmol/L)	4.44±0.5 (3.34-5.05)	4.17±0.4 (3.06-4.7)	0.019
	Creatinine (µmol/L)	86.77±23.2 (56-141.3)	78.84±19.3 (58-124)	0.029
	eGFR (mL/min/1,73m²)	83.26±18.3 (46-106)	88.63±15 (53-102)	0.049

Data are mean ± SD (range). IPSS, international prostatic symptom scores; Qmax, maximum urinary flow rate; PVR, post-voiding residual volume; prostate V, volume with transabdominal ultrasonography; eGFR, estimated glomerular filtration rate - 2021 CKD-EPI Creatinine equation

Table-2. Patients surgically treated with the TUR P technique. BPO related indicators at baseline and 6-months after surgery. RF related indicators at baseline and 7-10 days after the surgery

	TURP	Mean ± SD (range)		
	No. of pts.	20		
	Age	66.55±5.7 (59-79)		
		Baseline values	***6 months***	***P- value***
BPO related indicators	IPSS	22.89±4.4 (10-29)	6.68±5 (1-17)	0.000
	Qmax (ml/s)	7.96±3.5 (3-13.5)	18.14±6.6 (8.6-27.8)	0.000
	Prostate V (ml)	61.5±16.2 (21-80)	21.13±14.4 (7.1-67)	0.000
	PVR (ml)	128.9±86.1 (28-300)	23.45±47.2 (0-200)	0.000
		Baseline values	***7-10 days***	***P- value***
Renal function related indicators	Potassium (mmol/L)	4.32±0.3 (3.88-5)	4.13±0.5 (3.3-5.39)	0.041
	Creatinine (µmol/L)	78.59±12.3 (65-108)	73.44±12.0 (50.95-104)	0.0004
	eGFR (mL/min/1,73m²)	89.05±11.8 (68-104)	93.65±10.70 (69-106)	0.0028

Data are mean ± SD (range). IPSS, international prostatic symptom scores; Qmax, maximum urinary flow rate; PVR, post-voiding residual volume; prostate V, volume with transabdominal ultrasonography; eGFR, estimated glomerular filtration rate - 2021 CKD-EPI Creatinine equation

In the ThuVARP group (Table-1.), the mean values of all BPO related indicators improved significantly at 6 months postoperatively. A significant increase in Qmax and decrease in IPSS, prostate V, and PVR were estimated postoperatively. There was also a significant postoperative improvement in all RF indicators. The serum levels of potassium and creatinine significantly decreased, and eGFR increased at 10 days postoperatively, when compared with baseline values.

In the TURP group (Table-2.), a significant improvement in all BPO related indicators could also be noted at 6 months postoperatively. RF related indicators also improved significantly at 7-10 days after surgery, with a significant decrease in the serum levels of potassium and creatinine, and an increase in eGFR, when compared with the baseline values.

Discussion

In CKD, the loss of renal function is gradual and often progressive, resulting from the damage of the kidneys (intra-renal), the vessels supplying them (pre-renal) or any obstructive pathology within the distal urinary tract (post-renal).

Urologist's focus are the post-renal reasons for kidney impairment with BPO as the most common cause of distal urinary tract obstruction and CKD development by impacting both kidneys chronically [1]. Thus the other risk factors for CKD as diabetes, hypertension, smoking, obesity, dyslipidemia and metabolic syndrome were not considered in this study. As early as in 1957, Olbrich and associates observed that men with urinary obstruction due to prostatic enlargement had 33% reduction in GFR compared to men of similar age with no obstruction [7]. Additionally, the obstructed patients who presented with infected urine had even greater decrease in the GFR to 50 % of normal values for men of similar age [7-9]. For the literature search on the effect of BPO on the renal function, we used data from the three high volume clinical studies. In all three the decreased Qmax (<15 ml/s) was found as significantly positive predictive factor for renal impairment and CKD development. [5,6,10] In the first one, a large South Korean study from 2009, on a group of 2741 men with LUTS of varying severity the potential association of various BPO related indicators and those of CKD (RF related indicators) was analyzed and besides the decreased Qmax (<15 ml/s), a history of hypertension and DM were found as risk factors for RF worsening and development of CKD. Other indicators, e.g. age, BMI including other BPO related indictors as PSA level (>1.4 ng/ml), IPSS (>7), quality-of-life score, prostate volume (>30 ml), and PVR, were not significantly associated neither with elevated serum creatinine nor with decreased eGFR [6]. In the same line are also the results from a latter South Korean study (2013), on a large group of 1400 middle-aged men, aged 40-59, with moderate to severe LUTS in which BPO and RF related indicators were also evaluated for a possible association and found the decrease in Qmax as only indicator that significantly correlated with eGFR reduction and RF impairment. [10] In contrast to the previous two, the third study from Mayo Clinic College of Medicine from 2005 by Rule and all, on a sample of 2115 white men (in a subgroup of 476) found that besides decreased Qmax (<15 ml/s), an increased IPSS (>7), PVR(>100ml) and history of hypertension were significant predictors of RF worsening and CKD occurrence. [5] Similar results were presented in another study were men over age of 50 with a bladder outlet obstruction and decreased Qmax, had significantly lower eGFR compared to men with normal Qmax. (65±25 vs 81±17 mL/min/1.73 m2 p<0,005) [11].

Multiple mechanisms have been proposed to explain the association between BPO and a decrease in RF. This includes: 1. Chronic urinary retention, 2.Acute urinary retention and 3.Urinary tract infection (UTI) [6]. The chronic urinary retention is thought to be the dominant mechanism of renal function impairment. Knowing this mechanism is very important in order to estimate the possibility of RF reversal by the surgical treatment of BPO [12-14].

The results in our study proved both surgical techniques safe and effective in achieving relieve from BPO. The transurethral prostate surgery, irrespective of the chosen method, as expected, has sufficiently relieved the urinary tract obstruction (BPO), presented with a significant improvement in all BPO related indicators but our primary aim was to determine the effect of surgery on the RF. The outcome of all RF related indicators, measured 7-10 days postoperatively, showed simultaneous significant improvement, supporting the possibility of RF improvement and recovery after surgical treatment of BPO as the underlying cause. It is important to emphasize that our patients were selected solely in relation to BPO, with urinary retention and the need of a surgical treatment. The RF was not considered, thus patients in both groups were estimated having initial to moderate CKD, predominantly in Stadium I and II (only 2 patients in Stadium III), according to 2021 CKD-EPI equation. Even at this level of CKD, a significant renal function improvement was achieved after surgery.

We found our results in line with those in other clinical studies. Speakman *et al.*, presented chronic urinary retention to be the major mechanism for CKD development in patients with LUTSs/BPH with a confirmed association of BPO with decreased GFR. Upper urinary tract dilatation or increased serum creatinine was diagnosed in half of all patients with chronic urinary retention secondary to BPH/BPO. The surgical treatment of BPO with TURP improved renal function post-surgery [15]. Another study from 2019 by Zamzami on 88 patients with obstructive uropathy due to BPH, showed decrease in the mean serum creatinine levels to normal limits 14 days after TURP [2,4mg/dL (212,2µmol/L) to 1,1mg/dL (97,2µmol/L) p<0,001], with improvement of the kidney function [16]. In accordance with this finding was the study from 2018 by Sarier *et al*., on a group of 98 patients with renal transplant who underwent TURP due to BPH, in which 1 month after surgery a significantly decreased mean serum creatinine level was observed [1.99±0.83 mg/dL (175,9 µmol/L) to 1.67±0.9 mg/dL (147,6 µmol/L) p<0,001] [17].

Conclusion

The simultaneous and significant postoperative improvement in all BPO and RF related indicators in both surgical groups, suggest that transurethral prostate surgery with a consecutive relief of the lower urinary tract obstruction, regardless of the chosen method (Thu VARP or TURP) may improve the renal function being potentially benefitial in CKD patients.

Conflict of interest statement. None declared.

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