Significance of operative parameters on outcomes after transurethral resection of the prostate

Daimantas Milonas
Department of Urology, Kaunas University of Medicine, Lithuania

Key words: *benign prostate hyperplasia; transurethral resection of the prostate; residual prostatic weight ratio; outcome.*

Summary. *Objective. The aim of this prospective study was to establish the influence of operative parameters on outcomes after transurethral resection of the prostate.*

Materials and methods. In this prospective case series study, 89 patients underwent transurethral resection of the prostate. The standardized protocol was used to investigate the impact of operative parameters (resected tissue weight, residual prostate weight, and residual prostatic weight ratio [total prostate volume – resected tissue weight / total prostate volume]) on outcomes after six months following transurethral resection of the prostate. The evaluation of treatment efficacy was done using the criteria of the Second International Consultation on Benign Prostatic Hyperplasia. All postoperative results were categorized as excellent, good, fair, or none. Treatment was considered effective when the postoperative results were excellent and good, and ineffective when results were fair and none.

Results. Treatment was effective for 85.4% and ineffective for 14.6% of the patients. The univariate analysis of operative parameters detected the residual prostatic weight ratio (cutoff value, 0.71; P<0.001; sensitivity, 0.62; specificity, 0.96; OR, 39.47) as the strongest independent predictor of ineffective outcome. Logistic regression analysis revealed two important parameters of unfavorable outcomes: residual prostatic weight ratio (cutoff value, 0.71; P<0.001; OR, 62.16) and residual prostate weight (cutoff value, 26.6 mL; P=0.013; OR, 9.98). When the values of both these parameters were lower than their cutoff values, the probability of an ineffective outcome was reduced to 3%; however, when they were higher, the probability of an unfavorable outcome was increased to 95%.

Conclusions. Residual prostatic weight ratio and residual prostatic weight are significant operative parameters for the prediction of outcomes after transurethral resection of the prostate.

Introduction

Benign prostate hyperplasia (BPH) is a common troublesome condition for elderly men. Although medical therapy has recently become more popular, the functional results of BPH treatment are still much better after surgery. After medical and surgical treatment, the respective mean of symptoms severity decreased from 30% to 60% vs. 60% to 90%, and the respective mean of peak urinary flow rate (Qmax) increased to 40% vs. 140% (1, 2). Nonetheless, the improvement in the results of separate functions does not always imply that the treatment is beneficial because up to 20% of the patients had unfavorable results after transurethral resection of the prostate (TURP) (3, 4).

There are a few ways to lower the percentage of unfavorable results after TURP: better selection of patients and an understanding of how complete the resection should be. Although there are numerous discussions and investigations regarding the effort to find optimal preoperative parameters for a better selection of patients for TURP, very few studies evaluated the effect of operative parameters on outcomes. Comparing all BPH interventional treatment modalities, functional results are the best after an open operation (1, 5). During the open surgery, up to 97% of transition zone can be enucleated and that has a direct impact on the outcome (6). The logical conclusion is that TURP should be performed in the same way – by resecting as much tissue as possible. However, there are certain limitations for transurethral resection that do not allow removing the same amount

Correspondence to D. Milonas, Department of Urology, Kaunas University of Medicine, Eivenių 2, 50009 Kaunas, Lithuania
E-mail: daimantas.milonas@kmuk.lt

Adresas susirašinėti: D. Milonas, KMU Urologijos klinika, Eivenių 2, 50009 Kaunas
El. paštas: daimantas.milonas@kmuk.lt

of tissue, which can be removed during an open operation. So how much should prostate tissue be resected to assure a favorable outcome? Aagaard et al. suggested that even after 10 years of follow-up, the functional results after minimal resection of the prostate are comparable with the conventional one (7). Hakenberg et al. analyzed the impact of residual prostatic weight (RPW) on outcomes after TURP and did not find a significant influence of this parameter on outcome (8). In their study, Chen et al. detected a correlation between operative parameters and Qmax, International Prostate Symptoms Score (IPSS) and quality of life (QoL) (9) and concluded that better results were achieved when the residual prostate weight ratio (RPWR) was smaller. In the study presented herein, RPWR and RPW cutoff values that have a significant influence on an early outcome after TURP have been identified for the first time.

Material and methods

This prospective case series study involved 89 patients with lower urinary tract symptoms and histologically approved BPH, who underwent TURP from January 2002 to May 2003. The Ethics Committee of the hospital approved this study, and the patients signed their consent on a written form of information.

Criteria for inclusion were age of 45–85 years, IPSS of ≥13, Qmax of ≤15 mL/s, postvoid residual volume (PVR) of ≤300 mL, and a prostate biopsy to confirm benign disease, when prostate specific antigen (PSA) was >4 ng/mL, as well as a signed consent form.

Criteria for exclusion were a previous operation of the bladder, prostate, or urethra; urethral stricture; Qmax of >15 mL/s; IPSS of <13; prostate or bladder cancer; bladder stones, and chronic urinary tract infection.

The standard protocol was used for the pre-, intra-, and postoperative examinations. Examinations of the patients before their operations included PSA, IPSS, QoL, Qmax, PVR, total prostate volume (TPV), transition zone volume (TZV), and transition zone index (TZI=TZV/TPV). Transrectal ultrasound (TRUS) was used for the total estimation of the prostate and its zones.

TURP was performed using standard 24 or 26 French resectoscopes with either an intermittent or a continued flow according to the technique of complete adenoma resection, down to the surgical capsule. The resected tissue was weighed in the operative theatre after the resection was completed. Operating time from the first bite to removal of the resectoscope from the urethra was recorded during resection.

Follow-up was arranged six months after TURP and included IPSS, QoL, SBS, Qmax, PVR, and TPV investigations. The defined endpoint of the study was an evaluation of treatment efficacy using the criteria (pre/postoperative changes of IPSS, QoL, Qmax, and TPV) of the Second International Consultation on Benign Prostatic Hyperplasia (Table 1) (10, 11). All postoperative results were categorized as excellent, good, fair, or none. Treatment was considered effective when the postoperative results were excellent and good, and ineffective when results were fair and none (Table 2). All operative parameters were analyzed with regard to the study endpoint: effective or ineffective results.

The statistical analysis was performed using the *t* test, Pearson's correlation coefficient, and chi-square

Table 1. Response criteria for individual parameters

Parameter	Eligibility	Excellent	Good	Fair	None
IPSS	post / pre ratio post core	<0.2 and ≤7	≤0.6 and ≤13	≤0.8 and ≤19	>0.8 or ≥20
QoL	pre score ↓ post score	3 4–6 ↓ ↓ 0 0–1	4 5 6 ↓ ↓ ↓ 2 2 2–3	3 4 5 6 ↓ ↓ ↓ ↓ 2 3 3 4	Other pairs
Qmax, mL/s	post / pre ratio Qmax post	– ≥18	≥1.3 and ≥12	≥1.3 and ≥6	<1.3 or <6
Prostate size, mL	post / pre ratio	≤0.6	≤0.8	≤0.9	>0.9

IPSS, International Prostate Symptoms Score, QoL, quality of life, Qmax, maximal flow rate.

Table 2. Overall response criteria

Composition of individual evaluation	Overall evaluation
Excellent + Good ≥2	Effective
Excellent >Good	Excellent
Excellent ≤Good	Good
Excellent + Good <2	**Not Effective**
Fair >Good	Fair
Fair ≤None	None

test. Univariate and multivariate logistic regression analysis was employed to find the prognostic value of each parameter for predicting unsuccessful results. SPSS 12.0 for Windows (Statistical Package for Social Sciences, Chicago, Illinois, USA) was used to perform the statistical analysis. Differences were considered significant at $P<0.05$.

Results

Data of 89 (84.76%) of the 106 patients were included in the final analysis. In 10 cases, incidental carcinoma of the prostate was found (9.52%), 5 patients did not come for further investigation, and 2 were excluded because of postoperative urethral stricture detected.

Preoperative data

The values of various subjective or objective preoperative parameters and how these parameters changed after six months following TURP are shown in Table 3.

Operative data

The mean time in surgery was 68.8 min (range, 30–120; SD, 21.85), and the mean resected tissue weight (RTW) was 23.6 g (range, 5–66; SD, 14.43). During the operation, 89% of TZV and 50% of TPV were resected (1 g = 1 mL). TPV and TZV significantly correlated with the duration of the procedure ($r=0.58$, $P<0.001$ and $r=0.604$, $P<0.001$, respectively) and with RTW ($r=0.797$, $P<0.001$ and $r=0.861$, $P<0.001$). The mean RPWR (preoperative TPV–RTW/preoperative TPV) was 0.516 (range, 0.11–0.87; SD, 0.17). The mean calculated residual prostate weight (RPW=TPV–RTW) was 23.43 mL (range, 5.13–66.3; SD, 11.48).

Follow-up data

Six months after TURP, excellent functional results (ΔIPSS, ΔQmax, ΔTPV and ΔQoL) were detected in 59 (65.2%) patients, good in 18 (20.2%), and fair in 10 (11.2%), whereas unfavorable outcome was found in 3 (3.4%) patients. According to these postoperative results, all patients were divided into two groups by the treatment received: effective treatment (excellent and good, n=76) and ineffective treatment (fair and none, n=13). Each operative parameter was compared between these groups. The RPW value measured by TRUS during a follow-up visit was taken for analysis. All the compared operative parameters differed significantly, but RPWR (0.696±0.11 vs. 0.488±0.16, $P<0.001$) showed the most significant change between these groups (Table 4).

When significant operative parameters were detected, their correlations with ΔIPSS, ΔQmax, ΔTPV, and ΔQoL (differences in pre- and postoperative parameters determining efficacy of the treatment) were investigated. RPWR had the strongest correlation with all these parameters ($r=0.406$, $P<0.001$; $r=–0.288$, $P=0.006$; $r=–0.463$, $P<0.001$ and $r=0.404$, $P<0.001$, respectively).

Table 3. Preoperative subjective and objective parameters and their difference after 6 months following transurethral resection of the prostate

Parameter	Preoperative			Postoperative			Difference Δ (%)	*P*
	Mean	Range	SD	Mean	Range	SD		
IPSS	22.38	13–34	5.55	5.622	0–23	4.58	16.8 (74.9)	<0.001
QoL score	4.68	3–6	0.99	1.08	0–5	1.06	3.6 (76.9)	<0.001
PVR, mL	122.65	10–300	76.71	31.66	0–250	32.75	90.9 (74.2)	<0.001
Qmax, mL/s	8.67	3–15	2.77	18.75	6.2–45.3	7.79	10.08 (116)	<0.001
TPV, mL	47.21	18.3–113.3	19.20	21.22	8–58	9.01	25.9 (55.1)	<0.001
Age, years	68.3	45–84	7.75	–	–	–	–	–
TZV, mL	26.5	5–74.5	14.49	–	–	–	–	–
TZI	0.53	0.24–0.75	0.12	–	–	–	–	–

IPSS, International Prostate Symptoms Score, QoL, quality of life, PVR, postvoid residual volume, Qmax, maximal flow rate, TPV, total prostate volume, TZV, transition zone volume, TZI, transition zone index.

Table 4. Operative parameters according to treatment efficacy

Parameter	Ineffective treatment (n=13)		Effective treatment (n=76)		*P*	95% CI	
	Mean	SD	Mean	SD		lower	upper
Resected tissue weight	16.07	13.32	24.88	14.28	0.041	–17.25	–0.35
Residual prostate weight	27.88	14.15	20.21	7.5	0.004	2.46	12.87
Residual prostatic weight ratio	0.696	0.11	0.488	0.164	<0.001	0.113	0.302

The impact of individual operative parameters on treatment efficacy was investigated. RTW (cutoff value, 6.7; *P*=0.001; sensitivity, 0.46; specificity, 0.96; OR, 21.43; and 95% CI, 4.32–103.46), RPW (cutoff value, 25.56; *P*=0.007; sensitivity, 0.46; specificity, 0.86; OR, 5.14; and 95% CI, 1.45–18.19), and RPWR had a significant influence on postoperative results. However, only RPWR had an acceptable specificity and sensitivity; thus, it can be used as the strongest individual prognostic parameter (cutoff value, 0.71; *P*=0.001; sensitivity, 0.62; specificity, 0.96; OR, 39.47; and 95% CI, 7.92–196.76).

The logistic regression analysis was employed to investigate further the impact of operative parameters on treatment efficacy. Together RPW (cutoff value, 26.6 mL, *P*=0.013; and OR, 9.978) and RPWR (cutoff value, 0.71; *P*<0.001; and OR, 62.16) had the prognostic power for predicting the efficacy of an operation. Of these, RPWR was the most important. When the values of both these parameters were lower than their cutoff values (RPW, ≤26.6 mL; RPWR, ≤0.71), the probability of an ineffective outcome was reduced to 3% (Fig.). When the values of both parameters were higher than their cutoff values, the probability of an unfavorable outcome was increased to 95%.

Discussion

Generally, the outcome of TURP, performed because of lower urinary tract symptoms, is favorable in 78–93% of the patients (12). The effectiveness of transurethral surgery in this study was similar – 85.4%. All parameters after TURP changed significantly, from 55.1% to 116%, and that determined the overall effectiveness of the treatment. A greater change was detected for flow rate – ΔQmax was 116%. The impact of preoperative parameters on treatment-related functional results or treatment efficacy has been investigated in various prospective, randomized studies. Investigations of operative parameters are mostly confined to the detection of removed tissue weight, operative time, and values of complications but not to estimate the impact on treatment effectiveness (13).

There are only a few data on how the completeness of resection influences the outcome of TURP. The majority of such studies did not pay attention to operative parameters such as the weight of residual tissue or RPWR, both of which indicate how complete an operation is. The importance of RPWR was firstly mentioned by Chen et al. (9). These authors examined 40 men with symptomatic BPH and detected that the smaller the RPWR was at 16 weeks after TURP, the better was the clinical outcome. The contradictory

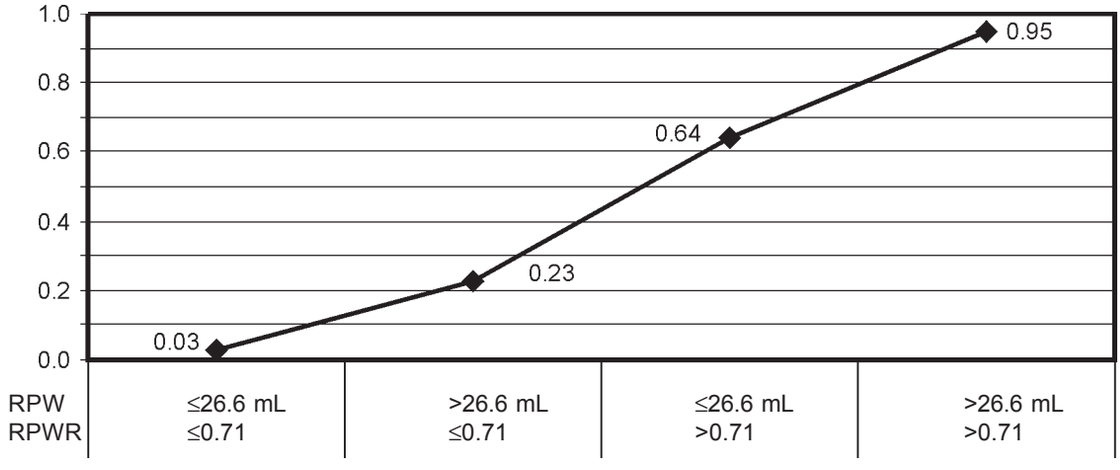

Fig. Logistic regression curve of significant operative parameters
RPW, residual prostate weight, RPWR, residual prostatic weight ratio.

data were published by Hakenberg et al. (8). This study included 138 men with symptomatic benign prostatic enlargement. There was no statistically significant correlation between the changes in symptoms and either the percentage of prostate volume removed or the RPW. These authors concluded that the symptomatic improvement after TURP is not primarily dependent on the relative completeness of the resection. These very sparse data are contradictory and cannot answer whether or not the completeness of resection is important for the outcome.

The data presented in this study indicate that RPWR changed the most significantly when effective and ineffective treatment groups were compared. Efficacy of treatment in this study was estimated following the criteria (pre/post operative changes of IPSS, QoL, Qmax, and TPV) of the Second International Consultation on Benign Prostatic Hyperplasia and it differs with aforementioned studies. The univariate analysis indicated that RPWR was the strongest independent operative parameter for predicting outcome (OR 39.47, P=0.001), and at a cutoff value of 0.71, it has significant sensitivity and specificity. It means that during the resection of the prostate, at least 30% of the prostate volume should be removed to avoid an unfavorable outcome.

Some precautions should be taken in the interpretation of cutoff value detected. Resection technique always plays a significant role in outcomes. Resection of only one lobe of the prostate, resection at the bladder neck leaving untouched tissue around the verum montanum will likely result in an unfavorable outcome even if 30% of TPV is removed. In generally, our results showed that resection of the prostate should be as much as possible complete and lower limit of resected tissue weight should compose 30% of TPV.

The multivariate analysis detected two important parameters, RPWR (cutoff value, 0.71; P<0.001; OR, 62.16) and RPW (cutoff value, 26.6 mL; P=0.013; and OR, 9.978). These data show that the rate of ineffective outcomes will be minimized if resected tissues account for more than 30% of TPV, and the residual tissue volume is less than 26 mL. Since this is the first detection of such a definition of a "successful" resection, there are no data to compare it with. The cutoff values of RPWR and RPW that are detected propose some practical aspects. Analysis of our data shows that 10 patients had RPWR greater than the cutoff value of 0.71. The mean TPV for these patients was 31.4 mL; TZV, 12.06 mL; and TZI, 0.36. Only in two cases, RPW was higher than the cutoff value of 26.6 mL. It shows that in the majority of cases, incomplete resection occurs when TPV, TZV, and TZI are very low. Seven of these 10 patients (70%) had unfavorable outcomes. Under such circumstances, it is not possible to remove more than 30% of the prostate, and the decision to select TURP will lead to a high rate of unfavorable results. The relation between complete resection and prostate volume is confirmed by analysis of 17 patients with an RPW of >26.6 mL. The mean TPV was 64.8 mL; TZV, 36.6 mL; RTW, 27 g; and TZI, 0.55. Only in two cases, resection was incomplete (RPWR, >0.71). In other cases, the amount of residual tissues greater than cutoff values was left because of high volume transition zone or other reasons. Only six of these 17 patients (35.3%) had unfavorable outcomes. This shows that from a practical point of view, RPW is less important than RPWR for predicting the outcome. That is confirmed by the logistic regression curve (Fig.). If RPW is higher (>26.6 mL) but RPWR is lower (≤0.71) than cutoff values, the probability for an unfavorable outcome is 23%. On the other hand, if RPWR is higher but RPW is lower than cutoff values, the probability of unsuccessful outcomes increases to 64%.

Some important messages can be read from this study. First is that resection will not be effective if less than 30% of the prostate volume is removed. Second is that TURP should be indicated if transitional zone accounts for more than 30% of TPV. Third is that TURP could be safely stopped if some unexpected difficulties occur and 30% of TPV has been resected.

Despite the greatly decreasing number of interventional treatments of lower urinary tract symptoms because of BPO, resection of the prostate remains the most effective treatment when long-term outcomes are compared (14). Minimal resection, as an acceptable treatment modality, was suggested by Aagaard et al. (7); however, other authors have not confirmed this. The data of this study suggest performing resection of the prostate as complete as possible with obligatory resected weight of 30% of TPV. If such amount of tissue cannot be resected because of small transition zone volume, the probability for ineffective outcomes is very high.

Conclusions

Transurethral resection of the prostate remains a very effective treatment modality of lower urinary tract symptoms because of the benign prostatic obstruction. Resection should be as complete as possible. Operative parameters such as residual prostatic weight ratio and residual prostatic weight are important parameters for the prediction of treatment outcome.

Operacinių veiksnių reikšmingumas transuretrinės prostatos rezekcijos rezultatams

Daimantas Milonas
Kauno medicinos universiteto Urologijos klinika

Raktažodžiai: gerybinė prostatos hiperplazija, transuretrinė prostatos rezekcija, santykinis liekamosios prostatos svoris, pooperaciniai rezultatai.

Santrauka. *Tyrimo tikslas.* Šio perspektyviojo tyrimo tikslas – nustatyti operacinių veiksnių reikšmingumą pooperaciniams transuretrinės prostatos rezekcijos rezultatams.

Tyrimo medžiaga ir metodai. Į tyrimą įtraukti 89 tiriamieji, kuriems atliktos transuretrinės prostatos rezekcijos. Operacinių veiksnių (pašalintų prostatos audinių svoris, liekamasis prostatos svoris ir santykinis liekamosios prostatos svoris, bendras prostatos tūris–pašalintų audinių svoris/bendras prostatos tūris) reikšmingumas pooperaciniams rezultatams, praėjus 6 mėn. po operacijos, buvo tirtas naudojant standartizuotą protokolą. Gydymo veiksmingumas buvo vertinamas remiantis Antrosios gerybinės prostatos hiperplazijos konsultacijos rekomendacijomis. Visi pooperaciniai rezultatai buvo suskirstyti į puikius, gerus, patenkinamus ir blogus. Gydymas veiksmingas, kai rezultatai buvo geri arba puikūs.

Rezultatai. Veiksmingas gydymas nustatytas 85,4 proc., neveiksmingas – 14,6 proc. tiriamųjų. Vienfaktorinės analizės metu nustatyta, jog santykinis liekamosios prostatos svoris (slenkstinė reikšmė – 0,71, p<0,001, jautrumas – 0,62, specifiškumas – 0,96, ŠS 39,47) yra reikšmingiausias operacinis veiksnys numatant neveiksmingus pooperacinius rezultatus. Logistinės analizės metu nustatyti du operaciniai veiksniai, kurie turi įtakos neveiksmingiems pooperaciniams rezultatams: santykinis liekamosios prostatos svoris (slenkstinė reikšmė – 0,71, p<0,001, ŠS 62,6) ir liekamasis prostatos svoris (slenkstinė reikšmė – 26,6 ml, p=0,013, ŠS 9,98). Kai abiejų nustatytų reikšmingų operacinių veiksnių dydžiai yra mažesni nei slenkstinės reikšmės, gerų ir puikių pooperacinių rezultatų tikimybė yra 95 proc. Jeigu šių veiksnių reikšmės yra didesnės nei slekstinės, veiksmingo gydymo tikimybė yra tik 3 proc.

Išvados. Santykinis likusios prostatos svoris ir likusios prostatos svoris yra reikšmingi operaciniai veiksniai, kuriais remiantis galima numatyti neveiksmingus transuretrinės prostatos rezekcijos pooperacinius rezultatus.

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