Diagnostic and Predictive Value of Voiding Diary Data Versus Prostate Volume, Maximal Free Urinary Flow Rate, and Abrams-Griffiths Number in Men with Lower Urinary Tract Symptoms Suggestive of Benign Prostatic Hyperplasia

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OBJECTIVES To investigate the information of voiding data in relation to symptoms and well-being in men with lower urinary tract symptoms (LUTS) suggestive of benign prostatic hyperplasia (BPH) and to compare this information with that of prostate volume (Vprostate), maximal free urinary flow rate ($Q_{max,free}$), and obstruction grade (OG).

METHODS We performed mandatory tests, recommended tests, and pressure-flow studies in 384 consecutive men with LUTS suggestive of BPH. We estimated nocturia, diuria, and mean voided volume (Vmean) from their voiding diaries. Symptoms and well-being were quantified by American Urological Association symptom index (SI), quality-of-life score (QoL), symptom problem index (SPI), and BPH impact index (BII). We investigated the influence of Vprostate, $Q_{max,free}$, OG, Vmean, nocturia, and diuria on SI, QoL, SPI, and BII. We re-evaluated 48 men 6 months after transurethral resection of the prostate (TURP). We analyzed the predictive value of preoperative $Q_{max,free}$, Vprostate, OG, Vmean, nocturia, and diuria for the improvements of SI, QoL, SPI, and BII after TURP. We studied the improvements of $Q_{max,free}$, OG, Vmean, nocturia, and diuria after TURP and the improvements of SI, QoL, SPI, and BII.

RESULTS Prostate volume, $Q_{max,free}$, and OG were only slightly associated with SI, QoL, SPI, and BII, in contrast to Vmean, nocturia, and diuria. The predictive value of all parameters on the outcome of TURP was poor. Improvements of all parameters were strongly associated with improvements of SI, QoL, SPI, and BII after TURP.

CONCLUSIONS Voiding data should have a prominent role in the initial evaluation of men with LUTS suggestive of BPH. UROLOGY 71: 469–474, 2008. © 2008 Elsevier Inc.

Objective data in treatment decision making in patients with lower urinary tract symptoms (LUTS) suggestive of benign prostatic hyperplasia (BPH) are mainly based on American Urological Association (AUA) symptom questions,[1] AUA quality-of-life question,[1] and findings at digital rectal examination.

In accordance with the recommendations of the International Scientific Committee (ISC) on BPH, before embarking on any active therapy urinary flow rate measurement should be performed.[2] Pressure-flow studies are recommended before invasive therapy or when a precise diagnosis of bladder outlet obstruction (BOO) is important.[2] Recently it was demonstrated[3] in a selected group of patients that the SI and QoL score are the most decisive in the treatment recommendations, followed by BOO and BOO-related parameters. The medical history, physical status, and duration of the reports do not significantly affect treatment recommendations in these patients.[3]

The AUA symptom scores quantify the occurrence of lower urinary tract symptoms. However, the degree to which patients report symptoms as bothersome is not the same as the presence and frequency of their symptoms.[4–6] Barry assumed that the degree of being bothered is a common denominator that causes men to present to urologists.[7] Baseline degree of being bothered has been described as more predictive of outcome after prostatic surgery than symptom score.[8] To quantify the degree of bother, the AUA Measurement Committee developed

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and validated a symptom problem index (SPI) with seven questions about degree of being bothered, each of which corresponds to a symptom question on the SI.[9] It could be demonstrated[10] that the order of the prevalence of symptoms (in decreasing order: weak urinary stream, frequency, urgency, incomplete emptying, intermittency, nocturia, and hesitancy) was different from that of the bother caused by the symptoms (in decreasing order: urgency, nocturia, hesitancy, incomplete emptying, frequency, intermittency, and weak urinary stream). The Measurement Committee also developed and validated the BPH impact index (BII) to measure how much the urinary problems affect various domains of health.[9]

Whereas prostate volume, maximal free uroflow rate ($Q_{max,free}$), and obstruction grade have a prominent role in the recommendations for treatment in men with LUTS suggestive of BPH, voiding data are still considered less important. The ISC recommends[2] the use of voiding diaries (also called frequency-volume charts) in the initial evaluation of men with LUTS suggestive of BPH, to identify patients with nocturial polyuria or excessive fluid intake. Voiding data are reflections of patients' voiding habits at night and at daytime, and thus these data should provide much more important information about patients' reports.

The first aim of our study was to analyze the information of voiding data about symptoms and well-being in men with LUTS suggestive of BPH, and to compare this information with that of prostate volume, $Q_{max,free}$, and grade of obstruction. We quantified symptoms and well-being of the patients with the SI, QoL, SPI, and BII. The second aim was to compare the predictive value of voiding data on the improvements of SI, QoL, SPI, and BII after transurethral resection of the prostate (TURP) with that of preoperative prostate volume, $Q_{max,free}$, and obstruction grade. Moreover, we compared the changes in voiding data, $Q_{max,free}$, and obstruction grade with changes in SI, QoL, SPI, and BII by TURP.

MATERIAL AND METHODS

In men with LUTS suggestive of BPH, we performed the basic standard evaluation and recommended tests, conforming to the recommendations of the ISC on BPH from 1993 (updated[2] in 2001). All men answered the SI questions, SPI questions, QoL question, and BII questions. We introduced an additional question concerning frequency of voiding in the daytime. On that question, the range of scores was: 0 = 1 to 3 times, 1 = 4 to 5 times, 2 = 6 to 7 times, 3 = 8 to 9 times, and 4 = 10 times or more. In our outpatient department, it was common practice to perform pressure-flow studies in all these men. Conforming the recommendations[11] of the Urodynamics Subcommittee, we calculated the Abrams-Griffiths (AG) number[12] from the pressure-flow studies. Patients were included if they were 50 years old or older and had none of the specified exclusion criteria of the ISC. We performed free uroflowmetry studies with a voided volume of at least 150 mL, and pressure-flow studies according to the recommendations of the ISC and the subcommittee. Frequency-volume charts[13] were reliably completed for at least 24 hours and the prostate volume was determined by transrectal ultrasound measurements.

All subjects were part of an extensive study on the treatment of LUTS. The local ethical committee approved this research program and we obtained informed consent. A randomized controlled trial comparing transurethral resection of the prostate (TURP), contact laser prostatectomy, and electrovaporization was part of this study. Men selected for this trial were analyzed 6 months after treatment with regard to AG number, $Q_{max,free}$, SI, QoL, SPI, BII, and the additional question concerning frequency of voiding in the daytime. In men who were selected for TURP, we analyzed improvements of the different parameters by resection.

We quantified improvement of AG-number, $Q_{max,free}$, and mean voided volume as the ratio between the change of the parameter divided by the preoperative value. Improvements of a parameter were rescaled such that maximal improvement of that parameter in the group was 100%. We calculated improvements of the discrete parameters SI, SPI, QoL score, BII, and the score on the additional question as described previously.[14] The maximum improvements of these parameters could be 100%.

We performed statistical analyses with the distribution-free Spearman's correlation test and the Mann-Whitney *U*-test. Significance (two-tailed) was set at $P = 0.05$.

RESULTS

A total of 384 consecutive men visiting the outpatient urology department from 1996 to 2003 were included in the analyses. Mean values of patient characteristics were: age, 65 years (10th to 90th percentile, 53 to 75); SI, 17 (10th to 90th percentile, 8 to 25); QoL score, 3.6 (10th to 90th percentile, 2 to 5); SPI, 12 (10th to 90th percentile, 3 to 22); BII, 6 (10th to 90th percentile, 2 to 10); Abrams-Griffiths (AG) number, 47 (10th to 90th percentile, 12 to 87); prostate volume, 42 cm^3 (10th to 90th percentile, 21 to 70); $Q_{max,free}$, 12 mL/s (10th to 90th percentile, 6 to 20); and voided volume, 190 mL (10th to 90th percentile, 110 to 280).

Figure 1 shows how prostate volume, AG number, and $Q_{max,free}$ are related to SI, SPI, QoL, and BII. In all graphs the minimum of the horizontal axis is the 10th percentile and the maximum is the 90th percentile of the actual parameter.

Figure 1 shows only a significant relation between $Q_{max,free}$ and the SI. No other significant relations were found. Figure 2 shows the highly significant relations among all voiding data and SI, SPI, QoL, and BII.

The gradient of the straight line is a measure for the strength of the influence of that parameter on the parameter plotted on the vertical axis. In all graphs the 10th percentile and 90th percentile of a parameter are the borders of the horizontal axis. Thus, gradients in all graphs for the SI can directly be compared showing that, for instance, the strength of the influence of mean voided volume on SI is greater than that of $Q_{max,free}$. The same applies for all graphs for SPI, for all graphs for QoL, and for all graphs for BII.

Of our 384 men, 48 underwent TURP as part of the

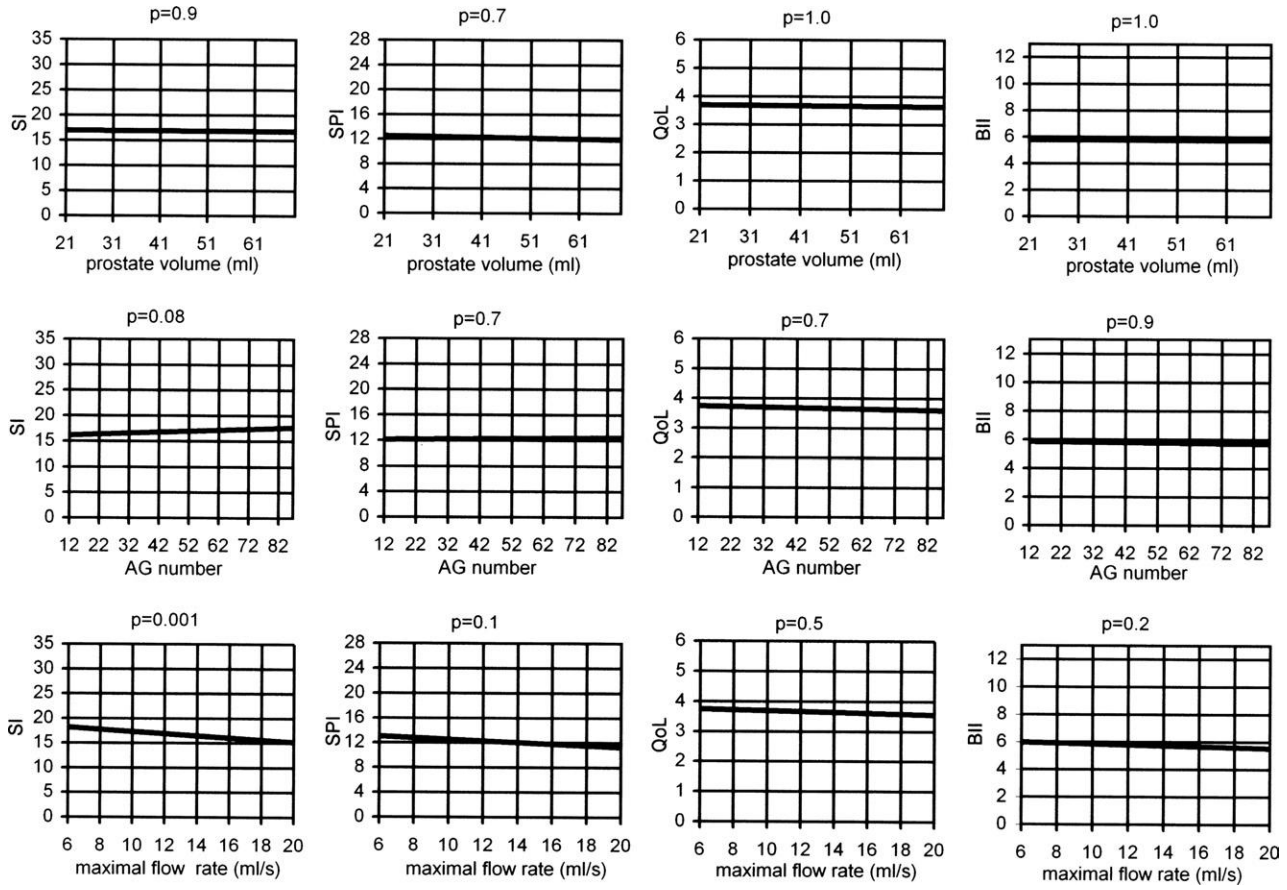

Figure 1. Relations among prostate volume, Abrams-Griffiths (AG) number, maximal free uroflow and AUA symptom index (SI), AUA symptom problem index (SPI), quality of life (QoL) score, and BPH impact index (BII). *P*-value above each section is the significance of the relation.

randomized study and were re-evaluated 6 months later. Preoperative $Q_{max,free}$ was only related to the improvement in BII ($P = 0.001$). Preoperative prostate volume was only related to the improvement in SI ($P = 0.03$) and preoperative AG number to the improvements in SI ($P = 0.01$) and BII ($P = 0.01$). Preoperative mean voided volume and nocturia were not related to improvements in SI, SPI, QoL, or BII. Finally, diuria was only related to improvement in SI ($P = 0.04$).

Figure 3 shows that improvements in $Q_{max,free}$, AG number, and mean voided volume (postoperative mean voided volume available for 45 men) after TURP were related to improvements in SI, SPI, QoL, and BII.

Unfortunately, we noted no information about diuria and nocturia postoperatively. To get an impression about the improvement of nocturia after TURP, we compared the preoperative score on the seventh question of the AUA symptom questions with the postoperative score on that symptom question. We analyzed the improvement in diuria by comparing the preoperative score on the additional question with the postoperative score on that question. The improvements in score on question 7 of the SI and the improvement in score on the additional question were related to the improvements in SI, SPI, QoL, and BII in Figure 3. In all graphs in Figure 3, the minimum of the horizontal axis is the 10th percentile and the maximum is the 90th percentile of the actual parameter. Thus, the gradients of the straight lines can be used in the same way as described for Figures 1 and 2.

COMMENT

As a consequence of our strict handling of the inclusion and exclusion criteria, a substantial dropout of patients occurred. More than 60% of all consecutive patients did not meet one or more criteria and were excluded, mostly because they used medication active on the urinary tract, especially alpha-blockers. The group of 48 patients going for TURP seems to be small; however, they also were strictly selected for the randomized controlled trial.

The condition that men were included in the study only when they voided at least 150 mL urine during free uroflowmetry may have excluded those with severe and prolonged obstruction. However, in a reasonable number of these excluded patients, bladder properties may have changed, resulting in a partly decompensated bladder. Our inclusion criteria were based on the recommendations of the ISC on BPH[2] and we did not consider it reasonable to change any of these recommendations.

Because patients are requested to arrive with a full

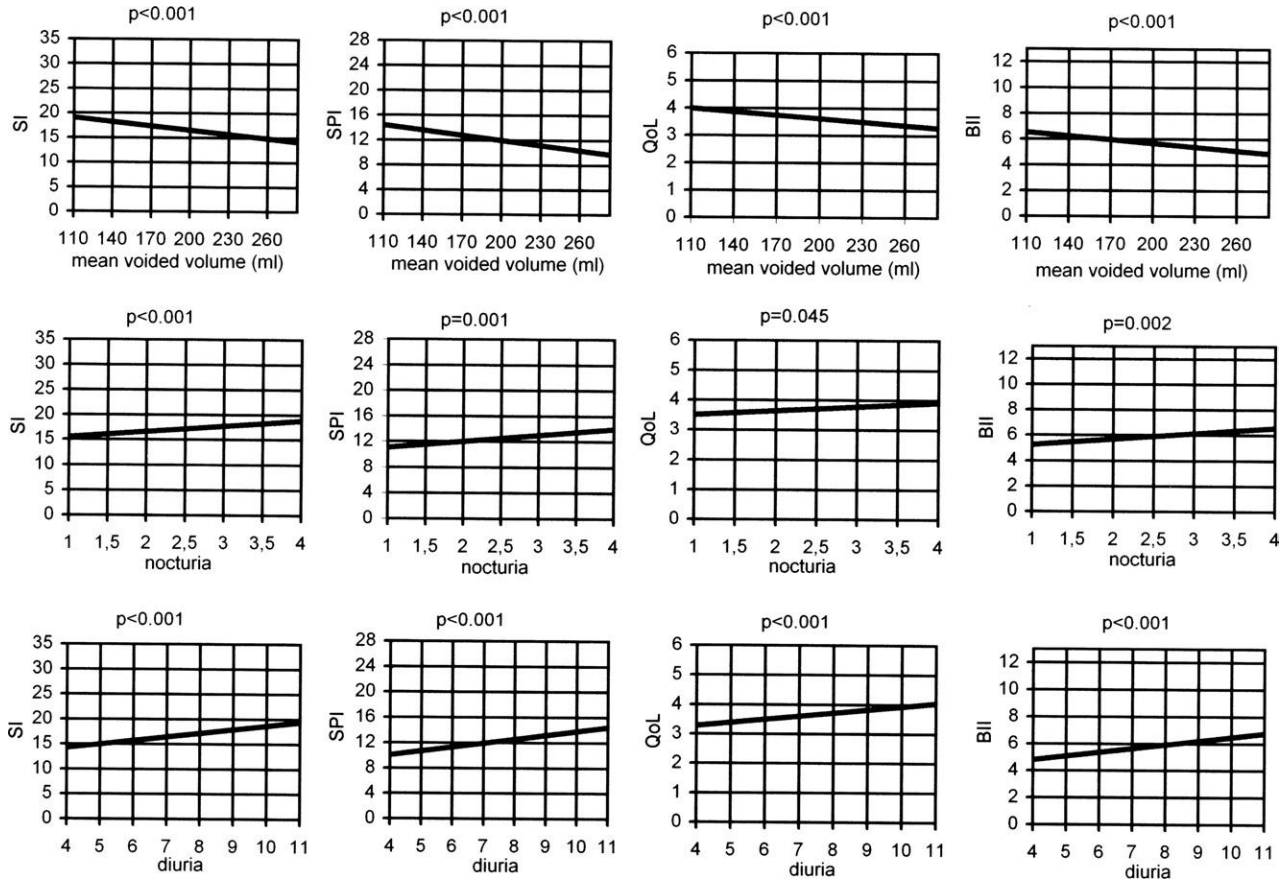

Figure 2. Relations among mean voided volume, nocturia, diuria and SI, SPI, QoL, and BII.

bladder, uroflowmetry is usually performed when patients have a strong desire to void. In daily life, patients will void at smaller bladder contents. This explains why the confidence intervals presented for the mean voided volumes calculated from the frequency-volume charts in our study show values down to 110 mL.

The figures show linear trend lines. The use of higher-order trend lines is not sensible because of the great variability of the variables.

Prostate volume, AG-number, and $Q_{max,free}$ were only slightly related to symptoms, bothering, quality of life, and well-being (Fig. 1). Voiding data estimated from voiding diaries were all highly significantly related to symptoms, bothering, quality of life, and well-being (Fig. 2). The prevalence of a weak urinary stream during voiding appears to be highest among all symptoms but the concern about it is the lowest among all bothering scores.[10] This explains why maximal free uroflow is related to symptom score but not to bothering, quality of life, and well-being. The frequent voiding of small volumes has a prominent role in the development of symptoms and the decrease in quality of life and well-being. Men compensate for these symptoms by decreasing their fluid intake.[15]

Surprisingly, preoperative nocturia and preoperative mean voided volume were not related to improvements of symptoms, degree of being bothered, quality of life, and well-being after transurethral resection of the prostate. Only preoperative diuria was related to the improvement of symptoms after TURP. The relations among preoperative values of $Q_{max,free}$, prostate volume, and AG number and improvements in SI, SPI, QoL, and BII were slightly better but not convincing. None of the preoperative values of the parameters was related to quality of life and symptom problem index.

Surprisingly, changes in $Q_{max,free}$, AG number, mean voided volume, nocturia, and diuria after TURP were all highly significantly related to changes in SI, SPI, QoL, and BII. Obviously, the grade of change in a parameter induced by TURP is more important for the success of the TURP than the preoperative value of that parameter. We could not use the actual postoperative values of nocturia and diuria. The scores on question 7 of the AUA SI and those on the additional question about frequency in daytime are rough approximations of the actual values. Nevertheless, improvements in these scores after TURP were significant. We assume that the association among improvements of the actual nocturia and diuria with improvements of SI, SPI, QoL, and BII were more pronounced.

The changes in parameters after 6 months presented for TURP did not appear to differ significantly from those found for contact laser prostatectomy and electrovaporization.[16]

Prostate volume, $Q_{max,free}$, and obstruction grade have

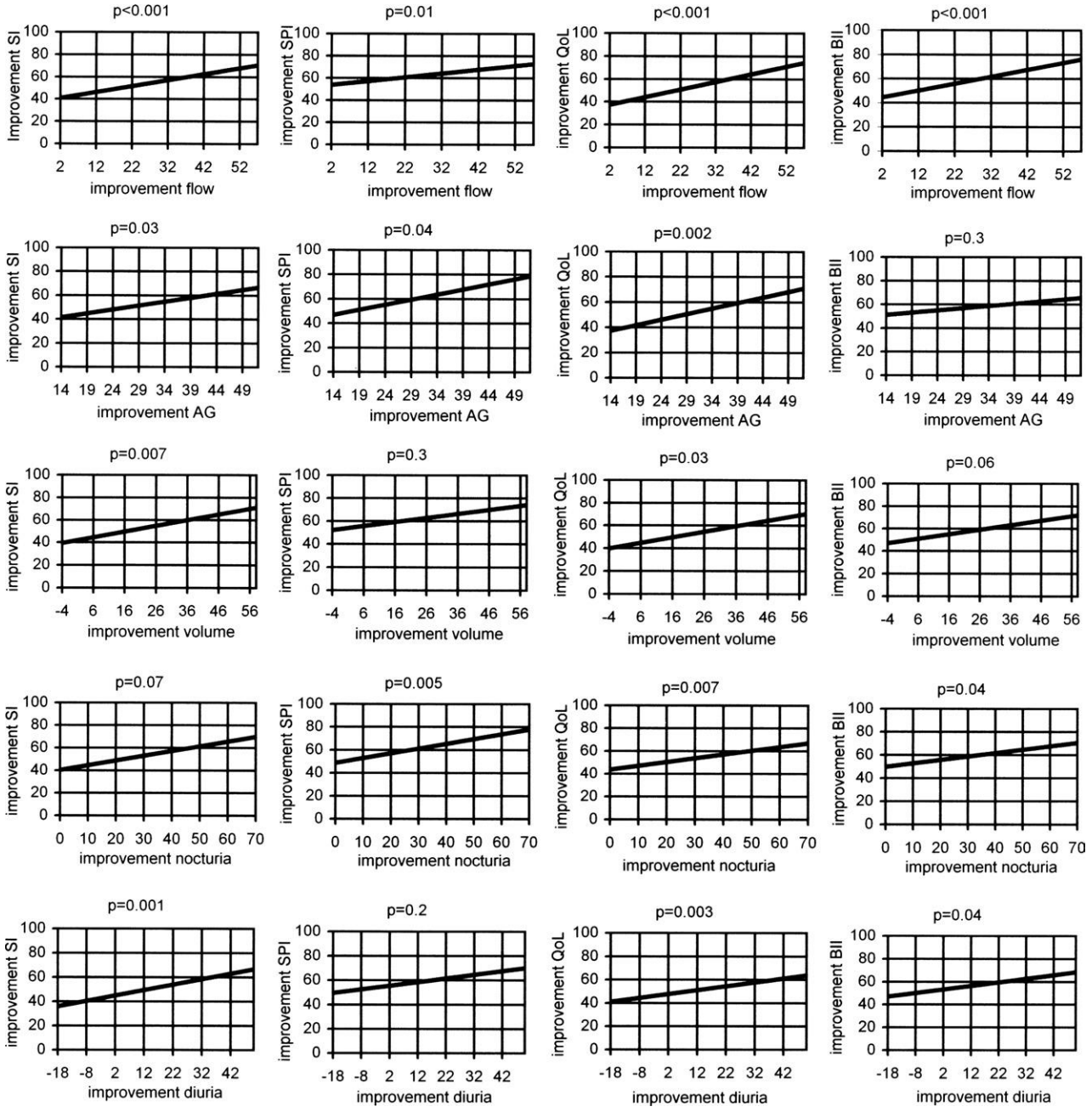

Figure 3. Improvements (%) in SI, SPI, QoL, and BII after TURP versus improvements (%) in maximal free uroflow, AG number, mean voided volume, nocturia, and diuria.

a prominent role in recommendations for treatment in men with LUTS suggestive of BPH. Voiding data, however, are still considered less important. Our results indicate that voiding data should have a prominent role in the initial evaluation of men with LUTS suggestive of BPH.

CONCLUSIONS

In our well-defined group of men, SI, SPI, QoL, and BII were only slightly related to Vprostate, $Q_{max,free}$, and grade of obstruction. In contrast, the voiding data for mean voided volume, diuria, and nocturia were highly significantly related to SI, SPI, QoL, and BII.

The predictive values for $Q_{max,free}$, Vprostate, grade of obstruction, mean voided volume, nocturia, and diuria on the outcome of TURP were disappointing. However, changes in all these parameters were highly significantly related to the improvements of SI, SPI, QoL, and BII after TURP.

Data from voiding diaries should have a prominent role in the initial evaluation of men with LUTS suggestive of BPH.

References

1. Barry MJ, Fowler FJ Jr, O'Leary MP, et al: for the Measurement Committee of the American Urological Association: The Ameri-

can Urological Association symptom index for benign prostatic hyperplasia. J Urol **148:** 1549–1557, 1992.
2. International Scientific Committee: Recommendations of the International Scientific Committee: evaluation and treatment of lower urinary tract symptoms (LUTS) in older men, in Chatelain C, Denis L, Foo KT, *et al* (Eds): *Benign Prostatic Hyperplasia: Fifth International Consultation on Benign Prostatic Hyperplasia (BPH)*. Plymouth, UK, Plymbridge Distributors, 2001, pp 519–534.
3. Boormans JL, van Venrooij GE, and Boon TA: Invasively estimated International Continence Society obstruction classification versus noninvasively assessed bladder outlet obstruction probability in treatment recommendation for LUTS suggestive of BPH. Urology **69:** 485–490, 2007.
4. Teillac P: Relief of BPO or improvement in quality of life? Eur Urology **34(Suppl 2):** 3–9, 1998.
5. Peters TJ, Donovan JL, Kay HE, *et al:* The International Continence Society "Benign Prostatic Hyperplasia" Study: the bothersomeness of urinary symptoms. J Urol **157:** 885–889, 1997.
6. Speakman MJ: Who should be treated and how? Evidence-based medicine in symptomatic BPH. Eur Urol **36(Suppl 3):** 40–51, 1999.
7. Barry MJ: Editorial comment: the International Continence Society "Benign Prostatic Hyperplasia" Study: International differences in lower urinary tract symptoms and related bother. J Urol **157:** 1300–1300, 1997.
8. Bruskewitz RC, Reda DJ, Wasson JH, *et al:* Testing to predict outcome after transurethral resection of the prostate. J Urol **157:** 1304–1308, 1997.
9. Barry MJ, Fowler FJ Jr, O'Leary MP, *et al:* Measuring disease-specific health status in men with benign prostatic hyperplasia. Med Care **33(Suppl):** AS145–AS155, 1995.
10. Eckhardt MD, van Venrooij GE, van Melick HH, *et al:* Prevalence and bothersomeness of lower urinary tract symptoms in benign prostatic hyperplasia and their impact on well-being. J Urol **166:** 563–568, 2001.
11. Abrams P, Griffiths D, Höfner K, *et al:* The urodynamic assessment of lower urinary tract symptoms, in Chatelain C, Denis L, Foo KT, *et al* (Eds): *Benign Prostatic Hyperplasia: Fifth International Consultation on Benign Prostatic Hyperplasia (BPH)*. Plymouth, UK, Plymbridge Distributors, 2001, pp 229–281.
12. Lim CS, and Abrams P: The Abrams-Griffiths nomogram. World J Urol **13:** 34–39, 1995.
13. Gisolf KW, van Venrooij GE, Eckhardt MD, *et al:* Analysis and reliability of data from 24-h frequency-volume charts in men with lower urinary tract symptoms due to benign prostatic hyperplasia. Eur Urol **38:** 45–52, 2000.
14. Van Venrooij GE, van Melick HH, Eckhardt MD, *et al:* Correlations of urodynamic changes with changes in symptoms and well-being after transurethral resection of the prostate. J Urol **168:** 605–609, 2002.
15. Van Venrooij GE, Eckhardt MD, and Boon TA: Data from frequency-volume charts versus maximum free flow rate, residual volume, and voiding cystometric estimated urethral obstruction grade and detrusor contractility grade in men with lower urinary tract symptoms suggestive of benign prostatic hyperplasia. Neurourol Urodynam **21:** 450–456, 2002.
16. Van Melick HH, van Venrooij GE, and Boon TA: Long-term follow-up after transurethral resection of the prostate, contact laser prostatectomy, and electrovaporization. Urology **62:** 1029–1034, 2003.