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Is there a correlation between prostate size and bladder-outlet obstruction?

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Summary. This retrospective study was conducted in 521 men with micturition complaints to determine the relationship between prostate size and bladder-outlet obstruction. Analysis showed a statistically significant correlation between bladder-outlet obstruction and prostate size. Urodynamic bladder-outlet obstruction was confirmed in 90% of the patients with a prostate size of more than 80 cm^3. In 32% of the patients with a prostate smaller than 40 cm^3, no urodynamic evidence of bladder-outlet obstruction was found. There was no correlation between symptom scores (Madsen and I-PSS) and the grade of bladder-outlet obstruction or prostate size. We conclude that precise determination of the prostate size and urodynamics investigations are important (complementary) parameters in the assessment of elderly men with micturition complaints.

The prostate size can be an important parameter in the investigation of patients with micturition complaints and is frequently used to decide between possible treatment modalities: transurethral prostatectomy (TURP) or suprapubic prostatectomy [1]. For many years, the gold standard for the evaluation of the size of the prostate was the urologist's fingertip. Unfortunately, the accuracy of this investigation appears to be low [2]. Nowadays the technical possibilities enable us to measure the in vivo volume of the prostate with transrectal ultrasound (TRUS) investigation, with computerized tomography (CT)-scan imaging, or with magnetic resonance imaging (MRI). Transrectal volumetry has shown a good correlation with the actual prostate size [3–5]. The most accurate and reliable method to determine the volume of the prostate appears to be the planimetric method [6, 7].

The correlation of prostate size with clinical parameters such as age, duration of symptoms, pattern of symptoms, and uroflow parameters is reported to be low [8–10]. There seems to be agreement in the observation that patients with larger prostates fare better after prostate resection [1, 11–13]. On the other hand, patients with small prostates do not need an extensive resection of prostatic tissue [14, 15]. In the majority of clinical (outcome) studies, the prostate size is estimated by rectal examination or by resected tissue weight.

The principle idea of removal of prostate tissue is to relieve outlet obstruction. However, not all men with micturition complaints treated by TURP have bladder-outlet obstruction (BOO). The introduction of advanced urodynamics investigation, which is considered to be the "gold standard" for the measurement of outlet obstruction, has shed a new light on this topic. Several authors came to the conclusion that up to one-third of the patients treated for benign prostatic hyperplasia (BPH) had no proven BOO [16–18]. On the other hand, several other investigators found that the estimated prostate size was associated inversely with urethral obstruction [19–21].

In view of the data available at the moment, an increasing number of urologists are questioning the relationship between prostate size and outlet obstruction. In this article we attempt to clarify this issue and present the results of a retrospective study conducted to investigate the correlation of prostate size with urodynamic parameters.

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Patients and methods

The results of urodynamics investigations of 521 men with lower-urinary-tract symptoms were evaluated. These results were correlated with the results of prostate size, measured by TRUS, and with the results of the (I-PSS and Madsen) symptom scores. Urodynamics investigations were performed with an 8-F transurethral lumen catheter equipped with an intravesical microtip pressure sensor for bladder pressure recording. Abdominal pressure was recorded intrarectally with an 8-F microtip sensor catheter (MTC, Dräger, Germany). Before cystometry the bladder was emptied through the lumen of the transurethral catheter. The bladder was filled with water of 20°C with a filling speed of 50 ml/min. Commercially available equipment (UD 2000; MMS, Enschede, the Netherlands) was used to record the pressure and flow data. Digitally stored data were translated to a urodynamics-analysis computer program developed at our department (UIC/BME Research Center, Department of Urology, Nijmegen, the Netherlands).

To provide an objective and precise grade of obstruction, P/Q graphs were fitted with a passive urethral resistance relation (PURR) curve at the lowest pressure part of the graph. The minimal urethral opening pressure (P_{muo}) and theoretical urethral lumen (A_{theo}) were calculated automatically on the basis of the manually adjusted PURR curves [22]. The urethral resistance factor (URA) was computed to enable the classification of patients on a continuous, one-parameter scale of obstruction [23]. Calculation of the URA was based on the positioning of a haircross on the point of maximal flow and corresponding detrusor pressure (P_{det} at Qmax). Correction for (maximal) flow artifacts was performed when necessary. We also added a nonparametric analysis of obstruction and prostate size with clinical classes according to the linearized PURR (L-PURR) P/Q nomogram [24]. For evaluation of the voiding efficiency, the voided percentage, which is the relative amount of bladder content that was expelled, was calculated.

The TRUS examinations were performed using a Kretz combison 330 ultrasound scanner with a 7.5-MHz transrectal transducer (Multiplane 3-D VRW 77AK). The prostate was imaged in the transverse plane starting at the base, and cross-section images were stored every 4 mm by retracting the probe with a fixture until the apex of the prostate was reached. After outlining of the prostate at every cross section with a pencil-follower, the volume is calculated.

For statistical analysis, we used Spearman correlation coefficients in the analysis of correlation, chi-square tests to compare proportional groups, and Student's *t*-test to test the mean differences between groups.

Results

The mean prostate size in this group of patients was 44.1 cm^3 (range, 12–170 cm^3). Figure 1 shows a histogram of the prostate sizes. The mean age of the patients was 64.5 (range, 42.7–90.7) years. The mean maximal uroflow was 7.6 ml/s (SD, 4.1 ml/s; range, 1.0–42.0 ml/s). According to the L-PURR nomogram, 140 patients (26.9%) were considered unobstructed (L-PURR grades 0 and 1), 317 patients (60.8%) had a moderate grade of outlet obstruction (L-PURR grades 2–4), and 63 (12.1%) had a severe outlet obstruction (grades 5 and 6). Figure 2 shows the bar chart of 20-cm^3 prostate-volume groups subdivided into relative numbers of patients in the various L-PURR classes.

Table 1 shows the mean cystometry parameters. The mean URA value was 37.6 cmH_2O. As value of more than 28 cmH_2O is considered to be indicative for BOO, the mean outlet obstruction in these patients was "moderate" [25]. The P_{muo} value of 32.0 cmH_2O and the A_{theo} value of 3.6 mm^2 indicate a moderate, average degree of outlet obstruction for the entire group as well. Table 2 shows the mean age and prostate size, the voided percentages, the total symptom scores of the patients, and the various L-PURR classes of BOO. One can recognize a trend toward an increase in age and prostate volume with increasing obstruction class. There appears to be no correlation between the results of the I-PSS or Madsen symptom scores and the classes of BOO. In Table 3 the age and symptom scores in 10-cm^3 classes of prostate size are listed and confirm the aforementioned conclusions. Table 4 shows the results of the pressure-flow analysis for each prostate-size class. With increasing prostate size, a decrease in maximal uroflow, A_{theo}, and voiding percentage is apparent. The outlet parameters URA and P_{muo} increase with prostate size.

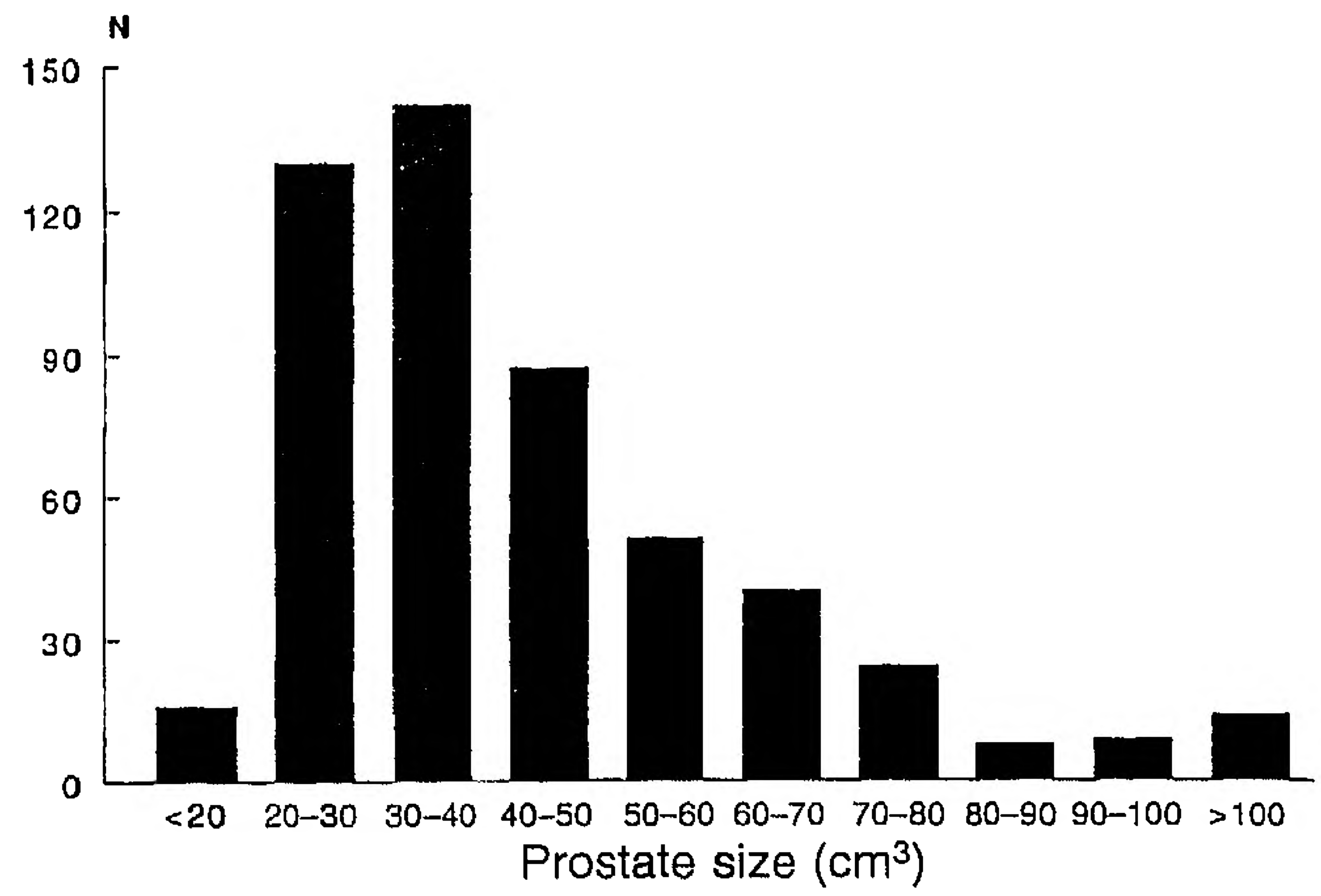

Fig. 1. Histogram of prostatic volumes (n = 521)

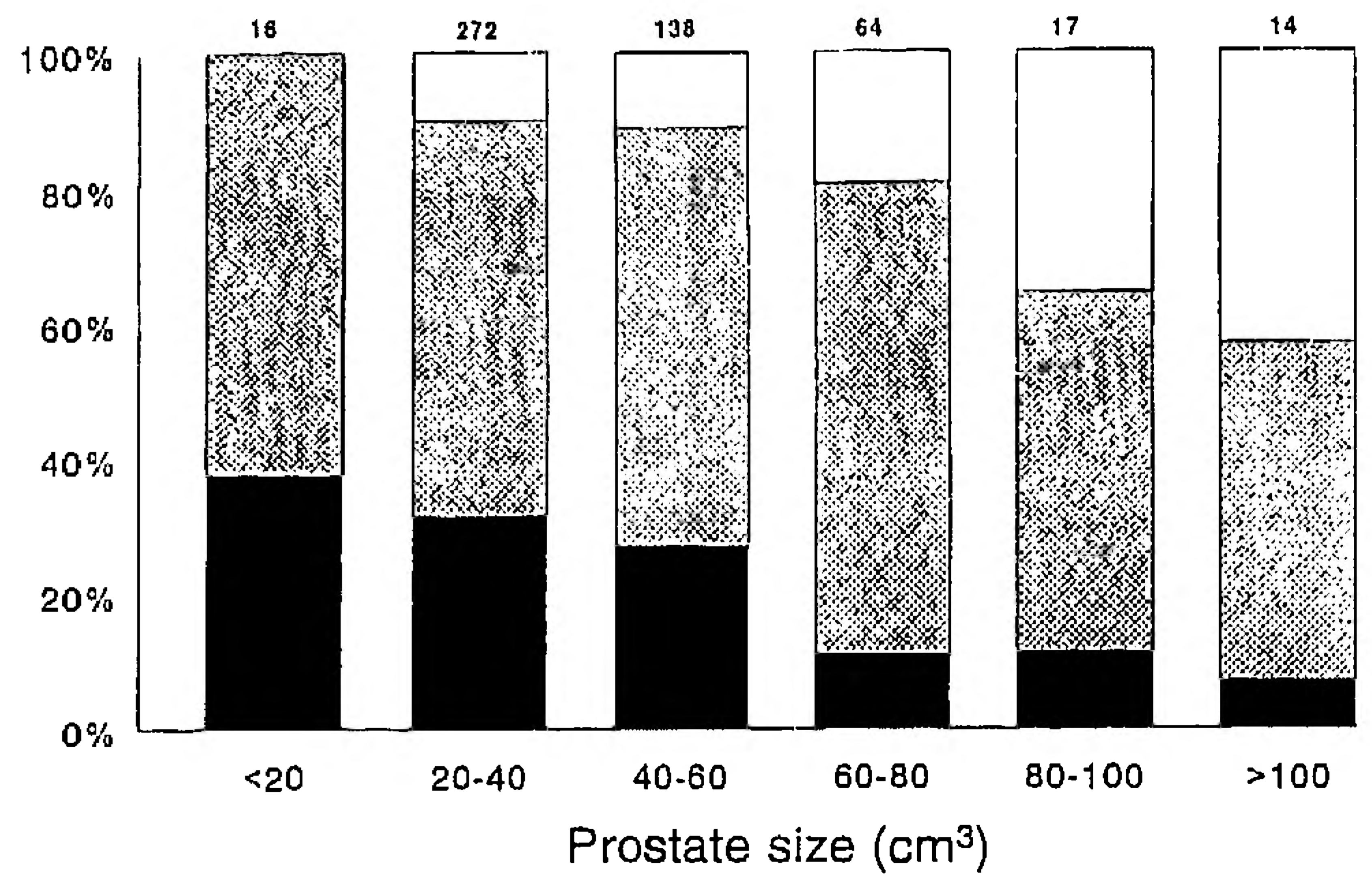

Fig. 2. Histogram of prostate, size classes (20 cm^3), and the percentage of patients in the L-PURR classes. ■ 0–1; ▩ 2–4; □ 5–6

Table 1. Urodynamic parameters of cystometry and pressure/flow analysis (n = 521)

	Mean	SD	Range
Bladder capacity (ml)	416	138	100 –951
Residual urine (ml)	65.6	93.0	0 –880
Voided percentage (%)	82	18	9 –100
Maximal flow (ml/s)	7.5	4.1	1 – 42
Mean flow (ml/s)	3.3	1.7	1 – 10.1
P_{det} at Qmax (cm H_2O)	60.6	29.1	4 –166
URA (cm H_2O)	37.6	19.1	2 –107
P_{muo} (cm H_2O)	32.0	19.0	1 –114
A_{theo} (mm^2)	3.6	2.5	0.4– 21.5

The correlations of prostate size with age (0.33), voided percentage (–0.19), Qmax (–0.20), P_{det} at Qmax (0.29), P_{muo} (0.32), A_{theo} (–0.19), and URA (0.32) were statistically significant at the $P < 0.001$ level. The correlation of prostate size with the I-PSS and Madsen symptom scores and with residual urine was not statistically significant. Neither the total Madsen score nor the total

Table 2. Age, prostate volume, symptoms, and voided percentage in relation to L-PURR classes of obstruction

	n	Age (years)	Prostate volume (cm^3)	Voided percentage (%)	Total Madsen	Total I-PSS
All	521	64.5	44.0	82.0	12.3	17.4
Obstruction class:						
0	41	63.2	34.2	87.0	12.1	17.1
1	99	63.6	38.2	86.4	11.7	16.5
2	123	63.2	38.6	86.9	12.1	17.2
3	83	65.0	43.6	81.5	11.9	17.0
4	111	65.4	52.4	78.2	12.4	18.4
5	45	66.9	57.3	73.9	12.8	16.9
6	18	65.8	53.4	61.3	15.7	22.3

Table 3. Age and mean symptom score in relation to prostate size

Prostate size (cm^3)	*n*	Age (years)	Total Madsen	Total I-PSS
All	521	64.5	12.3	17.4
< 20	16	61.9	11.2	17.9
20– 30	130	61.2	11.7	16.6
30– 40	142	63.3	12.7	18.4
40– 50	87	65.4	12.8	17.8
50– 60	51	66.6	12.2	17.3
60– 70	40	68.0	12.0	17.0
70– 80	24	69.0	13.6	17.4
80– 90	8	71.6	10.4	15.3
90–100	9	68.9	13.0	15.8
> 100	14	71.5	13.3	16.0

I-PSS score correlated with any parameter of pressure-flow analysis.

For further analysis the whole group of patients was divided into two groups: those with big prostates (> 40 cm^3, $n = 232$) and those with small prostates (< 40 cm^3, $n = 288$). This borderline was chosen because these groups showed a good (significant according to chi-square analysis) correlation with the obstructed L-PURR groups. Of the patients with a prostate size of > 40 cm^3, 79.7% had obstruction according to the L-PURR classification. According to the URA borderline value of 28 cmH_2O, 68.7% of the patients had BOO when the prostate size exceeded 40 cm^3. On the other hand, 47.9% of the patients were not obstructed according to URA when the prostate size was below 30 cm^3. When the group with a prostate size of > 40 cm^3 was compared with the group with small prostates, statistically significant differences in all parameters of pressure-flow analysis were observed. The mean Qmax recorded in the "big-prostate" group was 6.9 ml/s, whereas the "small prostates" had a Qmax of 8.1 ml/s. The mean URA value was 42.6 cmH_2O in the big prostates and 33.6 cmH_2O in the small prostates.

Discussion

It is generally believed that enlargement of the prostate results in BOO, which causes the clinical manifestations of BPH. The term BPH describes histopathologic abnormalities of the prostate gland. The prevalence of BPH is very high in men aged over 50 years, and it rises with each age group, attaining a peak of 88% in men aged over 80 years [26]. However, the term BPH is usually applied to describe a condition that can be characterized by nonhistologic criteria: the presence of symptoms of "prostatism," an enlarged prostate and outlet obstruction [27].

The majority of elderly men will eventually experience some voiding symptoms and will seek therapy. For decades, TURP has been the first-choice treatment, and it aims at reducing infravesical obstruction. Although an enlargement of the prostate, residual urine, and a decreased urine flow may be present, a significant proportion of these

Table 4. Cystometry parameters of different prostate-size groups

Prostate size (cm^3)	*n*	Qmax (ml/s)	P_{det}Qmax (cm H_2O)	URA (cm H_2O)	P_{muo} (cm H_2O)	A_{theo} (mm^2)	Voided (%)
< 20	16	7.8	51.6	33.8	29.3	3.62	73.6
20– 30	130	8.4	53.9	33.1	27.3	4.02	87.1
30– 40	142	7.9	55.9	34.0	29.0	3.92	84.9
40– 50	87	7.7	58.9	36.5	30.3	3.88	79.0
50– 60	51	6.9	61.4	38.2	33.7	3.16	80.3
60– 70	40	6.7	74.5	46.0	38.0	2.73	77.5
70– 80	24	5.9	82.2	53.3	45.1	2.35	77.4
80– 90	8	5.4	96.7	58.0	64.2	2.35	73.3
90–100	9	6.4	75.4	51.3	38.2	2.67	66.4
>100	14	5.4	82.5	54.5	53.5	2.57	76.0

patients appear not to be obstructed when urodynamics investigation is performed [16–18]. The concept of dividing BPH into obstructive and nonobstructive disease may have far-reaching consequences for the handling of individual patients. This is one of the reasons why TURP is now being questioned as the "gold standard" of treatment for every patient with BPH. Moreover, a host of alternative treatments have emerged in the last few years [28–35].

In the present study we observed a distinct correlation of ultrasound-determined prostate size with age and BOO. BOO was graded with pressure-flow analysis, considered the gold standard for examination of the condition of bladder and outlet function. Although never analyzed in this way, the results did not come as a surprise. Patients with larger prostates have a higher chance of being obstructed. Consequently, these patients may improve significantly following deobstructive therapy, and this study can thus be considered as a confirmation of the clinical experience of urologists that deobstruction is more successful in patients with larger prostates [11–13]. Patients with a smaller prostate have a lesser chance of being obstructed and must therefore be treated less invasively.

In all prostate-size groups there was a considerable proportion of urodynamically unobstructed patients: 26.9% of all patients analyzed, 32% of the patients with a prostate size of < 40 cm^3, 30% of those whose prostate measured between 40 and 60 cm^3, and 10% of those whose prostate size was > 60 cm^3. The high proportion of unobstructed patients is also reported by several other authors [16–18].

From this study we have learned that there is a statistically significant correlation of prostate size with outlet-obstruction parameters but that this correlation is poor. Prior to treatment, besides the prostate size, one should be informed about the presence and grade of BOO. Moreover, it should be stressed that commonly used prostate-symptom scores (I-PSS, Madsen) do not correlate with obstruction or with prostate size.

In view of the results of this study, it is indeed important that one be aware of the prostate size. The correlation of prostate size with BOO is superior to the correlation of symptoms with BOO. For evaluation of the function of the lower urinary tract, the urodynamics evaluation remains mandatory, especially in patients with relatively small prostates.

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