British Journal of Urology (1995), **76**, 604–610

Urodynamic assessment in the laser treatment of benign prostatic enlargement

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Objective To determine if bladder outlet obstruction can be adequately relieved after laser prostatectomy.

Patients and methods Since November 1992, a total of 105 patients underwent laser treatment of the prostate because of complaints related to benign prostatic enlargement (BPE). To date, urodynamic data from a study of pressure flow analysis are available for 79 patients both at baseline and at 6 months after treatment. Patients were evaluated using changes in symptoms (IPSS symptom score), peak flow rate (Q_{max}), post-voiding residual volume (PVR), detrusor pressure at maximum flow (P_{det} at Q_{max}), and the linear passive urethral resistance relation (LPURR). Moreover, patients with minimal bladder outlet obstruction were compared to patients with severe bladder outlet obstruction.

Results There was a significant improvement in mean IPSS score from 21.3 at baseline to 5.3 at the 6-month follow-up. The Q_{max} improved from 7.9 mL/s to 17.8 mL/s, and the PVR decreased from 91.6 mL to 15.6 mL. At baseline, >80% of the patients were considered obstructed according to the analysis of pressure flow, whereas 6 months after laser treatment, only 5% of the patients were still considered obstructed. A comparison of the outcome between minimally obstructed patients and severely obstructed patients showed comparable improvements.

Conclusion Laser therapy of the prostate was, according to urodynamic parameters, capable of relieving outlet obstruction and minimally obstructed patients also showed a significant relief of outlet obstruction.

Keywords Benign prostatic enlargement, urodynamics, pressure flow analysis, bladder outlet obstruction, laser

Introduction

Benign prostatic enlargement (BPE) impacts significantly on the quality of life of the ageing man, primarily by producing bothersome urinary symptoms. The symptoms of BPE are caused by a complex interaction between the prostate and bladder [1] which gives rise to both filling and voiding symptoms. As the prostate enlarges, urethral resistance may increase and consequently the ability of the bladder to generate pressure increases to maintain flow. An impaired bladder function may also present with symptoms similar to BPE. Presently, the decision to treat rather than observe a given patient is based largely on the extent to which his symptoms interfere with daily activities.

Open or transurethral prostatectomy (TURP) has been the 'gold standard' for many years for the treatment of BPE. In the last decade, new surgical and non-surgical alternatives have become available to the urologist, including drugs, prostatic stents, balloon dilatation, high intensity focused ultrasound (HIFU), transurethral needle ablation (TUNA) and thermotherapy (TUMT) [2–8]. Until now, none of these alternatives has attained the subjective and objective results comparable to those obtained after surgical treatment of the prostate.

Recently, laser treatment of the prostate became available for BPE, the advantages of which are a minimal hospital stay, minimal bleeding, no fluid absorption, rapidity of treatment, technical simplicity of performance and the chance to preserve antegrade ejaculation [9–12]. Although current studies have evaluated few patients over short follow-up periods, the results after laser treatment are comparable with those achieved after electroresection.

The objective success of treatment is usually defined by an improvement in uroflowmetry variables such as urinary peak flow rate (Q_{max}) and residual urine volume (PVR). In recent years, urodynamic investigation with pressure-flow analysis (PQ) has also played an increasingly important role in measuring objectively the results of different therapies [13].

To replace TURP by laser prostatectomy, the latter should also be able to relieve outlet obstruction. Although symptom scores, uroflowmetry studies, PVR and prostate size are associated with obstructive voiding, there is no clear correlation with the grade of obstruction.

Therefore, these parameters cannot determine objectively whether relief of obstruction is achieved [14–16]. To quantify the grade of bladder outlet obstruction, urodynamic investigation is considered the 'gold standard' [17].

Patients and methods

Laser treatment of the patients was performed with the Urolase (Bard) or Ultraline (Heraeus) side-firing fibres, and the technique used has been described more extensively elsewhere [18]. All patients underwent a screening programme comprising a history (including the IPSS symptom score), a physical examination (including digital rectal examination), biochemistry (including prostate-specific antigen determination), urine culture and sediment, and transrectal and renal ultrasonography. Objective voiding parameters were evaluated by estimating free urinary flow rate, PVR and urodynamic investigations with *PQ* analysis. The inclusion and exclusion criteria are listed in Table 1.

The urodynamic investigations were performed with an 8 F transurethral lumen catheter with an intravesical microtip pressure sensor (MTC, Dräger, Germany). The pressure and flow data were recorded digitally with commercially available equipment (UD2000, MMS, Enschede, the Netherlands) and transferred to a urodynamic analysis program, developed at the UIC/BME Research Centre, Department of Urology, Nijmegen, the Netherlands. To obtain useful information from pressure flow curves, the detrusor pressure must be related to the corresponding flow (Figs 1 and 2) and these plots were evaluated by a visual inspection of the shape of these

Table 1 Inclusion and exclusion criteria for laser treatment

Inclusion	*Exclusion*
Prostate volume >30 cm^3	Prostate carcinoma
Age >50 years	Bacterial prostatitis
Duration of symptoms >3 months	Urethral stricture
IPSS score >12	Neurogenic bladder dysfunction
Peak flow rate <15 mL/s	Urinary tract infection
	Use of drugs influencing bladder function
	History of TURP or TUIP
	Diabetes mellitus
	Bladder residual urine >350 mL

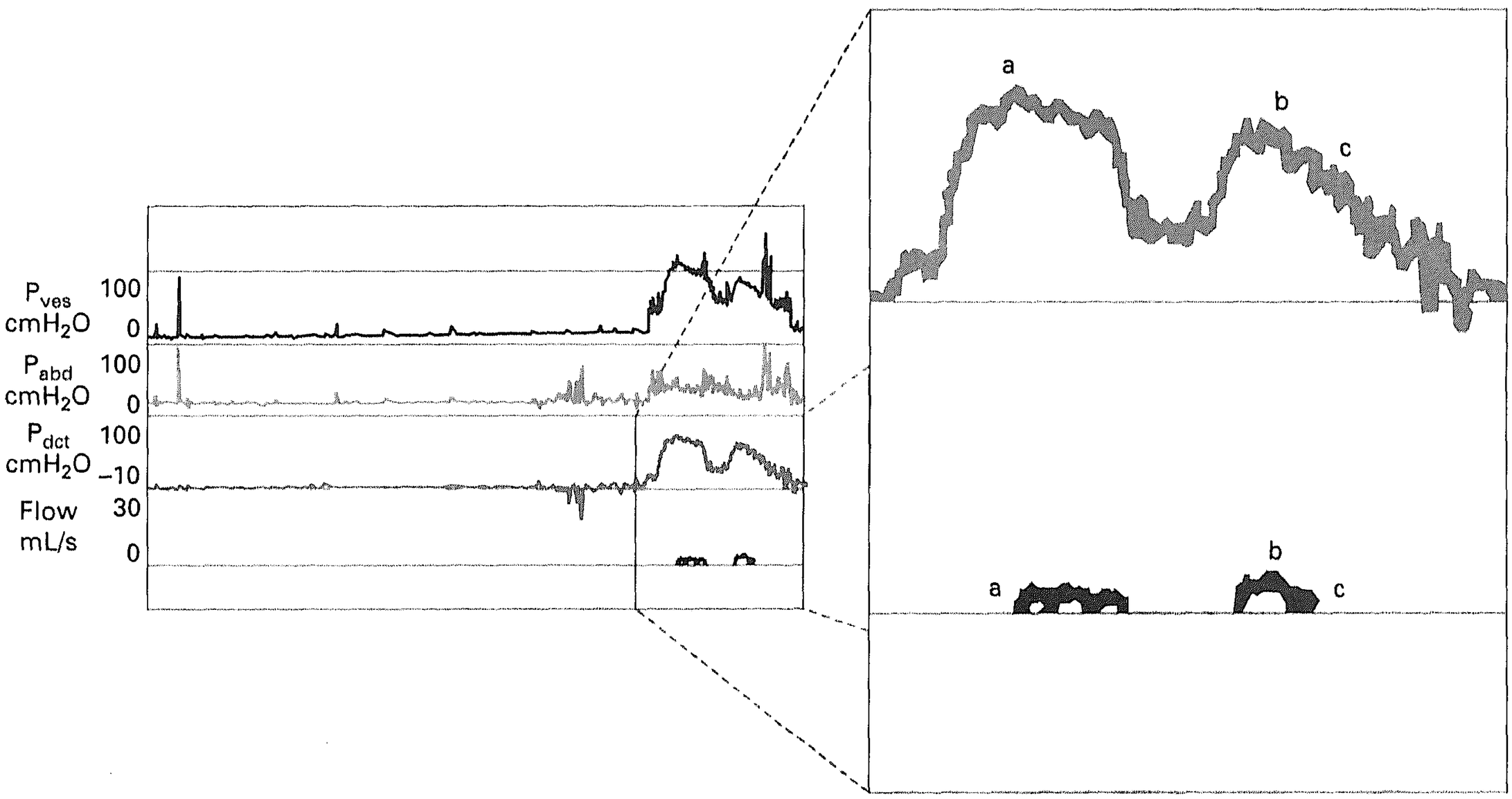

Fig. 1. Urodynamic registration (P_{ves}, vesical pressure; P_{abd}, Intra-abdominal pressure; P_{det}, detrusor pressure; flow, uroflowmetry) with magnification of the voiding phase: a, initiation of voiding with corresponding detrusor pressure; b, maximum uroflow with corresponding detrusor pressure; c, end of voiding with corresponding detrusor pressure.

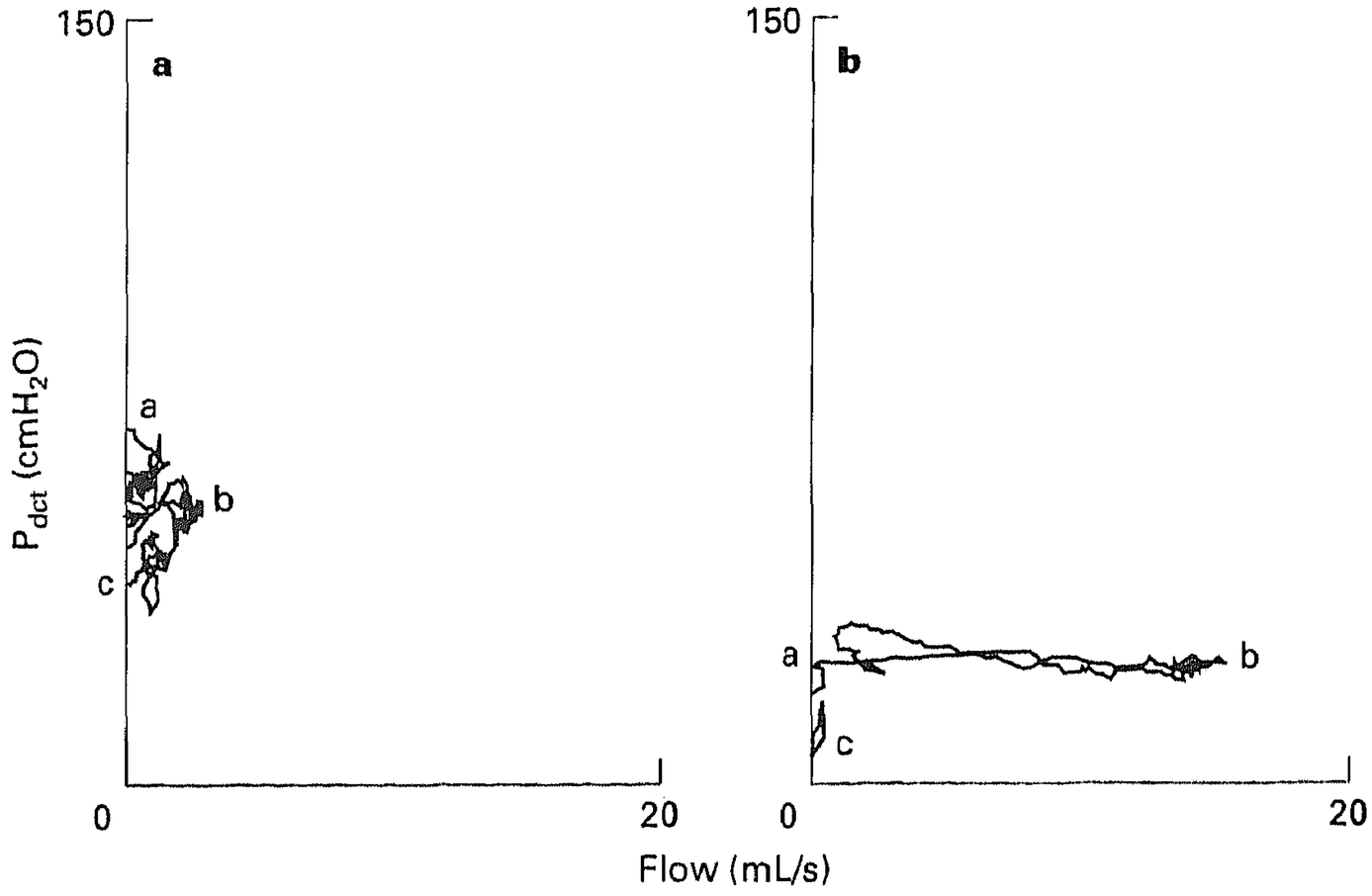

Fig. 2. Pressure/flow relation (in the patient of Fig. 1) before (**a**) and after (**b**) treatment. (P_{det}, detrusor pressure; flow, uroflowmetry): a, initiation of voiding; b, maximum uroflow; c, end of voiding.

curves. In cases of high pressure and low flow, the patient was considered obstructed (Fig. 2a). When there was a low pressure with a high flow, the patient was considered unobstructed (Fig. 2b). However, to quantify the grade of obstruction, classification is mandatory and the simplest way is to superimpose the plot on the Abrams-Griffiths nomogram [17]. The point of P_{det} at Q_{max} of this plot may fall in one of the three zones: obstructed, unobstructed or equivocal (Fig. 3).

More advanced methods allows obstruction to be further subdivided [13,19]. Schäfer presented the concept of linear passive urethral resistance relation (LPURR), connecting minimal opening pressure with pressure at maximum flow. Derived from this, for daily clinical practice, an obstruction classification was introduced (Fig. 4) [13]. Precise fitting of the *PQ* curves, with a correction for pressure or flow artefacts, was performed manually. The urodynamic investigation was repeated 26 weeks after treatment.

Since November 1992, 105 patients (mean age 64 years, range 51–80) were treated because of complaints related to BPE using a laser delivered by a side-firing fibre. Urodynamic data for 79 patients were available for analysis, the missing 26 patients having either refused a second urodynamic investigation, or had not yet been evaluated at the 6-month follow-up, or were impossible to catheterize (three patients).

Results

The mean IPSS symptom score improved from 21.3 (5.7) at baseline to 5.3 (4.0) 6 months after laser treatment, with a mean individual improvement of 16.0 (7.0; range 0–30). There was an increase in mean Q_{max} from 7.9

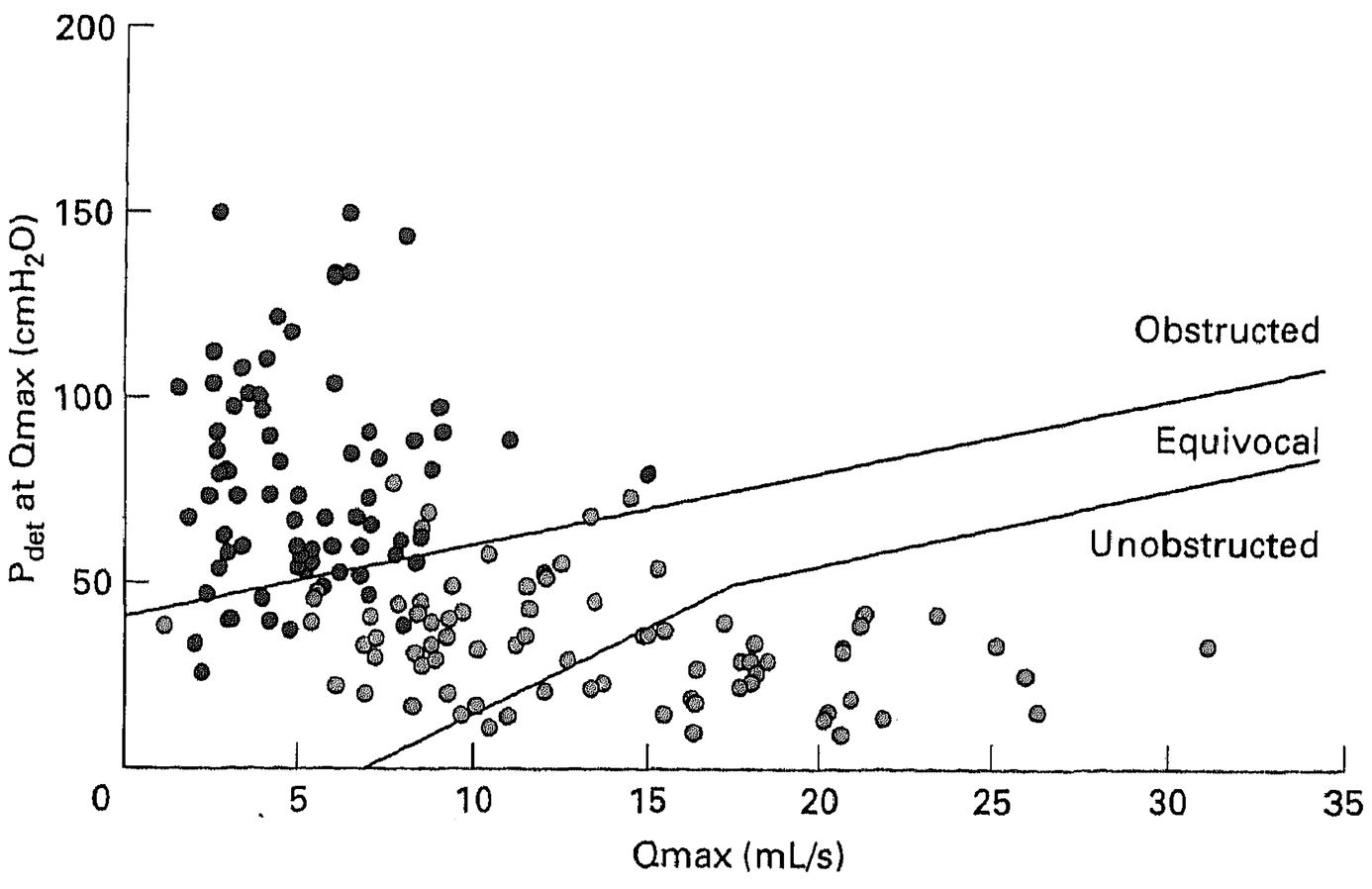

Fig. 3. Maximal pressure at maximal flow (P_{det} at Q_{max}) at baseline (dark green) and 6 months (light green) after laser treatment presented in the Abrams-Griffiths nomogram.

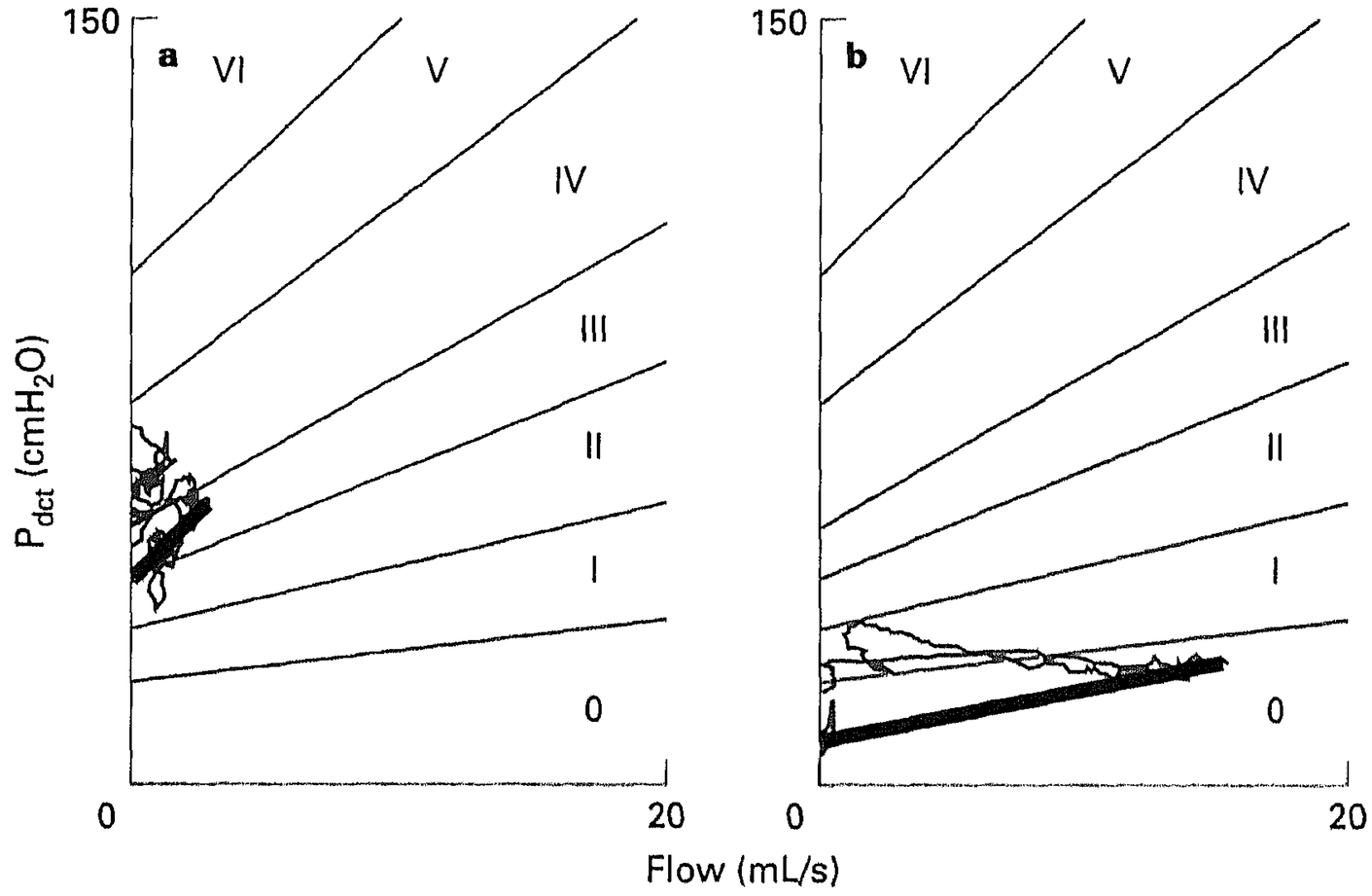

Fig. 4. Pressure/flow relation (in the patient of Fig. 1) before (**a**) and after (**b**) treatment. (P_{det}, detrusor pressure; flow, uroflowmetry) and the LPURR curve: 0–II, unobstructed; III/IV, moderately obstructed; V/VI, severely obstructed.

mL/s (3.0) before treatment to 17.8 mL/s (6.2) after treatment, with an individual improvement of 9.9 mL/s (6.6, range 3.1–28.1). The mean PVR changed accordingly from 91.6 mL (88.8) to 15.6 mL (36.6) 6 months after laser prostatectomy, with a mean individual improvement of 76.1 mL (86.3 mL, range 135–350). These data indicate that overall there was a change from urodynamically obstructed flow before treatment to urodynamically unobstructed flow after laser treatment. Indeed, the changes in the urodynamic variables of the *PQ* analysis also showed a significant improvement (Table 2). Using the Abrams-Griffiths nomogram of obstruction, the baseline P_{det} at Q_{max} of 66 patients (84%) was considered obstructed, whereas 13 patients (16%) fell into the equivocal zone. After treatment, only five patients (6%) were still considered obstructed, 37 patients (47%) fell into the equivocal zone and 37 patients (47%) were considered unobstructed (Fig. 3). There was a similar improvement in the LPURR parameter, where at baseline, 65 patients (82%) were considered obstructed (LPURR $\geqslant 3$) and 14 patients (18%) did not meet the criteria for urodynamic obstruction.

Table 2 Changes in urodynamic parameters of the PQ analysis of 79 patients

Obstruction parameter	*Before*		*After*	
	Number	*%*	*Number*	*%*
P_{det} at Q_{max}				
Obstructed	66	84	5	6
Equivocal	13	16	37	47
Unobstructed	0	0	37	47
LPURR				
>3	46	58	1	1
$=3$	19	24	3	4
<3	14	18	75	95

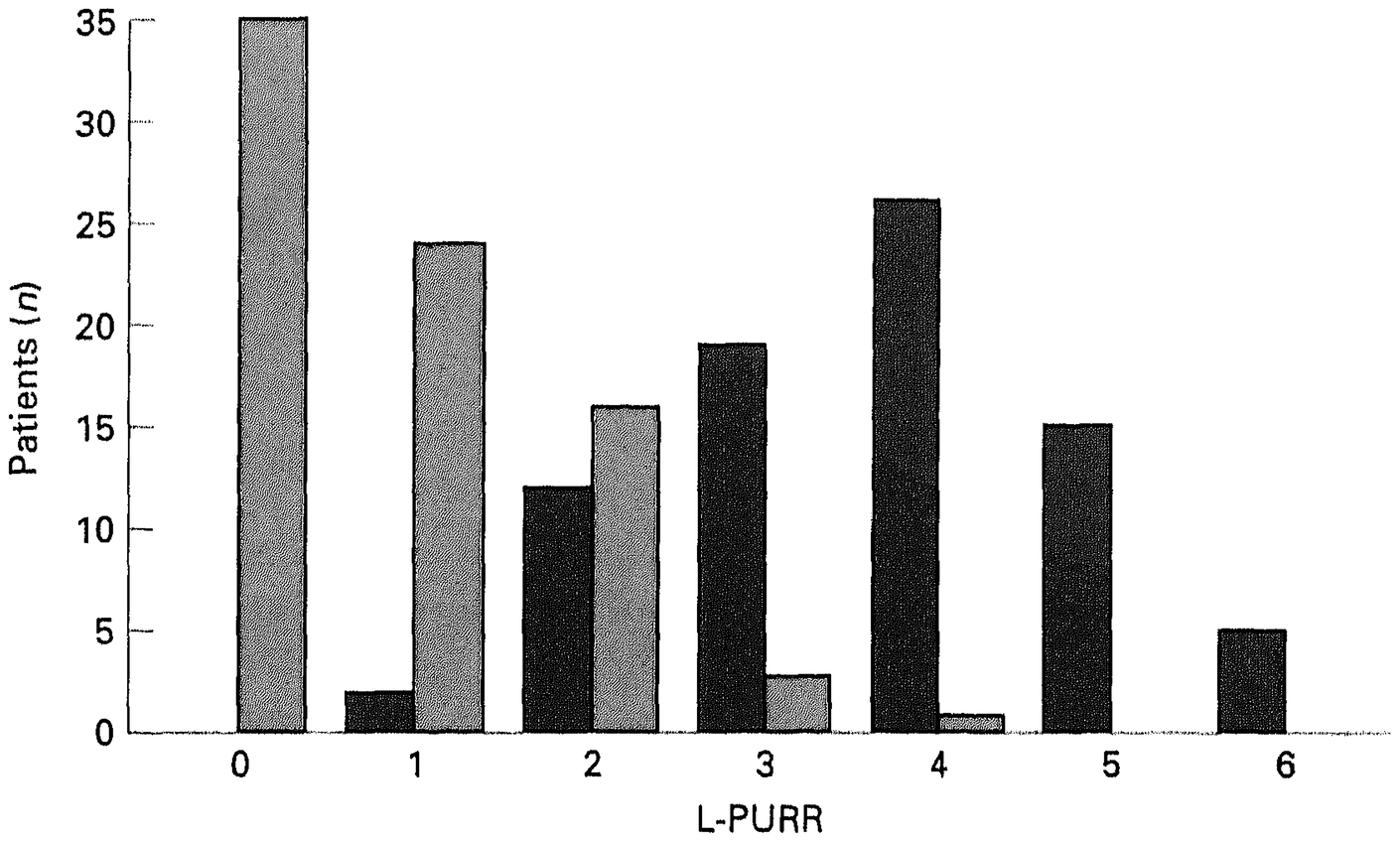

Fig. 5. Values of LPURR before (dark green) and after (light green) laser treatment versus the number of patients in each group.

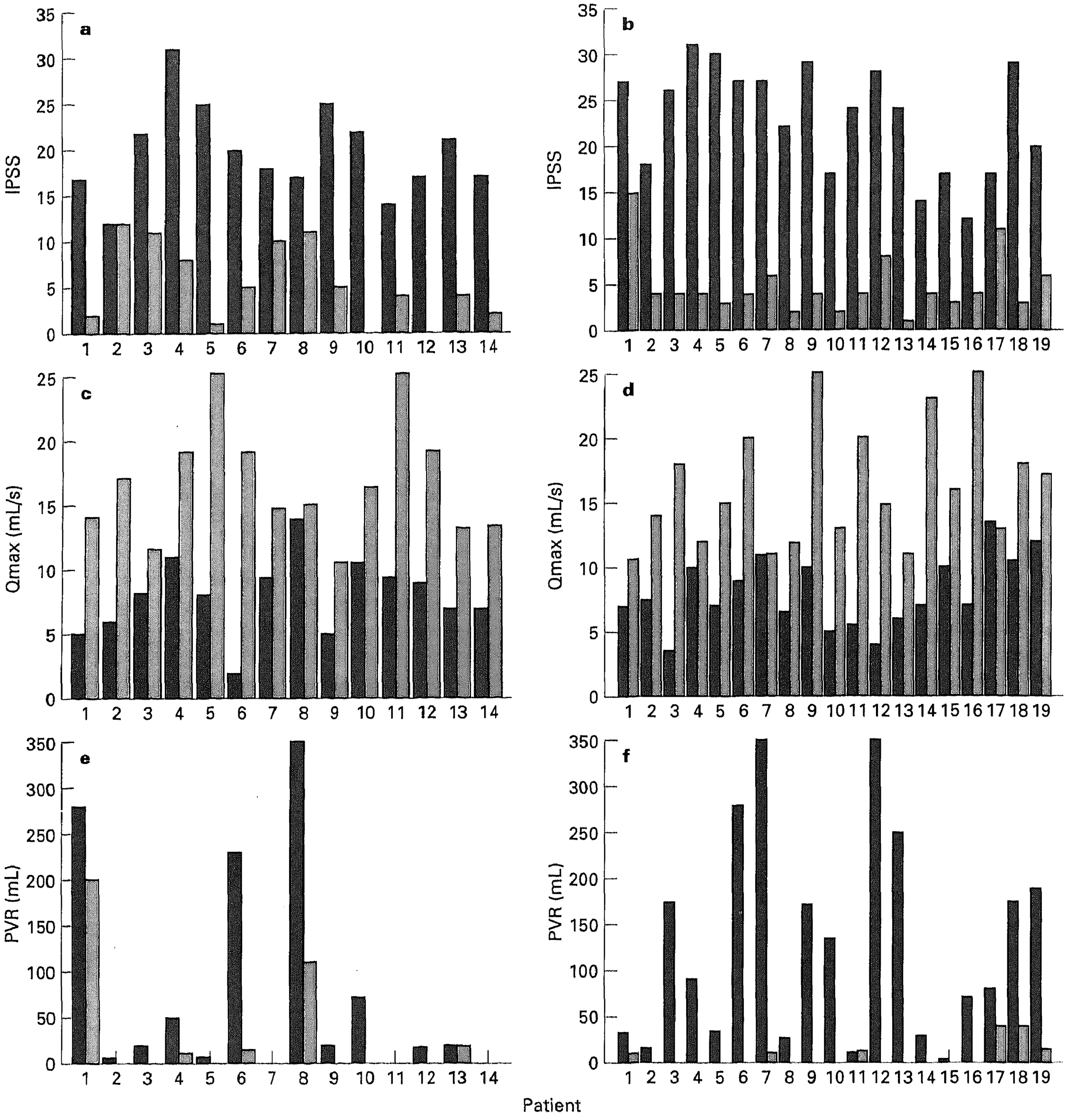

Fig. 6. Individual improvement in IPSS scores (a, minimally obstructed + b, severely obstructed), Q_{max} at free flow (c, minimally obstructed + d, severely obstructed) and PVR (e, minimally obstructed + f, severely obstructed) in 14 minimally obstructive patients and 19 severely obstructed patients. Dark green, week 0 for IPSS, Q_{max} and PVR. Light green, week 26 for IPSS, Q_{max} and PVR.

After laser treatment, only four patients (5%) were considered obstructed, but the majority of patients (75, 95%) were no longer obstructed (Fig. 5). Although a few patients were still obstructed after treatment, all patients showed a decrease in bladder outlet obstruction variables. Analysis of the two side-fire fibres showed no statistical difference in subjective and objective parameters at baseline or at the 6-month follow-up.

Discussion

Before acceptance, the efficacy of alternative therapies for the treatment of BPE has to be proven and be comparable with the 'gold standard' of TURP. Furthermore, the most effective therapy must be selected for each individual patient. Most alternative therapies show urodynamic changes which are smaller than those

after TURP [20,21]. Moreover, some treatments appear not to change outlet obstruction, but to change the pressure-flow relationship in a different way [22]. For these reasons, the disease in each patient must be classified objectively. The only method to evaluate voiding disturbance objectively is by the urodynamic registration of pressure and flow during voiding and its analysis according to well-defined algorithms [23,24]. Various methods have been proposed for the clinical application of the *PQ* analysis [13,24,25].

In cases of bladder outlet obstruction, elevated detrusor pressures may be achieved by compensatory hypertrophy of the smooth muscle within the bladder wall. Although this adaptive mechanism maintains a relatively normal flow during the initial phases of the disease, the detrusor smooth muscle does not function entirely normally. As prostatic growth continues to increase the urethral resistance, or as the bladder becomes less able to compensate, urinary flow decreases and bladder emptying is impaired. Moreover, many of the symptoms of BPE may be aggravated by age-related abnormalities in bladder structure and function, which occur independently of outlet obstruction [25]. Ageing of the bladder wall has been studied little, but probably contributes to the symptom complex commonly associated with prostatic enlargement. Lepor and Machi have shown that age-matched women have voiding symptoms of a similar nature and severity to their male counterparts [26].

Analysis of the present data shows that in most patients laser prostatectomy was capable of producing impressive and significant objective and subjective improvements, not only in commonly used variables like symptom scores and free-flow indices, but also in variables derived from *PQ* analysis in the advanced urodynamic investigation [27]. The results are largely comparable to those seen after TURP [28,29]. Literature on the changes in pressure-flow study variables after TURP are sparse. However, when compared to the available data, the changes after laser prostatectomy were very similar [27,30,31]. Laser treatment also has its individual treatment failures. Although all patients showed an improvement in symptom scores, in a few patients there was a decrease in Q_{max} or increase in PVR. Cystoscopy in these patients showed a good cavity in both lateral lobes, but a large residual middle lobe, imposing and obstructive, was seen. In general, evaluation 6 months after laser treatment showed a significant improvement of the *PQ* values in conjunction with a significant symptomatic improvement (IPSS score). Several papers have reported that operative results are superior in patients with infravesical obstruction [29,30]. The risk of attaining a less than satisfactory outcome from TURP is increased threefold in the unobstructed patients, yet 75–80% do well. The question is whether this alone is reason enough for ascertaining the presence of an obstruction pre-operatively by pressure-flow studies. However, the question can be posed another way; if 25–30% of patients seeking medical attention for BPE are indeed unobstructed, is there any reason to operate on them [30]? The analysis of outcome in the present study in 14 minimally obstructed patients (LPURR <3) showed a comparable improvement in both symptom scores and voiding parameters, comparable to the 19 severely obstructed patients (LPURR $\geqslant 5$) (Fig. 6). In view of the many available treatment modalities other than surgery, one should consider that these (minimally invasive) alternative treatments may also be applicable to this group of patients. Currently, there is no agreement on the place of urodynamic studies in the evaluation of patients with BPE, although most urologists agree that the main feature of the enlarging prostate is infravesical obstruction. As the results of surgery for BPE are generally favourable, there has been little enthusiasm for the use of resource-consuming investigations. Presently, most methods used for diagnosing infravesical obstruction are indirect and imprecise. Therefore, if an objective assessment of obstruction is desirable, the obstruction itself should be studied using urodynamic investigations with *PQ* analysis. Because simple methods are available for practical use to grade outlet obstruction, this is no reason for omitting this investigation.

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