# Urodynamic findings before and after noninvasive management of bladder calculi

F. MILLÁN-RODRÍGUEZ, C. ERRANDO-SMET, F. ROUSAUD-BARÓN, F. IZQUIERDO-LATORRE*, A. ROUSAUD-BARÓN and H. VILLAVICENCIO-MAVRICH

*Departments of Urology and †Radiology, Fundación Puigvert, Barcelona, Spain*

Accepted for publication 25 February 2004

## OBJECTIVES

To determine the most frequent urodynamic observations associated with bladder calculi, and to assess whether the presence of calculi alters these observations.

## PATIENTS AND METHODS

Fifty patients with bladder stones were included in a prospective study in which two urodynamic tests were used, one at inclusion and another once the patient was stone-free after treatment by noninvasive methods (mainly extracorporeal shockwave lithotripsy).

## RESULTS

The results from the urodynamic evaluation with the stone in the bladder were: bladder outlet obstruction in 51%, detrusor overactivity in 68%, detrusor under-activity in 10%, and a normal study in 18%. There were no significant differences between the urodynamic study before or after treatment in maximum flow rate and postvoid residual volume, detrusor overactivity and detrusor pressure at maximum flow.

## CONCLUSIONS

Conversely to what has been accepted for years, bladder calculi are not always associated with bladder outlet obstruction and the urodynamic results are not influenced by the presence of bladder stones during the urodynamic testing.

## KEYWORDS

bladder calculi, outlet obstruction, uroflowmetry, urodynamic study, BPH, ESWL

## INTRODUCTION

Bladder calculi account for 5% of the urinary calculi in the Western world and the proposed risk factors include BOO, neurogenic bladder, chronic bacteriuria (urea-splitting organisms), foreign bodies, bladder diverticula, renal transplant, augmented bladder and upper tract stones [1,2]. However, it is widely accepted that bladder calculi are often associated with BOO [1,2]; e.g. in the guidelines for BPH of the European Association of Urology the presence of stones in the bladder is a stated indication for BOO, as it suggests an abnormality in the voiding mechanism, and is usually preceded by the presence of residual urine or recurrent UTIs [3,4]. For this reason the presence of bladder calculi is a strong indication for the surgical management of BPH [3]. Although these theories are well accepted and still valid, there are several studies that analysed the relationship of the urodynamic evaluation in BPH with clinical findings [5–8]. However, there are no specific studies that have evaluated patients with bladder calculi and the association with BOO, and which urodynamic observations are associated with the presence of bladder calculi.

Thus we analysed initially which were the most frequent urodynamic features (including BOO) associated with bladder calculi, and second to what extent the presence of stones affected the reliability of the urodynamic results supporting these conditions. The design of this study implies two major problems; first, it is necessary to assess the patients twice (with and with no stones) because the potential influence of the stone on bladder activity during the filling and voiding phase is unknown. However, the treatment of bladder calculi should be minimally invasive as possible and not be associated with a treatment for BOO, because this would modify the results of the stone-free urodynamic study. Thus noninvasive management of bladder calculi was used, i.e. ESWL, with no treatment of the BOO, as proposed in former studies [9–11].

## PATIENTS AND METHODS

Fifty men diagnosed with bladder calculi in our hospital between January 2002 and December 2002 were consecutively included in a prospective study if they satisfied the inclusion and exclusion criteria. Inclusion: Presence of one or more stones in the bladder; age 18–75 years; the stones must not have been previously treated. Exclusion: neurogenic bladder; a history of chronic bacteriuria by urea-splitting organisms; foreign bodies in the bladder; bladder diverticula; transplant; augmentation of the bladder. The following were not considered exclusion criteria but were analysed: previous surgery of the prostate or the urethra, previous pharmacological treatment for BPH and previous history of lithiasis. The clinical symptoms, including any recent colic pain, were also recorded.

At the inclusion visit the patients were assessed using: simple radiology and ultrasonography to determine the number, size and opacity of the stones; a measurement of residual urine volume (PVR), volume of the prostate and PSA; urine analysis; the IPSS [12]; and two uroflow measurements with PVR and a pressure-flow study to assess whether the patient had BOO. Immediately after these measurements the patients were divided into two treatment groups according to the size of their stone(s); those with stones of <4 cm in diameter were treated by ESWL and with >4 cm were managed by endoscopic or open surgery. Regardless of the presence of BOO no treatment was given for BPH. If the bladder calculi were radiolucent an alkaline treatment was given. The patients were assessed again 3 weeks after treating the stone, using simple radiology and ultrasonography to evaluate the effectiveness of the treatment. If the ESWL was ineffective two more sessions were allowed. A month after the bladder was rendered stone-free the patients were assessed with a crystallographic study of the stone, a complete metabolic study, the IPSS and two uroflow measurements with a pressure-flow study. Later, pharmacological BPH therapy (finasteride or terazosin) was given according to the IPSS and the urodynamic findings, and if despite this therapy there was no clinical improvement TURP was proposed. If there was significant clinical and urodynamic detrusor overactivity oxybutynin was administered.

The urodynamic evaluation consisted of measuring the uroflow (twice), PVR and water cystometry (at 50 mL/min infusion rate) with pressure-flow measurement through an 8 F double-lumen transurethral catheter. The methods definitions and units conform to the standards recommended by the International Continence Society except where specifically noted [13]. The degree of obstruction was determined by using the International Continence Society obstruction nomogram [13] and the detrusor contraction evaluated using the Shafer nomogram [14]. During the first and the second urodynamic studies no patients received any anticholinergic or anti-BPH medication.

The main variables were the maximum flow rate ($Q_{max}$), the voided volume and the PVR before and after treatment, and the urodynamic findings in both pressure-flow studies: (BOO, presence of detrusor over- or under-activity). The mean differences between $Q_{max}$, voided volume and PVR before and after treatment were evaluated using a paired Student's *t*-test, and proportions of the urodynamic findings between the urodynamic studies using the McNemar test. The chi-square test with its respective relative risks was used to verify whether there were different urodynamic findings as a function of stone size (> or <4 cm). The analyses were two-sided with $P < 0.05$ taken to indicate significance, and values are shown as the mean (95% CI).

*TABLE 1 The main characteristics of the patients*

| Characteristic | Mean % (95% CI) |
|---|---|
| A history of lithiasis | 74 (60–85) |
| Clinical symptoms: | |
| Incidental finding | 44 (30–59) |
| Voiding symptoms | 10 (3–22) |
| Filling symptoms | 36 (23–51) |
| Colic pain | 2 (0.5–11) |
| Haematuria | 8 (2.2–19) |
| Previous lower urinary tract surgery | 10 (3.3–22) |
| Previous BPH pharmacological treatment | 18 (8.5–31) |
| Synchronous stones in upper urinary tract | 34 (21–49) |
| Mean area of the bladder stones, $cm^2$ | 5.41 (3.34–7.49) |
| Mean prostatic volume, mL | 64 (54–74) |

*TABLE 2 Urodynamic and uroflowmetry findings before and after treatment*

| Mean (95% CI) | Before | After | P |
|---|---|---|---|
| **Urodynamic** | | | |
| Presence of: | | | |
| BOO | 51 (37–66) | 45 (29–60) | 0.375* |
| detrusor overactivity | 68 (53–80) | 66 (48–80) | 0.344* |
| detrusor hypocontractility | 10 (5–24) | 10 (3–25) | 1* |
| Normal | 18 (9–31) | 23 (11–40) | 0.344* |
| Mean first-desire volume, mL | 146 (120–171) | 136 (109–162) | 0.843† |
| Mean compliance, $cmH_2O$ | 45 (27–65) | 53 (15–90) | 0.471† |
| **Uroflowmetry** | | | |
| $Q_{max}$, mL/s | 11 (9.6–12.5) | 11.6 (10.4–12.8) | 0.486† |
| Voided volume, mL | 246 (209–284) | 251 (216–286) | 0.272† |
| PVR | 93 (68–117) | 97 (56–138) | 0.792† |

*No values significant by *McNemar test, †paired Student's* t*-test.*

## RESULTS

Fifty patients (mean age 65 years, 61–69) were assessed; their main characteristics are shown in Table 1. Most of them (74%) had a history of lithiasis but only 2% were diagnosed after colicky renal pain. However, 10% of the patients had a history of lower urinary tract surgery (transurethral prostatic) and 18% had received pharmacological treatment for their BPH (α-blockers 14% and finasteride 4%); 34% of the patients also had lithiasis in the rest of the urinary tract, particularly in the renal calyx. The mean area of the bladder stones was 5.41 $cm^2$, the mean prostatic volume 64 mL and the mean PSA 2.94 ng/mL. According to the stone size, 45 patients were treated by ESWL, three by transurethral endoscopic lithotripsy and two by cystolithotomy with no surgery for BPH. Four patients refused to have the second study once they were stone-free, so the second urodynamic evaluation was only available in 46 patients.

The primary objective of the study was to determine the most common urodynamic features associated with bladder stones, as shown in Table 2. The first study with the stone in the bladder showed that only 51% of the patients had genuine BOO and 10% had detrusor under-activity. The most frequent finding was the presence of detrusor overactivity, and 18% had a completely normal urodynamic study.

The effect of the presence of stones in the bladder on the results of the urodynamic study is also shown in Table 2. There were no differences in $Q_{max}$, voided volume, or PVR, neither the association with BOO, detrusor over- or detrusor under-activity, or the

*TABLE 3 Urodynamic findings related to stone size*

| Finding | % | Chi-square P | Relative risk (95% CI) |
|---|---|---|---|
| BOO | | | |
| >4 cm | 50 | 0.918 | 0.97 (0.55–1.71) |
| <4 cm | 51 | | |
| Detrusor over-activity | | | |
| >4 cm | 94.4 | 0.002 | 1.83 (1.29–2.6) |
| <4 cm | 51.5 | | |
| Detrusor under-activity | | | |
| >4 cm | 5.6 | 0.309 | 0.36 (0.04–2.9) |
| <4 cm | 15.2 | | |

presence of a normal study differed with or with no bladder calculi (Table 2). When the urodynamic findings were analysed as a function of the bladder lithiasis being <or >4 cm (Table 3) there were no significant differences for BOO or detrusor under-activity, but detrusor overactivity was more common with bladder calculi of >4 cm, with an 83% greater risk of detrusor overactivity.

## DISCUSSION

The most common cause of bladder calculi is reportedly the presence of BOO, mainly caused by prostatic enlargement [1–3,15]. Therefore it has been classically accepted that the underlying cause of BOO must also be treated, with the bladder calculi. However, despite the general acceptance of this theory there are no studies evaluating the association of a BOO with the presence of bladder stones. Douenias *et al.* [15] retrospectively evaluated the predisposing factors in 100 bladder calculi and stated that 88% of the patients had some type of BOO. However, neither uroflowmetry nor urodynamic studies were used to confirm this conclusion. Thus the aim of the present study was to assess the most frequent urodynamic findings associated with bladder stone and whether these findings were affected by the stone. Two urodynamic studies were used in each patient, before and after treating the stone, with the stones treated non-invasively and with no treatment of possible BOO or detrusor overactivity, to minimise any interference with bladder function.

The major finding was that only half the patients with bladder calculi had BOO (Table 2); there were no significant differences in the ratio of obstruction with the size of the calculi (Table 3). These results disagree with the commonly accepted theory that bladder calculi are always associated with BOO [1–3]. This theory is based on 'received wisdom' rather than evidence-based studies. However, 10% of the patients had detrusor under-activity that could be a direct cause of the formation of bladder calculus. The role of detrusor under-activity in the formation of bladder calculi has not been proposed previously [1–3,15], perhaps because it is not possible to diagnose this condition based on symptoms only, without using a urodynamic study. Also, 18% of the patients with bladder calculi had a completely normal study; this disagrees with the suggestion that the presence of bladder calculi always has an underlying cause. Finally, two-thirds of the stones were associated with detrusor overactivity; this rate is higher than in the general population and the explanation might be that the stone leads to direct irritation of the bladder mucosa, producing detrusor overactivity. This is supported in that calculi of >4 cm were associated with more detrusor overactivity than those of <4 cm (Table 3); because the mean size of the bladder calculi was rather large (5.42 cm, Table 1), this would explain the rather high incidence of detrusor overactivity.

That there were no differences between the results of urodynamics and uroflowmetry (Table 2) with or with no stone shows that the presence of stones in the bladder does not affect the results of these measurements. Thus a urodynamic study can be used in the presence of bladder calculi and it is unnecessary to wait until the bladder is stone-free to assess actual bladder function.

After assessing previous publications and the present results it remains difficult to determine the mechanism of bladder lithogenesis. There are some situations that promote the formation of bladder calculi, e.g. foreign bodies, a neurogenic bladder, previous surgery, bladder augmentation or substitution, a history of chronic bacteriuria by urea-splitting organisms, or a previous bladder catheter [1,16–18]. In these situations the causal factor is well established but it accounts for a small proportion of all bladder calculi. However, in most cases (mainly men with prostatic enlargement) the cause of bladder calculi remains unclear. With the present results it is difficult to accept that the only cause of bladder calculi is BOO, as this was only found in half the cases; in 10% of patients the stones can be explained by detrusor under-activity, but there is no reason why 18% of patients with a normal urodynamic study developed bladder calculi. Another possibility is that regardless of the presence of BOO, a high PVR can promote lithiasis, although this proposal is not well supported, because the mean PVR was <100 mL.

There is also speculation about the role of stones from the upper urinary tract in the formation of bladder calculi. This is difficult to assess, because although 74% of the present patients had a history of lithiasis, only 2% of the bladder calculi were diagnosed after colicky flank pain, and the large mean size of the bladder calculi (5.41 cm) suggests a long period of formation within the bladder.

In conclusion, although the cause bladder calculi remains unclear and may be multifactorial, we showed that the presence of stones does not interfere with the results of urodynamic studies, and, conversely to what has been accepted for years in urology, the presence of bladder calculi is not always associated with BOO. Thus when treating bladder calculi it is not necessary to automatically add treatment for prostatic enlargement.

## CONFLICT OF INTEREST

None declared.

## REFERENCES

1 **Schwartz BF, Stoller ML.** The vesical calculus. *Urol Clin North Am* 2000; **27**: 333–46

2 **Lingeman JE, Lifshitz DA, Evan AP.** Surgical management of urinary lithiasis. In Walsh PC, Vaughan D, Retik AB eds, *Campbell's Urology.* 8th edn. Philadelphia: WB Saunders, 2002: 3384–7

3 **De la Rossette J, Alivizatos G, Madersbacher S *et al.*** *Guidelines on Benign Prostatic Hyperplasia.* EAU, February 2002

4 **Larsen EH, Bruskewitz RC.** Urodynamic evaluation of male outflow obstruction. In Krane RJ, Siroky B, eds. *Clinical Neurourology.* New York: Lippincott Williams and Wilkins, 1991: 427–43

5 **Shoukry I, Susset JG, Elhilali MM *et al.*** Role of uroflowmetry in the assessment of lower urinary tract obstruction in adult males. *Br J Urol* 1975; **47**: 559–66

6 **Simonsen O, Moller-Madsen B, Dorflinger T *et al.*** The significance of age on symptoms and urodynamic and cystoscopic findings in benign prostatic hypertrophy. *Urol Res* 1987; **15**: 355–8

7 **Barry MJ, Cockett AT, Holtgrewe HL *et al.*** Relationship of symptoms of prostatism to commonly used physiological and anatomical measures of the severity of benign prostatic hyperplasia. *J Urol* 1993; **150**: 351–8

8 **el Din KE, de Wildt MJ, Rosier PF *et al.*** The correlation between urodynamic and cystoscopic findings in elderly men with voiding complaints. *J Urol* 1996; **155**: 1018–22

9 **Frabboni R, Santi V, Ronchi M *et al.*** Echo-guided SWL of vesical stones with Dornier MPL 9000 lithotriptor in obstructed and unobstructed patients. *J Endourol* 1998; **12**: 81–6

10 **Delakas D, Daskalopoulos G, Crandis A.** Experience with the Dornier lithotriptor MPL 9000-X for the treatment of vesical lithiasis. *Int Urol Nephrol* 1998; **30**: 703–12

11 **Millán-Rodríguez F, Tornero-Ruiz J, López-Llauradó H *et al.*** Tratamiento de la litiasis vesical mediante litotricia extracorpórea por ondas de choque. *Actas Urol Esp* 2001; **25**: 504–9

12 **Barry MJ, Fowler FJ Jr, O'Leary MP *et al.*** The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. *J Urol* 1992; **148**: 1549–57

13 **Griffiths D, Höfner K, van Mastrigt R *et al.*** Standardization of terminology of lower urinary tract function: pressure-flow studies of voiding, urethral resistance, and urethral obstruction. International Continence Society Subcommittee on Standardization of terminology of pressure-flow studies. *Neurourol Urodyn* 1997; **16**: 1–18

14 **Schafer W.** Analysis of bladder-outlet obstruction function with the linearized passive urethral resistance relation, linPURR, and a disease-specific approach for grading obstuction: from complex to simple. *World J Urol* 1995; **13**: 47–58

15 **Douenias R, Rich M, Badlani G *et al.*** Predisposing factors in bladder calculi. Review of 100 cases. *Urology* 1991; **37**: 240–3

16 **Takasaki E, Suzuki T, Honda M *et al.*** Chemical compositions of 300 lower urinary tract calculi and associated disorders in the urinary tract. *Urol Int* 1995; **54**: 89–94

17 **Hall MK, Hackler RH, Zampieri TA *et al.*** Renal calculi in spinal cord–injured patient: association with reflux, bladder stones, and Foley catheter drainage. *Urology* 1989; **34**: 126–8

18 **Haddad FS, Chinichian A.** Postprostatectomy lithiasis. *Urol Int* 1991; **46**: 221–31

Correspondence: F. Millán Rodríguez, Fundación Puigvert, Cartagena 340–350, 08025-Barcelona, Spain.
e-mail: fmillan@fundacio-puigvert.es

Abbreviations: **PVR**, postvoid residual urine volume; **$Q_{max}$**, maximum urinary flow rate.