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THE OUTCOME OF RENAL ULTRASOUND IN THE ASSESSMENT OF 556 CONSECUTIVE PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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ABSTRACT

Purpose: We determined the additional value of renal ultrasonography in the assessment of patients with benign prostatic hyperplasia.

Materials and Methods: Renal ultrasound was performed in 556 consecutive patients with benign prostatic hyperplasia and the results were correlated with other clinical parameters.

Results: Of the patients 14 (2.5%) had dilatation of the renal pelvis, 65 (11.7%) had renal cysts and 1 (0.18%) had renal cell carcinoma. The serum creatinine level appeared to be correlated with dilatation of the renal pelvis. To predict dilatation additional information can be obtained by including the results of the post-void residual measurements.

Conclusions: Renal ultrasound is indicated only in patients with a specific serum creatinine level and/or post-void residual volume.

KEY WORDS: prostatic hypertrophy, ultrasonography, kidney, prostate, creatinine

Each patient suspected clinically of suffering urinary problems secondary to benign prostatic hyperplasia (BPH) should undergo screening investigations, including assessment of renal function. For decades excretory urography (IVP) was performed in these patients to exclude upper urinary tract pathology. The IVP reliably demonstrated renal cortical abnormalities, upper tract dilatation and nephrolithiasis. However, a few years ago the efficacy of an IVP in the assessment of uncomplicated BPH was questioned in that it is relatively expensive and time-consuming, and requires use of ionizing radiation and contrast medium, side effects may develop and treatment policy seldom is changed afterwards.¹⁻³

With introduction of ultrasonography, it was recognized that this less expensive and less invasive method demonstrated accurately the condition of the upper urinary tract. With careful scanning technique and interpretation, ultrasonography is a sensitive detector of upper tract distension. Moreover renal cortical abnormalities, such as renal cysts or a kidney tumor, as well as nephrolithiasis may be detected by renal ultrasound. Several investigators showed that a combination of renal ultrasound, plain abdominal x-ray, urinalysis and serum creatinine could replace the IVP in the assessment of patients with BPH.⁴⁻⁶ Consequently ultrasonography is recommended as the first choice procedure when upper urinary tract imaging is indicated before therapy.

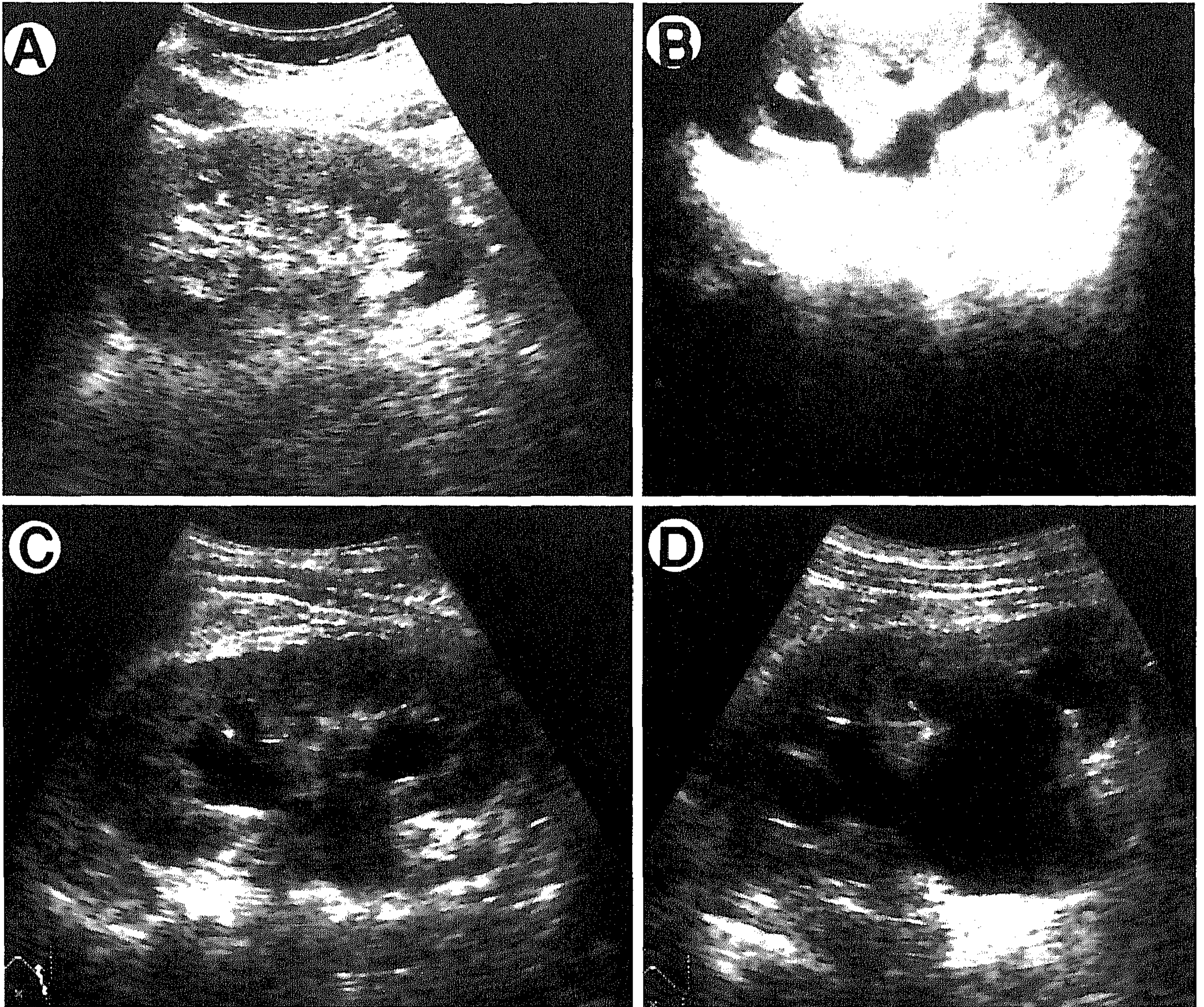
The treatment of BPH is currently being reevaluated and numerous alternative therapies are being introduced. In combination with changes in social habits and increasing life expectancy the demand for therapy is almost limitless. Consequently the costs involved in assessment and therapy increase rapidly, and authorities stress wise use of available resources. To determine the additional value of standard ultrasonographic imaging of the upper urinary tract we evaluated the outcome of renal ultrasound examinations performed in 556 consecutive patients with lower urinary tract symptoms and BPH. Moreover, we provide recommendations for the use of renal ultrasound in these patients.

PATIENTS AND METHODS

A total of 556 consecutive patients with lower urinary tract symptoms and BPH underwent a complete standardized pre-treatment screening consisting of history taking (including symptom scores) and physical examination with digital rectal examination, urinalysis, serum creatinine and prostate specific antigen (PSA) measurements, transrectal ultrasonography of the prostate, flexible urethroscopy, uroflowmetry with post-void residual volume measurements via transabdominal ultrasound, urodynamic investigation, plain abdominal x-ray and renal ultrasound. During the initial visit, before history and physical examination, blood was drawn and a midstream urine specimen was collected. Transrectal ultrasound was performed by an experienced urologist using a Kretz Combison 330 ultrasound scanner with a transrectal probe (VRW 77AK multiplane 3-dimensional rectal transducer). Longitudinal and transverse prostate images were recorded to judge the presence of abnormalities and to measure the prostate volume using a planimetric method. If any abnormality was found during transrectal ultrasound of the prostate, digital rectal examination and/or at PSA determination, ultrasound guided prostate biopsies were obtained to exclude malignancy.

The same ultrasound scanner was used in combination with a transabdominal probe (Kretz AWP 3.5) to image both kidneys. During ultrasonography the presence of hydronephrosis, nephrolithiasis and cortical lesions was evaluated. If such an abnormality was detected the patient was referred to the department of radiology for further complementary and detailed imaging. Dilatation of the renal pelvis on ultrasonography was classified as slight—renal pelvis enlarged just beyond normal size, moderate—dilated calices present and severe—grossly enlarged renal pelvis and clubbed calices (see figure). Furthermore, the presence of renal cysts, concrements or other renal masses was documented.

During the second visit complete urodynamic investigations were performed after free uroflowmetry via an 8F transurethral lumen catheter with an intravesical microtip pressure sensor. The pressure and flow data were recorded and stored with equipment developed at our department. To obtain useful information from pressure-flow curves it is necessary to relate detrusor pressure to the corresponding flow.



Transabdominal ultrasound of kidney. A, normal kidney, no dilatation. B, slight dilatation of renal pelvis is barely visible. C, moderate dilatation of renal pelvis. Note gross enlargement without involvement of calices. D, severe dilatation of renal pelvis with involvement of calices, which are dilated and clubbed.

Schäfer presented the concept of a classification system (linear passive urethral resistance relation) connecting minimal opening pressure with pressure at maximal flow. This concept was used to classify bladder outlet obstruction as minimal (grades 0 to 2), moderate (grades 3 and 4) and severe (grades 5 and 6). Finally, flexible urethroscopy was performed to judge the patency of the urethra, evaluate the configuration of the prostatic urethra and inspect the bladder for abnormalities.

The results obtained during ultrasonography were correlated with all other parameters described previously. For data base management we used software developed at our urological center. Differences between the groups were evaluated with the chi-square test, with $p < 0.05$ considered statistically significant.

RESULTS

Patient age ranged from 42 to 91 years (mean age 64.4) and the history revealed complaints at least 3 months in duration by all patients based on the International Prostate Symptom Score (average 17.5, ranged 1 to 35). Average prostate volume as measured by transrectal ultrasound was 43.7 cm.³ (range 12 to 160). Renal ultrasonography demonstrated ab-

TABLE 1. Findings at renal ultrasound

	No. Pts. (%)
Normal	477 (85.8)
Abnormal:	79 (14.2)
Dilatation*	14 (2.5)
Cysts	65 (11.7)
Tumor	1 (0.2)

* Slight in 6 patients (42.8%), moderate in 5 (35.7%) and severe in 3 (21.4%).

normalities in 14.2% of the patients (table 1), the majority of which were renal cysts (65), followed by dilatation (14) and a renal tumor (1). A more detailed evaluation revealed dilatation of the renal pelvis, which was slight in 42.8% of the patients, moderate in 35.7% and severe in 21.4%.

When the different screening modalities were correlated with dilatation of the renal pelvis, serum creatinine appeared to be a good criterion to predict the presence of dilatation. The serum creatinine level for the entire group ranged from 68 to 328 $\mu\text{mol./l.}$ (average 98, normal 62 to 110) compared to 84 to 250 $\mu\text{mol./l.}$ (average 142) in patients with dilatation of the renal pelvis. Analysis revealed 2 cutoff points for serum creatinine, correlating with a high prevalence of dilatation.

Only 4 patients with serum creatinine less than 115 $\mu\text{mol/L}$ had dilatation (3 slight and 1 moderate), compared to 10 of 53 (18.9%) with serum creatinine greater than 115 $\mu\text{mol/L}$ (3 slight, 4 moderate and 3 severe dilatation). Of 21 patients with serum creatinine more than 130 $\mu\text{mol/L}$, 7 had dilatation on renal ultrasound (3 severe, 3 moderate and 1 slight). There appeared to be no correlation with patient age, prostate size and the grade of bladder outlet obstruction or symptoms (table 2).

The post-void residual urine volume ranged from 0 to 1,250 ml. (average 77.6). Further analyses showed that dilatation of the renal pelvis was closely related to this measurement in combination with the serum creatinine level. To decrease the number of unnecessary renal ultrasound studies in the 32 patients whose serum creatinine was 115 to 130 $\mu\text{mol/L}$, the post-void residual urine was also measured. It appeared that in this subgroup all patients with dilatation presented either with urinary retention (1) or a post-void residual urine volume larger than 150 ml. (2). Based on the aforementioned criteria the number of ultrasound studies performed could be decreased from 556 to 31 (5.6%). Thus, 3 patients with slight and 1 with moderate dilatation would be missed. Moreover, nephrolithiasis occurred in 49 patients and was sometimes visualized during ultrasonography. No patients with dilatation of the renal pelvis had urolithiasis.

DISCUSSION

Until the early 1980s an IVP before treatment of urinary outlet obstruction in patients with BPH was advocated as the first choice screening method for the (upper) urinary tract. However, several studies demonstrated that 73 to 92.2% of the patients with lower urinary tract symptoms have a normal IVP, with hydronephrosis being the most common reported abnormality in 3 to 13%.^{1,6,7} Because hydronephrosis may cause renal impairment, this finding can influence the treatment approach and, therefore, hydronephrosis is obviously the most important condition to be excluded. This fact and that an IVP involves radiation exposure plus the risk of possible allergic reactions to intravenous contrast material³ question the necessity of IVP in cases of uncomplicated BPH. Moreover, this investigation lacks ready availability, and is time-consuming and uncomfortable for the patient. Matthews et al elegantly demonstrated that ultrasonography could well replace IVP to detect most abnormalities in uncomplicated cases.⁶ Lilienfeld et al suggested replacement of IVP by a combination of renal ultrasound, plain abdominal x-ray, urinalysis and blood urea nitrogen determination.⁴ The combination of blood biochemical evidence of renal impairment and the presence of hydronephrosis in patients with bladder outlet obstruction was also noted by Marshall et al.⁸ Logically, several investigators questioned the need for preoperative imaging procedures at all in uncomplicated cases.^{2,9}

We evaluated the efficacy of a standard transabdominal ultrasound investigation of the kidneys performed by a urologist experienced with ultrasonography before treatment of BPH. Ultrasound results were abnormal in 14.2% of the cases, similar to the study of Fidas et al, who noted an

abnormality in 16% of the cases with hydronephrosis being the most important finding.¹⁰

From our study we learned that routine ultrasonography of the kidneys in all patients would be unrewarding in the majority. Criteria to select patients for renal ultrasound are needed to limit the number of ultrasound studies and subsequently decrease costs without the risk of missing clinically relevant pathology of the upper urinary tract. Analysis of parameters used in the assessment of patients with BPH showed that serum creatinine may be used as an indicator for renal impairment and could be a useful selection criterion for performing renal ultrasound. All but 2 patients with serum creatinine less than 115 $\mu\text{mol/L}$ had no clinically significant renal pathology on ultrasound. Renal cysts and slight dilatation of the renal pelvis are not considered clinically significant, since their presence does not change treatment policy and they apparently do not cause renal impairment within a short period.¹⁰ In 1 patient (0.18%) a lesion suspicious for renal cell carcinoma was confirmed by nephrectomy. In this patient none of the other assessment parameters indicated the presence of the renal malignancy, thus making it a coincidental finding in accordance with the incidence rate of renal cell carcinoma in the general population.¹¹ Performing renal ultrasound only in patients with serum creatinine greater than 115 $\mu\text{mol/L}$ revealed all but 1 clinically significant dilatation of the renal pelvis. The missed patient appeared to have preexisting hydronephrosis not caused by urinary outlet obstruction and without impairment of renal function. To diagnose all relevant dilatations of the renal pelvis with a minimum of renal ultrasound studies we analyzed the number of dilatations noted in patients with serum creatinine greater than 115 $\mu\text{mol/L}$ and a post-void residual urine volume or urinary retention. In patients whose serum creatinine was 115 to 130 $\mu\text{mol/L}$, a post-void residual volume larger than 150 ml. or urinary retention provided additional information for the decision to perform renal ultrasound. With these selection criteria the use of renal ultrasound decreased from 53 to 31 studies performed without missing a clinically significant dilatation of the renal pelvis. When serum creatinine was greater than 130 $\mu\text{mol/L}$, significant dilatation occurred in a considerable number of patients, making routine renal ultrasound scanning in these patients mandatory. Although there were few patients with hydronephrosis, a chi-square test showed a statistically significant difference ($p < 0.0001$) between the creatinine value and the presence of hydronephrosis.

The outcome of our investigation has changed the policy at our department for performing routine ultrasound of the kidneys in patients with uncomplicated BPH. We now only perform this imaging procedure in patients with serum creatinine greater than 130 $\mu\text{mol/L}$, or with a level of 115 to 130 $\mu\text{mol/L}$ plus a post-void residual urine volume larger than 150 ml. or urinary retention at presentation to the outpatient clinic. Using these criteria we decreased the percentage of noncontributory renal ultrasounds by 94.4%. With these criteria there is the possibility that a coincidental renal malignancy, for example as noted in 1 of our patients, may be missed. However, we believe that the incidence of renal malignancy in our patients (less than 0.2%) does not justify performance of renal ultrasound to exclude upper urinary

TABLE 2. Correlation among serum creatinine level, presence of renal pelvis dilatation and other clinical parameters

Creatinine ($\mu\text{mol/L}$)	No. Pts.	No. With Dilatation (%) ^a	Mean \pm SD [†]			
			Pt. Age	International Prostatic Symptom Score	Prostate Vol.	Linear Passive Urethral Resistance Relation
Less than 115	503	4 (0.8)	63.9 \pm 8.47	17.5 \pm 7.04	42.9 \pm 20.36	2.5 \pm 1.59
115-130	32	3 (9.3)	68.2 \pm 8.99	16.9 \pm 6.57	54.8 \pm 27.75	2.7 \pm 1.73
130 Or more	21	7 (33.3)	69.2 \pm 7.85	20.8 \pm 8.65	47.0 \pm 23.88	2.5 \pm 2.14
Totals	556	14 (2.5)	64.4 \pm 8.57	17.5 \pm 7.07	43.7 \pm 21.18	2.6 \pm 1.62

^a $p < 0.0001$.

[†] Not significant.

tract pathology in all patients with uncomplicated bladder outlet obstruction. Moreover, we concluded that in view of our results there is only limited use for an IVP. This opinion is endorsed by other investigators who reject routine IVP for uncomplicated cases merely because of curiosity, habit or tradition.¹¹ Of course any complicating factors, such as haematuria or a positive medical history for urological disease such as renal stones, justify the use of IVP. However, in all other cases it remains the sole responsibility of the treating urologist to decide on upper urinary tract imaging in the assessment of patients with lower urinary tract symptoms and BPH.

CONCLUSIONS

Renal ultrasound to exclude upper urinary tract pathology in patients with bladder outlet obstruction and BPH will provide additional information only if the serum creatinine is greater than 130 $\mu\text{mol}/\text{l}$. For serum creatinine levels of 115 to 130 $\mu\text{mol}/\text{l}$, renal ultrasound is advocated if a post-void residual volume is larger than 150 ml. or bladder retention is present.

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