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USEFULNESS OF BLADDER-PROSTATE ULTRASOUND IN THE DIAGNOSIS OF OBSTRUCTION/HYPERACTIVITY IN MALES WITH BPH

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Summary.- *OBJECTIVE: To determine the utility of prostate ultrasound in the diagnosis of infravesical obstruction (IVO) and detrusor hyperactivity(DH).*

METHODS: Prospective study with 39 patients consulting for LUTS. Clinical history was compiled, IPSS was determined, a digital rectal exam was performed, abdominal ultrasound was used to calculate detrusor thickness/weight, prostate volume, and middle lobe length (MLL). Urodynamic study (UD) was performed with determination of the Abrams-Griffiths number and ICS nomogram. Mean values were compared with Mann-Whitney U-test, and ROC curves were plotted determining the cutoff points for optimum sensitivity/specificity.

RESULTS: Mean age was 63.1 years (SD: 7.8), with a mean IPSS score of 14 (SD: 6). 53.8% of the patients presented IVO at UD evaluation, and 43.6% DH. The differences between free flowmetry Qmax(p=0.015) and MLL (p=0.003) between patients with and without IVO proved significant. The ROC curves yielded an AUC for middle lobe length of 0.772, with a maximum sensitivity and specificity cutoff point at 10.5 mm (sensitivity 90%, specificity 73%, PPV 76%, NPV 85%). There were no significant differences in any parameter between patients with and without DH.

CONCLUSION: Ultrasound MLL measurement in patients with LUTS offers high sensitivity/specificity in diagnosing IVO, with a cutoff point of 10.5 mm. In our study it wasn't effective in the noninvasive diagnosis of DH.

Keywords: *Ultrasound. Urodinamic study. Obstruction. Hiperactive detrusor.*

Resumen.- *OBJETIVO: Determinar la utilidad de la ecógrafía prostática para el diagnóstico de obstrucción infravesical(OIV) y del detrusor hiperactivo(DH).*

MÉTODOS: Estudio prospectivo sobre 39 pacientes que consultaron por STUI. Se realizó historia clínica, IPSS, tacto rectal, ecografía abdominal midiendo grosor del detrusor, peso del detrusor, volumen prostático, longitud lóbulo medio(LLM) y estudio urodinámico (EUD) con obtención del número de Abrams-Griffiths y nomograma ICS. Se compararon medias con el test de U Mann-Whitney y se construyeron curvas ROC determinando los puntos de corte óptimos de sensibilidad y especificidad, con una significación estadística $p < 0.05$.

RESULTADOS: La edad media de los 39 pacientes fue 63,1 años(DE:7,8 años) con IPSS medio de 14 puntos(DE:6) siendo la puntuación media de los sínto-

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mas de urgencia de 5,9 puntos(DE:3,1).El 53,8% de pacientes presentaron OIV en el EUD y el 43,6% DH. Resultaron significativas las diferencias entre el Qmax de la flujometría libre(p=0,015) y la LLM(p=0,003) entre los pacientes con OIV y los que no . Las curvas ROC mostraron un área bajo la curva para la LLM de 0,772 con punto de mayor sensibilidad y especificidad en 10,5mm(S:90%,E:73%,VPP:76%,VPN:85%). No hubieron diferencias en ningún parámetro entre pacientes con y sin DH.

CONCLUSIONES: La medición de la LLM mediante ecografía en pacientes con STUI presenta una alta sensibilidad/especificidad para el diagnóstico de OIV con punto de corte 10,5mm. Es bien tolerada, económica y rápida. En nuestro estudio no se ha mostrado como una prueba eficaz en el diagnóstico no invasivo del hiperactividad del DH.

Palabras clave: *Ecografía. Estudio urodinámico. Obstrucción. Detrusor hiperactivo.*

INTRODUCTION

Urodynamic (UD) exploration is currently the gold standard for the diagnosis of infravesical obstruction (IVO) and detrusor hyperactivity (DH). Although UD is simple, it can have complications (up to 19% of all cases according to some series) (1), including urinary infection, hematuria or local irritation. It therefore must be regarded as an invasive procedure, with a non-negligible cost and important physician dedication in terms of time (2).

Not all patients with benign prostatic hyperplasia (BPH) and lower urinary tract symptoms (LUTS) will require UD exploration. The European clinical guides on the management of BPH recommend UD in patients under age 50 or over age 80 years with a postmicturition residual (PMR) of over 300 ml, following radical prostatectomy or BPH surgery, with voiding volumes of under 150 ml, or suspected neurogenic bladder (3).

A number of studies have attempted to define other tests capable of offering information similar to that obtained with UD, but with lesser invasiveness or lower costs. Among these tests, mention should be made of transabdominal ultrasound, due to its convenience, tolerability, rapidity and low cost (4-11). According to the results of these studies, middle lobe length (MLL) is related to increased PMR, a larger prostate volume, higher prostate specific antigen (PSA) levels, and a greater incidence of acute urinary retention. A sensitivity of 95% with a specificity of 50% has been reported for predicting IVO, using a MLL cutoff value of 5 mm.

In this context we present this study designed to determine the usefulness of transabdominal ultrasound in the functional diagnosis of IVO and DH.

For that we determined the sensitivity, specificity and positive and negative predictive values (PPV and NPV) of a number of ultrasound parameters in the diagnosis of IVO and DH.

MATERIAL AND METHODS

A prospective study was made of 39 consecutive patients during the year 2009, consulting in our Urodinamyc Department due to both filling and voiding LUTS.

These patients were referred due to poor response to medical treatment for BPH or BPH surgical evaluation. All patients had received treatment with alpha-blocker + / - inhibitors of 5 alpha-reductase with little clinical improvement.

Inclusion criteria were for both men previously diagnosed with BPH sent to the Urodynamics Unit for poor response to medical treatment. None of the patients had kidney failure, bladder stones, indwelling catheter or other major complication of BPH.

We excluded patients with previous prostate or urethral surgery, patients with urethral stenosis, neurological disorders capable of accounting for the symptoms, patients treated with anticholinergic agents, and those subjects failing to sign the informed consent document(for personal reasons, age or surgery refusal).

A clinical history, physical examination and rectal digital exam were performed in all cases. The patients completed the validated International Prostate Symptom Score (IPSS) for urinary symptoms, and the scores were posteriorly divided into filling and voiding symptoms scores. All subjects underwent transabdominal ultrasound and UD exploration.

At ultrasound we determined, reproducing the measurement criteria of previous studies, the prostate volume (Figure 1) (calculated from the ellipse volume formula: p xAxBxC), postmicturition residual volume (PMR) and the following parameters:

Middle lobe length (MLL) (red line): Determined from the mean of the two measures (transverse and

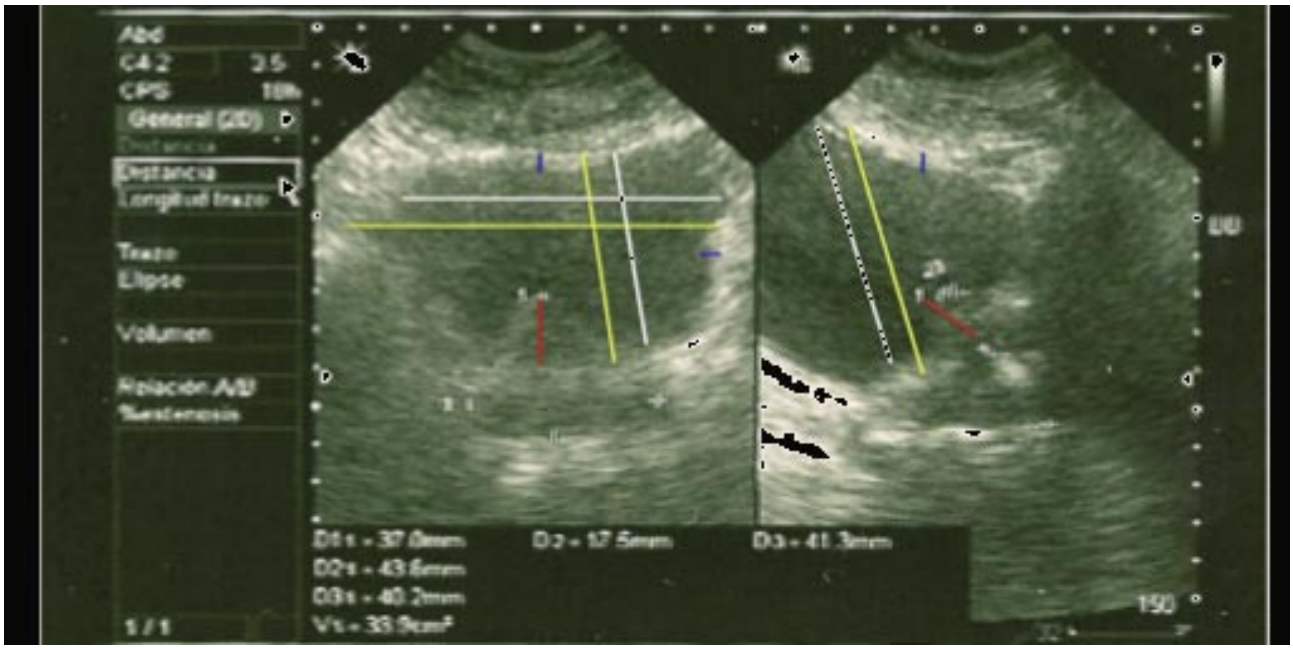

FIGURE 1. Abdominal ultrasound.

longitudinal) from the prostate peak to the theoretical bladder neck.

Detrusor muscle thickness (DT) (blue line): Determined from the mean of three random measurements of the thickness of the detrusor muscle wall.

Detrusor muscle weight (DW): This was established from the difference between bladder volume to the external wall of the detrusor (yellow line) and bladder volume to the internal wall of the detrusor (white line).

The ultrasound was performed prior to flowmetry and required a minimum fill volume of 150ml.

All patients underwent UD exploration including free flowmetry (FF), filling cystomanometry and study of pressure and flow, according to the recommendations of the International Continence Society for Good Urodynamics Practices. The study variables were UD and FF Qmax, opening detrusor pressure, and detrusor pressure at Qmax and PMR in UD. The nomograms of Abrams-Griffiths and of Schafer were determined.

To define the presence or absence of IVO we used the nomogram proposed by the ICS. We also calculated the number of Abrams & Griffiths (PQmax - 2Qmax) so that if it is greater than 40 cm H2O is a sign of obstruction. If it is under 20 cm H2O can be excluded obstruction, presenting an area between 20 and 40 cm H2O which is described as indeterminate.

We defined the presence of overactive detrusor as the presence of elevated phasic detrusor pressure during bladder filling, over 15 cm H2O.

The data were analyzed using the SPSS® version 11.0 statistical package, applying the comparative Mann-Whitney U-test and calculating receiver operating characteristic (ROC) curves to establish the sensitivity and specificity of the different tests, followed by calculation of the PPV and NPV for the cutoff points of greatest sensitivity and specificity.

We calculated the accuracy of the test (proportion of subjects correctly classified) and positive likelihood ratios (a result greater than 1 implies that the outcome is more likely in patients), the negative likelihood ratio (indicating that the result is less likely in patients) and diagnostic odds ratio (measures the strength of the association between test result and the presence of disease not being influenced by predefined cutoffs)

RESULTS

A total of 39 patients were recruited where 21 (53.8%) presented IVO at UD exploration, while

TABLE I. CLINICAL, ULTRASOUND AND URODYNAMIC DATES OF PATIENTS WITH AND WITHOUT OIV.

	NO OBSTRUIDO	OBSTRUIDO	p
clinic dates			
Age	64,7	61,6	0,294
IPSS	13,7	14,7	0,945
ultrasound dates			
Prostatic vol.	46,7	61,6	0,202
MLL	10,50	19,24	0,004
DW	59,56	72,33	0,245
DT	3,56	4,30	0,202
Qmax uroflow	13,85	9,21	0,015
PMR uroflow	44	69	0,308
urodynamic dates			
Qmax UDS	12,28	7,7	0,002
PDet opening	41,33	79,45	0,001
PDte Qmax	59,67	85,14	0,001

14 (35.9%) showed no IVO in the nomograms – the rest of the subjects, 4 (10.3%) yielding indeterminate results. Clinically, 30.8% of these patients had experienced an acute urinary retention episode. Of these subjects, 8 presented IVO at UD exploration (66.7%), while four did not (33.3%). In patients with IVO, the prevalence of HD was 33,3% and in the group of patients without IVO was of 51%.

There were no statistically significant differences in terms of age, IPSS score or prostate volume between the patients with and without obstruction; as a result, the two samples were comparable (Table I).

Firstly, the relationship between MLL, detrusor weight and detrusor thickness and the presence of IVO was analyzed. No statistically significant differences were found in terms of detrusor weight and detrusor thickness between the patients with and without obstruction. Among the noninvasive parameters, MLL and Qmax in free flowmetry showed statistically significant differences between the patients with and without obstruction. The results relating to the variables included in the study are shown in Table I.

It is seen that in effect, the patients with IVO showed significantly lower Qmax at UD (invasive) exploration, and significantly higher Qmax and opening detrusor pressure values, versus the patients without obstruction. In the noninvasive setting, the variables likewise showing differences were evidently free flowmetry Qmax and MLL (Figure 2).

With these results we plotted ROC curves to obtain the sensitivity and specificity of these two parameters (Figures 3).

The area under the curve (AUC) was found to be greater for MLL than for free flowmetry Qmax (0.772 versus 0.728). The MLL value offering the greatest sensitivity and specificity was seen to be 10.5 mm.The diagnostic accuracy for this cutoff point was 82%. For this cutoff point, MLL measurement yielded a sensitivity of 90.5%, a specificity of 72.2%, a PPV of 76% and a NPV of 85% in the diagnosis of IVO, taking as reference the diagnosis based on UD exploration.The positive likelihood ratio was 3.25 and negative likelihood ratio of 0.13. The diagnostic odds ratio or strength of association between the positive test and the presence of disease was 25.

We then examined the usefulness of these same ultrasound parameters in the diagnosis of hyperactive detrusor muscle. As can be seen in Table 1, the filling symptoms represented an average of

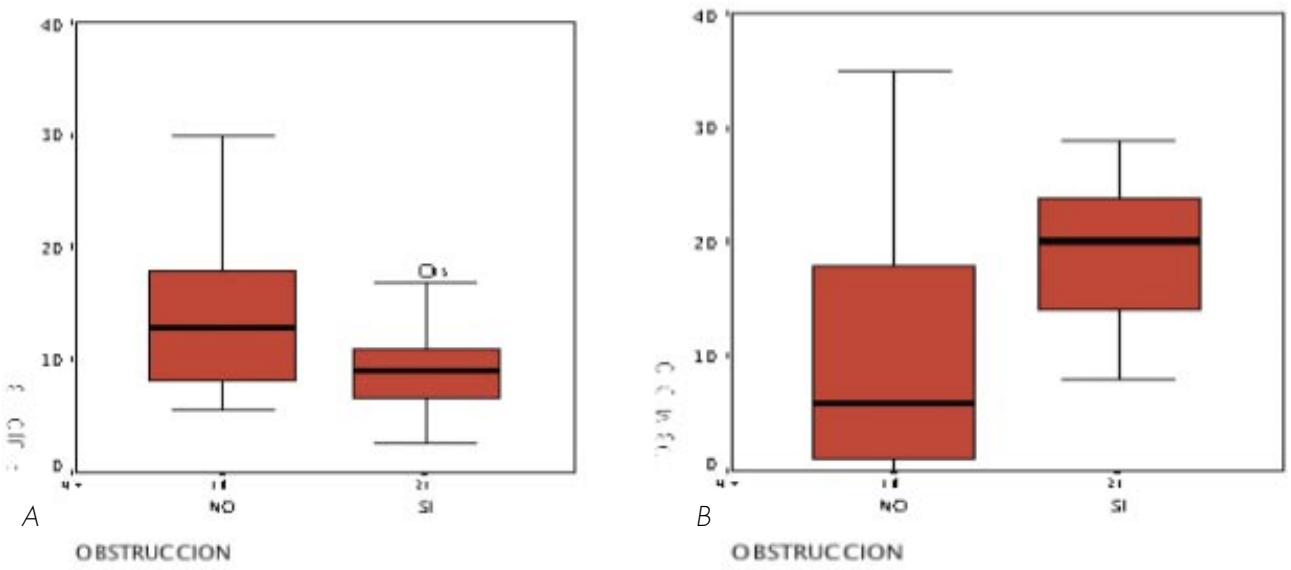

FIGURE 2. Qmax (A) and MLL (B) in patients with and without IVO.

almost 6 points in the IPSS questionnaire. Involuntary contractions diagnostic of detrusor hyperactivity were recorded in 43.6% of the patients (17).

None of the variables in our study showed statistically significant differences between the patients with and without detrusor hyperactivity. Likewise, detrusor weight and thickness were not effective in differentiating between patients shown to present involuntary contractions at UD exploration and those without contractions.

DISCUSSION

Lower urinary tract symptoms (LUTS) are among the most common causes of urological consultation, and in males are often accompanied by benign prostatic hypertrophy (BPH). The role of urodynamic (UD) exploration in these patients has been well defined in the European clinical guides on the management of BPH. While UD exploration is well tolerated, it is an invasive procedure requiring bladder catheterization, and is not without morbidity

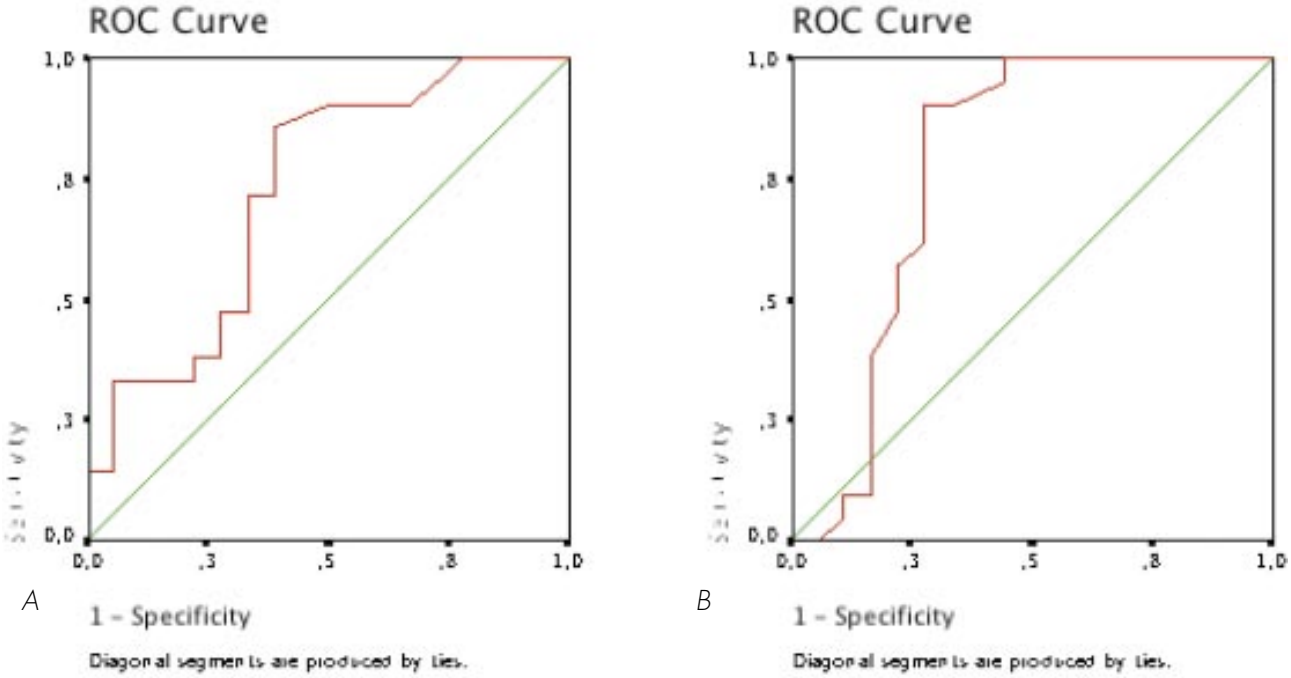

FIGURE 3. ROC curves of Qmax (A) and MLL (B).

in the form of hematuria, urinary tract infections or intensification of micturition symptoms in the days following exploration. On the other hand, UD exploration is more expensive than other techniques, and requires considerable dedication on the part of the urologist in terms of time. Nevertheless, it remains the gold standard for the diagnosis of infravesical obstruction (IVO) and detrusor hyperactivity (DH) (1,2).

Is it possible that in some of these patients UD exploration could be replaced by other less invasive procedures involving a lesser use of resources and better patient tolerance while still affording similar information? Many studies have attempted to evaluate the usefulness of transabdominal ultrasound and of the measurement of certain parameters with this objective in mind (4-11). Such parameters are basically middle lobe length (MLL) and detrusor muscle thickness (DT) and weight (DW).

Regarding the evaluation of infravesical obstruction (IVO), in the present study we have seen that of the results produced by the noninvasive measurements (free flowmetry (FF) and ultrasound), only free flow Qmax and MLL showed statistically significant differences between patients with and without obstruction. The free flowmetry data were concordant with the UD findings – thus demonstrating that the former may be a good technique for patient follow-up. MLL was seen to be potentially very useful in the diagnosis of IVO with a diagnostic accuracy of 82% and a diagnostic odds ratio of 25. ROC curves were plotted, and an AUC of 0.772 was obtained (greater than that corresponding to free flowmetry). These results are similar to those of other authors such as Lin et al. (4) or Keqin et al. (5).

The cutoff point corresponding to maximum sensitivity and specificity in the diagnosis of IVO was 10.5 mm, with a sensitivity of 90.5% and a specificity of 72.2%. The positive and negative predictive values with this cutoff point were 76% and 85%, respectively. This value is greater than the 5 mm obtained by Reis et al. (6). However, our cutoff point offers much greater specificity (72% versus 50%), with no large differences in sensitivity (90.5% versus 95%). This difference could be explained by the variability in prostate volume (45 ml in the series of Reis versus 54 ml in our study).

No statistically significant differences were found in our series in terms of detrusor weight and detrusor thickness between the patients with and without obstruction. In contrast, other authors with larger patient series have documented significant differences. In this sense, Kojima et al. (7) found a detrusor weight of over 35 g to be strongly associated to IVO in the flow pressure studies. Likewise, Manieri et al. (8) found a detrusor thickness of 5 mm to be the best cutoff point, whereby 87.5% of the patients with a thickness of ≥ 5 mm showed IVO in the urodynamic study. This discrepancy can be explained by the limited number of patients in our study.

Regarding the diagnosis of detrusor hyperactivity (DH), none of our study variables (mainly detrusor muscle thickness or weight) showed statistically significant differences between patients with and without DH. Most studies in males focus on the obstructive symptoms. Studies have been made in women with DH, demonstrating the usefulness of the measurement of detrusor weight (9) but not thickness (10). A recent study by Salinas et al (11) demonstrated ,in a design similar to ours, a relationship between detrusor thickness and the presence of DH. In this study the thickness measurement is performed in the anterior and ours is calculated using the average of three random readings. It is Described to be no differences between the different areas of the detrusor to calculate its thickness. We therefore consider that the average of three measurements can be quite approximate to the true thickness of the detrusor (12). In addition to these differences, it is noteworthy that in our study required a minimum volume of 150ml for measuring the thickness of the detrusor but not have a protocol as recommended by other authors (13). This could have been one of the limitations that have limitated us to demonstrate statistically significant differences. However, no differences were found regarding the weight of the detrusor.

Recently published a systematic review (14) on the relationship between detrusor thickness and DH has been published. Of 190 studies, only 5 were valid for analysis and presented conflicting results, mainly due to non-standardization regarding how to measure the parameters studied. This is especially significant in ultrasound measures but not for terms of urodynamic, where urologists have standardized terminology of the ICS.

Up to 50-60% of patients with DH can associate IVO (15). The DH could disappear after surgery (also up to half of cases) but may be considered a sign of possible failure of surgery which won't fulfill the expectations of the patient. In our study the presence of DH in the group of patients with IVO was 33% , somewhat lower than the reported in the literature. Highlights 51% of patients without IVO presenting DH . This is a sample that does not correspond to the general population but yes for a group of patients with LUTS who had not responded to drug treatment and which were referred to the

urodynamics unit for evaluation of surgical treatment. This higher rate of DH in obstructed patients can be justified by the fact that these patients did not respond well to targeted therapies for BPH to the IVO as the initial problem could be not that latter. Therefore, the prevalence of DH among the population without IVO may be higher than expected. Although this relationship is established, the object of our study population were those men who consulted for LUTS who were undergoing surgery and not patients with suspected DH. Therefore, the conclusions d in this regard must be considered with caution. However our results are similar to those of studies such as Chung et al (10).

CONCLUSIONS

MLL measurement with ultrasound in patients with LUTS offers high sensitivity and specificity in diagnosing IVO, adopting a cutoff point of 10.5 mm (sensitivity 90%, specificity 73%, PPV 76%, NPV 85%). However, in our series it was not found to be useful for avoiding flowmetry exploration when a hyperactive detrusor muscle is suspected. The technique is well tolerated, inexpensive, rapid and accessible in diagnosing infravesical obstruction.

Additional prospective studies involving larger patient series are needed, though the data found in the literature are encouraging regarding the use of abdominal ultrasound for the evaluation of patients with LUTS, with a view to establishing a firm diagnosis of IVO.

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