The measurement of the prostatic Resistive Index is a reliable ultrasonographic tool to stratify symptoms of patients with benign prostatic hyperplasia

Esin Yencilek¹, Hakan Koyuncu², Deniz Arslan³, Yavuz Bastug⁴

¹Department of Radiology, Haydarpasa Numune Education and Research Hospital, ²Department of Urology, Yeditepe University Medical Faculty, ³Haydarpasa Numune Education and Research Hospital, ⁴Beykoz State Hospital, Istanbul, Turkey

Abstract

Aims: To evaluate the correlation between lower urinary tract symptoms (LUTS) and the resistive index (RI) of the transitional (TZ) and peripheral zone (PZ) of the prostate and to assess the impact of alpha blocker (AB) treatment on RI changes.

Material and methods: TZ-RI and PZ-RI values of 60 patients with LUTS were calculated by using transrectal ultrasound (TRUS). Correlations between the severity of LUTS and RI values were established. Then, AB was given to moderately and severe symptomatic patients with LUTS. One month after AB usage, TRUS was applied to assess the impact of AB on the TZ-RI, PZ-RI and the international prostate symptom score (IPSS).

Results: Participants were divided into 3 groups as mild (n=14), moderate (n=25) and severe symptomatic (n=21) patients. Mean TZ-RI and PZ-RI were statistically different between the three groups (p<0.01). TZ-RI and PZ-RI were correlated with the severity of LUTS (r=0.757, p<0.01 and r=0.699, p<0.01 respectively). A decrease in symptom severity and RI values in moderate and severe symptomatic groups were significant after AB treatment.

Conclusions: TZ-RI and PZ-RI values can reflect the severity of LUTS and the AB treatment decreases the TZ-RI and the PZ-RI. Measuring the RI of the prostate by TRUS can be a useful tool to stratify LUTS’s severity

Keywords: lower urinary tract symptoms, prostate, resistive index, transrectal ultrasonography

Introduction

Lower urinary tract symptoms (LUTS) are a serious health problem that reduce the quality of life, especially in aging males due to the increasing prevalence with age (31-36% in 60-69 years aged males and 44% in males >70 years of age) [1]. Although LUTS is of multiple origin, benign prostatic hyperplasia (BPH) is the most frequently seen underlying cause in males.

BPH is a chronic and progressive lower urinary system dysfunction. Management of patients with BPH related LUTS depends on the severity of the discomfort. Currently, surveillance, medical treatment, and surgery can be options for BPH management. Uroflowmetric parameters, postmicturation residuel urine volume, digital rectal examination (DRE), international prostate symptom score (IPSS), and even urodynamic evaluations are some of the parameters used to estimate the severity of patient’s symptoms.

Measurement of prostate and transitional zone volumes are used in the evaluation of patients with BPH related LUTS. In the last 20 years, with the development in Doppler ultrasonography (PDU), radiologists have started to analyze the Doppler signals from blood vessels of organs. Today, prostate gland vascularity can be evaluated by PDU with the use of a transrectal probe [2,3]. The Resistive index (RI) is a diagnostic tool to measure the ten-
sion in blood vessels and was used for the first time by Kojima et al. in the differentiation of the normal prostate in BPH patients [3]. Also, the correlation between increased prostatic RI values and higher IPSS scores was reported as well as inverse correlation with voiding parameters [2,4,5].

Currently, IPSS is a widely used questionnaire to evaluate the severity of LUTS caused by BPH. Also, it has a critical role in the management and follow-up of patientsʼ symptoms. Generally, urologists use alpha blockers (AB) as an initial treatment in those having a moderate or severe IPSS score. It may improve LUTS by decreasing smooth muscle tone in prostatic urethra and bladder neck.

In this study, the correlation between the IPSS score and RI of prostate, both the transitional (TZ-RI) and peripheral zone RI (PZ-RI), was evaluated. In addition, the impact of AB treatment on RI was measured in patients with moderate and severe IPSS.

Material and methods

Sixty patients with the complaint of LUTS were included in this study. Patients with a history of urethral stricture, prostatic malignancy, prostatic surgery, AB or 5-alpha reductase inhibitor, or anti-hypertensive medication, neurologic diseases affecting the lower urinary system, systemic diseases threatening the vascular system such as diabetes mellitus, prostatic volume < 30 or > 50 cm³ (measured by transrectal ultrasonography, TRUS), serum PSA value >2.5 ng/ml, and those with abnormal findings at DRE were excluded from the study. All patients were evaluated with a detailed medical history and physical examination by urologists. Physical examination included a complete genitourinary evaluation together with DRE. Additionally, laboratory studies including an ordinary urinalysis and urine culture to rule out active urinary tract infection, serum biochemical assessment, and the measurements of prostate specific antigen (PSA) were made in all patients. Written informed consent was obtained from all patients and the study was approved by an institutional review board.

The IPSS questionnaire was applied to each patient in order to stratify the severity of LUTS at the time of the initial visit. According to the IPSS scoring system, patients were divided into three groups: mild (Group 1, IPSS score <8), moderate (Group 2, IPSS between 8 and 19) and severe (Group 3, IPSS >19) groups.

TRUS examination was performed in all patients with a Toshiba Apio XV (SSA-770-A) device using a 6 MHz endocavitary probe on the left lateral decubitus position. The bladder was emptied before the TRUS imaging. Then, the lubricated endocavitary probe was engaged transrectally. During the TRUS, the prostate volume (PV), transitional zone volume (TZV), transitional zone index (TZI), TZ-RI, and peripheral zone (PZ) RI were recorded. The gray scale prostate examinations were made taking multiple axial and sagittal images. PV and TZV of patients were calculated using the following formula: 0.52 X transverse diameter X anteroposterior diameter X superinferior diameter of the prostate. TZI was calculated by the following formula; TZI=TZV/PV.

Power Doppler examination was performed by using the low gain setup to generate minimal artifact, low PRF, and low wall filter with a minimal pressure applied to the rectal wall. TZ-RI and PZ-RI were measured in axial cross-sections of the prostate (fig 1). The RI was measured in 3 different points for each artery in each prostatic lobe and the mean of these measurements was used.

According to the initial TRUS exam, TZ-RI and PZ-RI values of 3 groups were compared with each other. Then, all patients in three groups were treated by their urologist according to study protocol. The mild symptomatic group was managed with surveillance. In the moderate and severe symptomatic groups AB medication was administered (Tamsulosin 0.4 mg, od). One month after the initiation of AB medication, the patients from Group 2 and 3 were invited to redo the TRUS examination and IPSS re-evaluation.

The Kruskal Wallis, Mann Whitney U, and Wilcoxon Rank’ tests were used for statistical analysis. P value<0.05 was accepted as significant at the 95% confidence interval. The Spearman’s correlation test was used to evaluate the correlation between the IPSS score and TZ-RI and PZ-RI values.

Results

From the 60 patients enrolled in this study 14, 25, and 21 patients were in mild, moderate and severe IPSS groups, respectively. The demographic characteristics and the mean values of the studied parameters in the 3 groups are detailed in Table I. A significant positive correlation between IPSS and TZ-RI (r=0.757, p<0.01) was...
The measurement of the prostatic Resistive Index is a reliable ultrasonographic tool to stratify symptoms

FIG 2. Positive correlation between resistive index of transitional zone of prostate and severity of LUTS. LUTS: Lower Urinary Tract Symptoms

FIG 3. Resistive index of peripheral zone of prostate is positively correlated with symptom severity of the patients.

Table I. Demographic characteristics of the study group.

<table>
<thead>
<tr>
<th></th>
<th>Mild (n=14)</th>
<th>Moderate (n=25)</th>
<th>Severe (n=21)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>59.35±4.36</td>
<td>60.97±5.65</td>
<td>58±7.21</td>
<td>0.713</td>
</tr>
<tr>
<td>PV (cm³)</td>
<td>43.3±5.27</td>
<td>41.9±7.99</td>
<td>44.5±6.41</td>
<td>0.878</td>
</tr>
<tr>
<td>TZV (cm³)</td>
<td>19.5±3.82</td>
<td>17.86±2.9</td>
<td>18.25±3.1</td>
<td>0.635</td>
</tr>
<tr>
<td>TZI</td>
<td>0.45±0.18</td>
<td>0.42±0.21</td>
<td>0.41±0.25</td>
<td>0.375</td>
</tr>
<tr>
<td>PSA (ng/ml)</td>
<td>1.6±0.9</td>
<td>1.7±0.7</td>
<td>1.9±0.5</td>
<td>0.926</td>
</tr>
<tr>
<td>IPSS</td>
<td>5.07±1.32</td>
<td>14.84±2.99</td>
<td>24.76±3.70</td>
<td>≈0.00</td>
</tr>
<tr>
<td>PZ-RI</td>
<td>0.59±0.02</td>
<td>0.64±0.04</td>
<td>0.70±0.02</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>TZ-RI</td>
<td>0.60±0.03</td>
<td>0.66±0.05</td>
<td>0.71±0.05</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

PV: prostate volume; TZV: transitional zone volume; TZI: transitional zone index; PSA: prostate specific antigen; IPSS: International Prostate Symptom Score; TZ-RI: transitional zone resistive index; RZ-RI: peripheral zone resistive index (PZ)

Table II. Changes in IPSS, TZ-RI and PZ-RI values after α-blocker treatment.

<table>
<thead>
<tr>
<th></th>
<th>Before α-blocker</th>
<th>After α-blocker</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate group (n=17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPSS</td>
<td>14.84±2.99</td>
<td>8±3.11</td>
<td>≈0.00</td>
</tr>
<tr>
<td>TZ-RI</td>
<td>0.66±0.05</td>
<td>0.58±0.09</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PZ-RI</td>
<td>0.64±0.04</td>
<td>0.54±0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Severe group (n=15)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPSS</td>
<td>24.76±3.70</td>
<td>12±4.01</td>
<td>≈0.00</td>
</tr>
<tr>
<td>TZ-RI</td>
<td>0.71±0.05</td>
<td>0.62±0.04</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PZ-RI</td>
<td>0.70±0.02</td>
<td>0.57±0.05</td>
<td>≈0.00</td>
</tr>
</tbody>
</table>

IPSS: International Prostate Symptom Score; TZ-RI: transitional zone resistive index; RZ-RI: peripheral zone resistive index (PZ)

found (fig 2). Likewise, the PZ-RI value was positively correlated with the IPSS score of the patients (r=0.699 p<0.01) (fig 3).

One month after the initiation of AB treatment, 17 patients in moderate and 15 patients in the severe IPSS group accepted to redo the TRUS examination. IPSS score and RI value of the patients in group 2 and 3 were calculated and compared with the initial values. Both mean RI values and mean IPSS were statistically significant lower after tamsulosin medication (table II).
Discussions

LUTS reduce the quality of life in aging men and BPH is a common cause for LUTS due to mechanical or functional alteration of the urinary outflow. Surveillance, medical treatment, and surgery are the options for managing BPH related symptoms. Although, there is no strict validated algorithm to predict the exact treatment modality in the management of patients with BPH, medical treatment is the most commonly used fashion among them. In clinical practice, it is important to know the degree of severity of LUTS before and after AB treatment and IPSS is the widely used questionnaire to measure and stratify the subjective complaints of patients.

Some clinical parameters are used to assess the severity of symptoms such as prostatic volume, transitional zone volume, uroflowmetry, DRE, post-voiding residual urine, etc. PV and TZV were the most studied tools used in radiological investigations to estimate the degree of LUTS. But, the impact of PV or TZV on BPH related LUTS is an ongoing controversial issue in the literature. Witjes et al. found a weak correlation between the IPSS and prostate sizes [6]. Also, they noted that the prostate volume alone may not be adequate to evaluate and manage the treatment of patients with BPH.

On the other hand, some authors reported no significant correlation between the prostate volume and symptom score [7,8]. Although the effect of TZV seemed to correlate with LUTS, authors argued that this parameter was not useful in evaluating the clinical degree of severity of BPH [7,9,10]. So, up to now, no consensus has been noted between PV or TZV and the severity of symptoms. This might be also due to the heterogeneity of the study groups and complicated underlying pathophysiology of LUTS. In this study, there was no statistical difference between the three groups regarding TZV and PV. So, our study group appeared rather homogenous in order to evaluate the relationship between IPSS and RI.

In the last two decades, color and power Doppler ultrasonography has begun to be used to evaluate vascular structure of tissues. PDU is considered as the superior generation of color Doppler study to show the intraprostatic hemodynamic changes although Neumaier et al defined intraprostatic vascular anatomy by using transrectal Doppler ultrasonography [11]. Imaging in PDU is not angle dependent which potentially makes it 3-5 times more sensitive to measure intraprostatic vascularity [12]. We also used PDU to measure the RI by a transrectal probe.

Measurement of prostatic RI has been only recently used as a tool to estimate the degree of BPH related LUTS. Most of the published studies indicated the possible relationship between PV and prostatic RI. Firstly, capsular artery RI was studied by Kojima et al who recorded that TZ-RI values are useful in differentiating normal prostate and BPH tissues [3]. Also, some authors demonstrated that increased prostate and zonal volume was correlated with increased prostatic RI [2,5]. However, Berger et al determined the increased RI values only in the TZ [13]. But, these results do not reflect the severity of a patient’s symptoms knowing that an increased volume does not correlate with degree of LUTS in urological practice [7,9,10]. In our study TZV, PV, and TZI were similar between groups so, we excluded the possible impact of prostatic volume on RI and secondary on the relationship between RI and IPSS and on the effect of AB. There were authors that studied the possible relationship between the IPSS questionnaire and RI in their heterogenous series [14,15]. They found that the RI of prostatic arteries was related with patients’ complaints due to BPH. In the present study, our series was rather homogenous and we found a close relationship between the RI of TZ and PZ and the severity of the IPSS questionnaire. A slope in RI value of prostatic arteries was seen after AB treatment which indicates that RI measurement is an objective tool to reflect LUTS related complaint severity in BPH patients.

It is not well understood how prostatic RI increases in BPH patients. It is generally considered that the hypertrophied prostate squeezes the capsule outwards, which results in an increase in intraprostatic pressure and prostatic RI. Kojima et al. [13] and Berger et al. [16] reported a decrease in RI values after the surgical treatment of BPH. The decrease in RI value after a prostatectomy also supports this hypothesis. However, in our study we did not remove hypertrophied tissue from the patients. We have just given AB to BPH related LUTS patient and we also noted a decrease in RI value. Our results show that there should be other pathophysiology causing high RI value in those patients. We think that increased RI values in BPH related LUTS can be more complicated than it appears.

A limited number of studies in literature detected the relationship between the degree of symptom severity and prostatic RI. It was shown that prostatic RI was positively related to IPSS but inversely to the maximum urinary flow rate in patients with BPH [4,17]. Also, Ozden et al. indicated a positive correlation between RI and IPSS [18]. In our study, we measured both transitional and perferic RI and we demonstrated a positive correlation between RI value and the severity of LUTS. Mean RI values differed in three different groups according to IPSS severity index.

The impact of treatment on RI changes is not a well studied subject. Some authors reported a decrease in RI
The measurement of the prostatic Resistive Index is a reliable ultrasonographic tool to stratify symptoms.

Esin Yencilek et al

after a TUR-P operation and an increase in the urinary flow rate [18]. Similarly, a diminished RI measurement was found in some series [13,16]. In our study we studied the effect of AB treatment on the RI value since AB treatment is widely accepted as the initial management in moderate or severe symptomatic patients. We found a decrease in the RI value (both TZ-RI and PZ-RI) after AB treatment and this decrease was correlated with the decrease in IPSS. Up to now, there has been no study indicating the effect of AB on RI changes in the literature.

There is consensus that the evaluation of the PZ-RI is easier than the TZ-RI [11]. Ozdemir et al stated that the RI values of both PZ-RI and TZ-RI increase in patients with BPH. Authors explained this increase as the diffusion of increased intraprostatic pressure through the entire prostatic tissue [17]. We also studied PZ-RI values and it was easy to localize and measure its RI values. Also, we determined a significant correlation between the PZ-RI and IPSS as similar to the relation between TZ-RI and IPSS. Similar to Ozdemir et al our opinion is that increased RI affects the whole prostatic vasculature due to hemodynamic integrity.

The small number of patients enrolled is the main limitation of this study. Secondly, all patients in this study were accepted as BPH on the basis of a PSA lower than 2.5 ng/ml and normal DRE findings, without proven histopathology. The PSA <2.5 ng/ml does not exclude the likelihood of prostate cancer. In addition, DRE can be operator dependent and applied by different urologists. It has been demonstrated that the presence of prostate cancer could affect RI values [19]. Therefore, we do not know whether there was any silent prostate cancer existence in this series because no TRUS guided biopsy was performed.

In conclusion, the severity of symptoms in patients with BPH is the main factor in the decision for a medical approach or surveillance. Although the IPSS questionnaire is an extensively used tool to evaluate and measure LUTS severity, this present study demonstrated that both TZ-RI and PZ-RI measurement are reliable ultrasonographic tools to stratify the severity of the disease in patients with BPH related LUTS. So, they can be a predictor of bothersome complaints in BPH patients.

Conflict of interest: There is no conflict of interest.

References

16. Kojima M, Ochiai A, Naya Y, Ukimura O, Watanabe M,

