Is intravesical prostatic protrusion a risk factor for hydronephrosis and renal insufficiency in benign prostate hyperplasia patients?

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Abstract

Background: Some patients with benign prostate hyperplasia (BPH) and lower urinary tract symptoms hesitate to undergo surgical treatment until acute urinary retention (AUR) occurs. Some of these patients have been found to have hydronephrosis or even renal insufficiency. This study aimed to analyze the risk factors for hydronephrosis in patients with AUR who needed to receive transurethral resection of the prostate (TURP).

Methods: We retrospectively analyzed 91 patients from January 2014 to June 2015, who had BPH and received TURP for AUR. Patients with urolithiasis, prostate cancer, bladder cancer, gross hematuria, previous bladder radiation therapy, or urinary tract surgery were excluded. Parameters of intravesical prostatic protrusion (IPP), serum prostatic specific antigen (PSA), total prostate volume (PV), age, body mass index (BMI), hypertension (HTN), diabetes mellitus (DM), coronary artery disease (CAD), and serum creatinine (Cr) were compared between the hydronephrosis and non-hydronephrosis groups.

Results: There were significant differences in IPP (p < 0.001) and Serum Cr (p < 0.001) between the hydronephrosis and non-hydronephrosis groups. For IPP, the cut-off values of the highest risk of hydronephrosis was 1.95 cm. There were no significant differences in age, BMI, DM, HTN, CAD, total PV, and PSA between the two groups. IPP was not correlated with total PV (p = 0.423). Most of the patients with hydronephrosis had renal function improvement after TURP.

Conclusion: IPP was a significant risk factor for hydronephrosis in BPH patients. If the patients' IPP exceeded 1.95 cm, they had a higher risk of having hydronephrosis when AUR occurred. Hydronephrosis is a risk factor for renal insufficiency, and Serum Cr levels decreased significantly in the patients of our study.

Keywords: Hydronephrosis; Prostatic hyperplasia; Renal insufficiency; Transurethral resection of prostate

1. INTRODUCTION

The prevalence of benign prostatic hyperplasia (BPH) with lower urinary tract symptoms (LUTS) is associated with increasing age. Transurethral resection of the prostate (TURP) is considered the gold standard surgical treatment for LUTS secondary to BPH. The number of TURPs performed has declined and the timing of surgical treatment for patients with BPH is delayed significantly over the last three decades owing to pharmaceutical therapy.

Many complications have been reported in patients with BPH, including urinary tract infections, bladder stones, bladder diverticula, vesicoureteral reflux, hydronephrosis, renal insufficiency, and urinary retention. Among which hydronephrosis, renal insufficiency, and urinary retention are the most prevalent. These complications are regarded as being absolute or relative indications for the surgical removal of the prostatic transition zone. Surgical treatment may relieve the aforementioned complications if performed early enough.

TURP is indicated for patients with bothersome moderate or severe LUTS who request active treatment or who either fail or do not want medical therapy. Among indications for TURP, urinary retention is still by far the most common condition. In the real life, when life expectancy is steadily increasing, many patients with BPH and LUTS hesitate to receive surgical treatment and prefer medical control until the occurrence of acute urinary retention (AUR). These patients appear to be able to tolerate bothersome LUTS, even those refractory to medical control. However, some of these patients may also have hydronephrosis or renal insufficiency with the progression of BPH. Most of whom are unaware of these problems until the incidental finding of AUR.

One of the mechanism of hydronephrosis has been postulated that bladder muscle hypertrophy induced anatomic obstruction of the uretero-vesical junction (UVJ) or functional compression of the UVJ due to increase of ureteral resistance through the ureteral tunnel when there is bladder overdistension. It remains to be evaluated what kind of factor would increase the risk of hydronephrosis and even further induce renal insufficiency in men with BPH.

Therefore, the aim of this study is to analyze whether patients who needed TURP for AUR tended to have hydronephrosis and renal insufficiency. We also present serum Cr and hydronephrosis condition before and after TURP. This is the first article that presents these data completely.
## 2. METHODS

We retrospectively evaluated 184 patients with BPH who received TURP for AUR at Taipei Veterans General Hospital from January 2014 to June 2015. Before analysis, patients with urolithiasis, prostate cancer, bladder cancer, bladder radiation therapy, previous urinary tract surgery, or gross hematuria when AUR occurred were excluded. The patients with systemic inflammatory response syndrome were also excluded. The rationale was to exclude other risk factors for AUR rather than BPH-related factors. We divided the patients into two groups: those with or without hydronephrosis before TURP. Hydronephrosis was evaluated by abdominal sonography within 1 month before TURP. Parameters of intravesical prostatic protrusion (IPP), serum prostatic specific antigen (PSA), total prostate volume (PV), age, body mass index (BMI), hypertension (HTN), diabetes mellitus (DM), coronary artery disease (CAD), and serum creatinine (Cr) were analyzed among these two groups. The lowest serum Cr level within 1 month after surgery was recorded. Total PV was measured by using sonography with the ellipsoid formula: width × height × length × 0.52.

In this study, we measured IPP by sonography within 1 month before TURP. IPP was defined as the distance between the tip of the prostate median lobe and bladder neck in the mid sagittal plane.

### 2.1. Statistical analysis

The statistical analysis was performed by using IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA). \( \chi^2 \) tests, fisher’s exact test, \( t \)-test, Wilcoxon scores, and receiver operating characteristic curve were used.

## 3. RESULTS

Of the 184 patients, 93 patients were excluded due to urolithiasis, prostate cancer, bladder cancer, or gross hematuria. Totally, 91 patients were enrolled. The average age was 75.6 ± 11.4 years (mean ± SD). BMI was 24.5 ± 3.4. The patient number of DM was 19, HTN was 54, and CAD was 12 people. Serum Cr before TURP was 1.83 ± 2.2 mg/dL; PV was 94.4 ± 51.9 cc; PSA was 7.46 ± 6.6 ng/mL and IPP was 1.86 ± 0.77 cm.

We divided these 91 patients into two groups by the hydronephrosis in sonography within 1 month before TURP was performed. There were 24 patients in hydronephrosis group and 67 patients in another. Table 1 shows that there were significant differences in IPP \( (p < 0.001) \) and Cr \( (p < 0.001) \) between the hydronephrosis and non-hydronephrosis groups. There were no significant differences in age, BMI, DM, HTN, CAD, pre-TURP, PSA, UFR between the two groups. IPP was not correlated with total PV \( (p = 0.423) \).

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Hydronephrosis</th>
<th>Non-hydronephrosis</th>
<th>( p )</th>
</tr>
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<tbody>
<tr>
<td>No., n</td>
<td>24</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>75.2 ± 11.7</td>
<td>75.8 ± 11.5</td>
<td>0.93*</td>
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<tr>
<td>BMI</td>
<td>23.3 ± 3.5</td>
<td>24.9 ± 3.4</td>
<td>0.06*</td>
</tr>
<tr>
<td>DM, n</td>
<td>3</td>
<td>16</td>
<td>0.02**</td>
</tr>
<tr>
<td>HTN, n</td>
<td>15</td>
<td>39</td>
<td>0.04**</td>
</tr>
<tr>
<td>CAD, n</td>
<td>2</td>
<td>10</td>
<td>0.37**</td>
</tr>
<tr>
<td>Cr before TURP, mg/dL</td>
<td>3.49 ± 4.09</td>
<td>1.40 ± 1.13</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Prostate volume, cc</td>
<td>101.79 ± 60.83</td>
<td>121.46 ± 240.67</td>
<td>0.36*</td>
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<tr>
<td>IPP, cm</td>
<td>2.36 ± 0.72</td>
<td>1.70 ± 0.71</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>PSA, ng/mL</td>
<td>7.73 ± 6.03</td>
<td>7.50 ± 6.95</td>
<td>0.78*</td>
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</tbody>
</table>

Data are presented as \( n \) or mean ± SD (range). \( * \)Mann–Whitney test. **Fisher’s exact test.

### Table 2

<table>
<thead>
<tr>
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<th>Hydronephrosis</th>
<th>Non-hydronephrosis</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fr/U, No., n</td>
<td>22</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>75.7 ± 11.5</td>
<td>81.3 ± 11.5</td>
<td>0.21*</td>
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<tr>
<td>BMI</td>
<td>23.4 ± 3.6</td>
<td>24.3 ± 3.3</td>
<td>0.48*</td>
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<tr>
<td>Cr before TURP, mg/dL</td>
<td>3.44 ± 3.70</td>
<td>1.71 ± 0.87</td>
<td>0.04*</td>
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<tr>
<td>Cr after TURP, mg/dL</td>
<td>1.32 ± 0.44</td>
<td>1.55 ± 0.93</td>
<td>0.04*</td>
</tr>
<tr>
<td>Difference value of Cr, mg/dL*</td>
<td>2.12 ± 3.58</td>
<td>0.16 ± 0.34</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

Data are presented as \( n \) or mean ± SD (range).

#### 4.1. Renal insufficiency

The mechanism of renal insufficiency is thought to be induced by urine reflux or urinary tract infections. In our study, the serum Cr level was statistically higher in the hydronephrosis group, with a level before TURP as 3.49 ± 4.09 mg/dL in the hydronephrosis group and 1.40 ± 1.13 mg/dL in the non-hydronephrosis group, \( (p < 0.001) \).

Table 2 showed the difference in serum Cr levels before and after TURP. In our retrospective study, most of non-hydronephrosis patient did not have post-TURP serum Cr record due to normal preoperative serum Cr. There were 22 patients and 16 patients followed serum Cr value before and after TURP, respectively. In hydronephrosis group, serum Cr was 3.44 ± 3.70 mg/dL before TURP and 1.32 ± 0.44 mg/dL after TURP. In non-hydronephrosis group, serum Cr was 1.71 ± 0.87 mg/dL before TURP and 1.55 ± 0.93 mg/dL after TURP. Most of the hydronephrosis patients had renal function improvement except one patient who had chronic kidney disease and complicated urinary tract infection after the operation. Difference value of serum Cr (Cr before TURP – Cr after TURP) showed statistically significant decreased serum Cr in hydronephrosis patients compared with non-hydronephrosis patients \( (p < 0.0001) \).

There were only seven patients who repeated sonography after TURP. Six patients showed hydronephrosis with renal insufficiency before operation. Postoperative sonography showed that only one of them had no hydronephrosis improvement. Serum Cr on this patient still improved from 1.95 to 1.35 mg/dL and his IPP was 3.5 cm. All other post TURP hydronephrosis improved patients showed serum Cr improvement.

In a total of 63 patients, 23 patients’ sonography before the operation were with foley catheter inserted. Four patients had hydronephrosis and 19 patients did not. There was no statistically significant \( (p = 0.541) \) relationship of Foley insertion and hydronephrosis before the operation in our data base. In 23 Foley-inserted patients, nine patient’s serum Cr > 1.3 mg/dL before TURP and 14 were not. There was also no statistically significant \( (p = 0.597) \) relationship. Normal serum Cr range was 0.7-1.3 mg/dL in men.

As shown in the Fig. 1, we used ROC curve to analyze the correlation of IPP with hydronephrosis, the cut-off point of IPP was determined as 1.95 cm. AUC (area under curve) = 0.751. And Youden’s index (sensitivity + specificity−1) was 0.376. The sensitivity and specificity was 72.0% and 65.6%, respectively. The odds ratio was 4.909 (95% CI, 1.781 to 13.533).

#### 4. DISCUSSION

Many patients with BPH hesitate to receive surgical treatment even when LUTS cannot be controlled by medications, and some of them suffer from renal insufficiency during disease progression. In this study, we aimed to determine whether patients who needed TURP for AUR tended to have hydronephrosis or renal insufficiency.
Furthermore, men with decreased bladder compliance had higher intravesical pressures compared to those without renal insufficiency. Patients with renal insufficiency have numerous causes for increased intravesical pressure. The most frequent cause is anatomic obstruction of the ureterovesical junction, leading to an increase in vesical pressure during the filling phase. This may play a role in upper urinary tract complications. This may also be the explanation for the high prevalence of hydronephrosis. The degree of IPP was defined as the shortest diameter between the bladder neck and the tip of the IPP on a sagittal image as described by Mariappan et al. Their data base was 121 men. They classified IPP into three grades: grade I, an IPP of <5 mm; grade II, an IPP of 5 to 10 mm; and grade III, an IPP of >10 mm. Grade I, protrusion is 0 to 4.9 mm; grade II, 5 to 10 mm; and grade III >10 mm. All IPP lengths in the patients with BPH with hydronephrosis were grade III in this study. In the non-hydronephrosis group, 11 patients had IPP grade II and 56 patients had grade III. In our study, the cut-off value of IPP that yielded the highest risk of hydronephrosis was 1.95 mm. IPP was well correlated with obstruction condition of BPH in urodynamic testing 11. The result can help patient-physician communication with treatment strategy including TURP or to follow medication. In the future, adding a grade IV, maybe IPP > 2 cm, is to emphasize the risk of hydronephrosis and renal insufficiency. Our study was a retrospective study of 91 patients. The idea of grade IV needs more prospective studies and more patient numbers to support the new grading system.

IPP may also be correlated with PV, detrusor overactivity, bladder compliance, detrusor pressure at maximum urinary flow, bladder outlet obstruction index and post-void residual (PVR), and negatively correlated with Qmax11. Several studies have reported that IPP may predict successful outcomes of trial without catheter after AUR.10,12 More studies are needed to evaluate IPP as a noninvasive alternative to pressure flow studies in the assessment of male LUTS.

The values of PV and IPP are listed in Table 1. IPP was not correlated with total PV (p = 0.423) in our study. The relationship between PV and BPO has been extensively investigated, and a weak correlation has generally been accepted. A reasonable explanation is that not only the size but also the shape of the prostate adenoma causes urethral tract obstruction. The severity of LUTS suggestive of BPH was poorly correlated with BPO.13,14 It had also been shown that IPP is strongly correlated with BPO, and in the current study 21% of the prostate with grade 1 IPP were obstructed, compared to 94% of those with grade 3 IPP. This finding is consistent with a previous study, and suggests that IPP may be a better predictor of BPO than PV.15

4.3. Acute retention of urine

All of our patients had AUR, which can often present as a urological emergency with a sudden inability to urinate often with the symptom of lower abdominal pain.16 Although the etiologies of AUR are variable, BPH accounts for most episodes with the prevalence rate estimated to be as high as 53%.9 For this reason, the prevalence of AUR in the ageing population is likely to increase.

4.4. Hydronephrosis

Two mechanisms have been proposed for hydronephrosis: First, anatomic obstruction of the ureterovesical junction due to bladder muscle hypertrophy as a result of BPO; Second, functional compression of the ureterovesical junction, leading to an increase in ureteral resistance through the ureteral tunnel due to bladder over-distension. Many other possible causes for hydronephrosis have also been proposed.10 One trial enrolled 27 patients with hydronephrosis and found that 52% of these patients had bladder storage pressures (Pdet) > 40 cmH2O at maximum bladder capacity. In addition, higher and sustained urine pressures were related to renal insufficiency in the patients with hydronephrosis, indicating that vesical pressure during the filling phase may play a role in upper urinary tract complications. This may also be one of the mechanisms for the relationship between bladder outlet obstruction and upper urinary tract complications.

With the improvement of medication, the timings of TURPs have been prolonged in this ageing society. Urinary tract problems are still by far the most common indication that motivate patient to receive TURP. In our study, we indicated the risk of hydronephrosis and renal insufficiency in these patients. Young et al. reported...
4.5. Limitations

There are some limitations to this study. First, it was conducted at a single institution and was retrospective. Therefore, certain selection bias is likely to have affected our data. For example, we did not query whether the physicians chose to obtain blood tests or not from their patients. In some patients, postoperative Cr data were not available. Second, ultrasonography was not performed by the same operator, and there were no definite criteria for diagnosing hydronephrosis based on bedside ultrasound. Dilatation of the renal pelvis is a subjective determination tool that may be too difficult to define patients with mild hydronephrosis. In addition, the time duration to AUR before Foley placement was unavailable in most of the patients. It is possible that this may be a factor that helps to distinguish which patients are at risk of hydronephrosis or elevated Cr. Further studies should also investigate this issue. A larger study with more complete baseline and follow-up data collection using the same well-trained ultrasonographers may improve the study results.

In conclusion, IPP was a significant risk factor for hydronephrosis in BPH patients. If the patients’ IPP exceeded 1.95 cm, they had a higher risk of having hydronephrosis when AUR occurred. IPP was not correlated with total PV. Hydronephrosis is a risk factor for renal insufficiency, and Serum Cr decreased significantly in our study. The result can help patient–physician communication with treatment strategy including TURP or keep medication.

REFERENCES