Evaluation of the risk factors associated with the development of post-transurethral resection of the prostate persistent bacteriuria

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Abstract \textbf{Objectives:} To determine the preoperative, intraoperative and postoperative risk factors that influence the development of persistent post-transurethral resection of the prostate (TURP) urinary tract infection (UTI) defined as pyuria and/or bacteriuria remaining for 3 weeks after surgery.

\textbf{Patients and methods:} This is a prospective study including 100 patients scheduled for TURP. Urine analysis and culture was performed immediately after catheter removal, then at 1 and 3 weeks postoperatively, and the results were correlated to various preoperative, intraoperative and postoperative potential risk factors to detect any significant relation to persistent UTI.

\textbf{Results:} There was a statistically significant relationship between bacteriuria and the following risk factors: old age, past history of diabetes mellitus, large prostatic size, positive preoperative urine analysis and culture, preoperative catheter use, previous urological interventions, large size of sheath, long duration of operation, postoperative catheter events and postoperative manual wash.
**Conclusions:** Many risk factors have been found to contribute to the development of post-TURP UTI and avoiding these factors can enhance recovery of patients undergoing TURP.

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**Introduction**

There is much controversy regarding urological endoscopic surgeries and the proposed risk of UTI [1]. TURP has monopolised surgical intervention of BPH-induced LUTS for a long time [2]. However, TURP still carries high morbidity [3], and UTI is the most common complication secondary to this procedure [4]. Post-TURP UTI affects postoperative voiding patterns, and can be followed-up reliably by postoperative urine analysis and culture [4]. The aim of the present study was to evaluate and assess different possible preoperative, intraoperative and postoperative risk factors influencing the development of UTI (pyuria and bacteriuria) after TURP, particularly that which persists for up to 3 weeks after the procedure.

**Patients and methods**

This was a prospective clinical study carried out during the period between March 2014 and September 2016. In all, 100 consecutive men scheduled for TURP were included in this study. Verbal and written consents explaining the purpose of the study were obtained from all patients. Concomitant bladder pathology, including stones, was considered an exclusion criterion. Standard preoperative evaluation was done routinely, including urine culture and antibiotic sensitivity, full laboratory evaluation, abdominopelvic ultrasonography, uroflowmetry, and urodynamic studies, whenever indicated.

**Surgical procedure**

All patients were given 1 g ceftriaxone at induction of anaesthesia, which was regional in all cases, and all were operated upon in the lithotomy position. All surgeons had ≥15 years of experience and had performed ≥300 TURP procedures. TURP was done with either 24- or 26-F resectoscope according to surgeon’s preference and with standard monopolar loops. The cutting power ranged from 90 to 150 W and the coagulation power ranged from 60 to 90 W. Glycine was the standard irrigation fluid in all operations. All procedures were performed using the modified Nesbit technique, whereby the median lobe was resected first, then resection of each lateral lobe starting from the 12 o’clock position to the 6 o’clock position was carried out one lobe at a time, with care taken to avoid subtrigonal resection or injury of the external sphincter. Finally, the apical lobes were resected followed by adequate haemostasis. A three-way urethral Foley catheter was then inserted with a continuous irrigation system. Postoperative management included a 3 day course of i.v. third-generation cephalosporin, unless the preoperative urine antibiotic sensitivity stated otherwise. The catheter was removed after 3 days. Catheter events were handled first by manual wash to relieve clot retention, up to catheter exchange if required.

**Study design**

Urine analysis and culture were obtained for all patients on three occasions: immediately after catheter removal, then at 1 week after TURP, and finally at 3 weeks after TURP. Pyuria was defined as the presence of >5 pus cells/high-power field in a urine sample, whilst bacteriuria was defined as the presence of >100,000 colony-forming units/mL in a urine sample.

All possible preoperative, intraoperative and postoperative risk factors were studied in relation to post-TURP UTI (bacteriuria and pyuria; Table 1).

| Table 1 Possible preoperative, intraoperative and postoperative risk factors that may lead to persistent post-TURP UTI. |
|---|---|---|
| Preoperative | Intraoperative | Postoperative |
| Age | Surgeon’s experience (years and number of TURP operations) | Catheter (size and type) |
| Presentation | Sterilisation (duration of activation of CIDEX®, sterilisation of instruments and telescope) | Blood transfusion |
| Prostate size | Irrigation fluid volume | Catheter events (block, clot retention and exchange) |
| PSA level | Resectoscope size | Continuous irrigation (type of fluid, duration) |
| Urine analysis/culture tests | Power current setting (cutting and coagulation) | Need for manual irrigation to drain clots |
| Catheter if present (type, size and duration) | Duration of operation | Urine analysis/culture 3 weeks after TURP |
| Previous urological interventions | | |
Statistical analysis

The mean and standard deviation (SD) were reported for continuous variables. The chi-squared test and independent t-test were used for univariate analysis to detect statistical significance in categorical and continuous variables. Multivariate logistic regression analysis was used to assess the independent factors affecting UTI. Statistically significant and statistically highly significant results were considered as \( P < 0.05 \) and \( P < 0.001 \), respectively.

Results

Incidence of UTI

The incidence of bacteriuria and pyuria at the three aforementioned post-TURP urine analyses was studied in relation to preoperative, intraoperative and postoperative risk factors. However, only the results of the 3-week post-TURP urine analysis results are shown to avoid repetition and redundancy, especially as there were no apparent differences in the incidence of UTI at the different intervals. Moreover, our main focus in this study was persistent UTI (up to 3 weeks after TURP). In all, 36% and 44% of the patients included in our study had persistent bacteriuria and pyuria, respectively.

Persistent post-TURP bacteriuria and relation to perioperative factors

Univariate analysis

The relation of post-TURP bacteriuria to preoperative risk factors. There was a significant relationship of persistent post-TURP bacteriuria to the patient’s age, prostatic size, positive preoperative urine analysis and culture, preoperative catheterisation, previous urological interventions, and history of diabetes mellitus (DM). There was no statistically significant relationship for the other variables measured (Table 2).

The relation of post-TURP bacteriuria to intraoperative risk factors. Persistent post-TURP bacteriuria was only significantly related to the size of the resectoscope sheath used for TURP and the duration of the operation (Table 3).

The relation of post-TURP bacteriuria to postoperative risk factors. There was only a significant relationship of persistent post-TURP bacteriuria to postoperative catheter events (block, exchange, and manual wash; Table 4).

Multivariate analysis

On multivariate logistic regression analysis, we found statistically significant relationships between persistent post-TURP bacteriuria and the following risk factors: old age, past history of DM, large prostatic size, positive preoperative urine analysis, preoperative catheter use, previous urological interventions, large size of sheath, long duration of operation, postoperative catheter events, and postoperative manual wash (Table 5).

Persistent post-TURP pyuria and relation to perioperative factors

Univariate analysis

There was a statistically significant relationship between persistent post-TURP pyuria and the following risk factors: old age, past history of DM, large prostatic size, positive preoperative urine analysis, positive urine culture, preoperative catheter use, large size of sheath, long duration of operation, postoperative catheter events, and postoperative manual wash.

Multivariate analysis

Our multivariate logistic regression analysis revealed many independent statistically significant risk factors related to the occurrence of persistent post-TURP pyuria: old age, past history of DM, large prostatic size, positive preoperative urine analysis, positive urine culture, preoperative catheter use, large size of sheath, long operation time, postoperative catheter events, and postoperative manual wash.

Sterile pyuria

Eight of the studied patients (8%) had persistent postoperative pyuria without bacteriuria. This was not statistically significant. Causes of sterile pyuria are multiple and beyond scope of our study.

Discussion

In urology, the prevention of postoperative infectious complications is important and only a few studies have evaluated the risk factors [5]. Studies on the epidemiology and risk factors for post-TURP bacteriuria in urology have been limited [7,10]; so we carried out our present study to identify the potential risks factors that may increase the incidence of post-TURP infection (particularly persistent pyuria and bacteriuria).

The reported incidence of UTI in patients undergoing TURP varies widely. In two different studies it was 26% and 34.9% [5,6], whilst in other reports the infection rate was as low as 3.5% [4] and 1.9% [7]. The specific incidence of postoperative bacteriuria has been reported to be 7.6–26% [7,8].

In our present study, we found a higher incidence of postoperative bacteriuria (36% at 3 weeks) compared to Colau et al. [6] (5% at 4 weeks) and Wagenlehner et al. [9] (28% at 3–5 weeks). This could be attributed to peri-
operative patients' characteristics and postoperative catheter events.

For the influence of preoperative risk factors on postoperative UTI, two studies in addition to our present study found that age was a risk factor for postoperative bacteriuria [7,11]; however, this was contradicted in two other studies that found no statistically significant effect of age [6,8]. In the present study, a prostate size of > 60 g was significantly correlated with postoperative bacteriuria and this was also reported by Hwang et al. [11]. In the present study, DM was a significant risk factor for post-TURP UTI and various reports have identified DM as a risk factor [7,8,11].

Table 2 The incidence of bacteriuria in relation to preoperative variables of patients scheduled for TURP.

| Preoperative variable                  | Postoperative bacteriuria | Chi-squared test |
|---------------------------------------|---------------------------|-----------------|
|                                       | Negative | Positive | \( \chi^2 \) | \( P \) |
| Age, years                             |          |          |              |        |
| <65, \( n \) (%)                      | 24 (85.7)| 4 (14.3) | 7.96        | 0.005 HS |
| >65, \( n \) (%)                      | 40 (55.6)| 32 (44.4)|            |          |
| Presentation                          |          |          |              |        |
| LUTS, \( n \) (%)                     | 28 (70) | 22 (30)  | 4.42        | 0.109   |
| Haematuria, \( n \) (%)               | 11 (73.3)| 4 (26.7) |            |          |
| Urine retention, \( n \) (%)          | 30 (75) | 10 (25)  |            |          |
| Prostatic size, g                     |          |          |              |        |
| <60, \( n \) (%)                      | 23 (82.1)| 5 (17.9) | 5.56        | 0.018 S  |
| >60, \( n \) (%)                      | 41 (56.9)| 31 (43.1)|            |          |
| Free PSA, ng/mL                       |          |          |              |        |
| Mean (SD)                             | 0.85 (0.57)| 1.04 (0.92)| 1.28     | 0.325 S  |
| Range                                 | 0–2      | 0–2.91   |            |          |
| Total PSA, ng/mL                      |          |          |              |        |
| Mean (SD)                             | 3.10 (1.75)| 3.77 (2.19)| 1.66     | 0.100 S  |
| Range                                 | 0–6.1    | 0–6.5    |            |          |
| Preoperative urine analysis           |          |          |              |        |
| No pyuria, \( n \) (%)                | 39 (75.0)| 13 (25.0)| 5.69        | 0.017 S  |
| Pyuria, \( n \) (%)                   | 25 (52.1)| 23 (47.9)|            |          |
| Preoperative urine culture            |          |          |              |        |
| No bacteriuria, \( n \) (%)           | 54 (79.4)| 14 (20.6)| 21.90       | <0.001 HS|
| Bacteriuria, \( n \) (%)              | 10 (31.3)| 22 (68.8)|            |          |
| Urea, mg/dL                           |          |          |              |        |
| Mean (SD)                             | 26.22 (7.05)| 28.61 (8.93)| 1.48     | 0.143 S  |
| Range                                 | 17–44    | 18–44    |            |          |
| Creatinine, mg/dL                     |          |          |              |        |
| Mean (SD)                             | 1.23 (0.33)| 1.31 (0.49)| 1.09     | 0.439 S  |
| Range                                 | 0.7–1.9  | 0.7–2.6  |            |          |
| Preoperative catheter                 |          |          |              |        |
| No, \( n \) (%)                       | 52 (72.2)| 20 (27.8)| 7.55        | 0.006 HS |
| Yes, \( n \) (%)                      | 12 (42.9)| 16 (57.1)|            |          |
| Catheter size, F                      |          |          |              |        |
| Mean (SD)                             | 18.33 (0.78)| 18.75 (1.00)| 1.20     | 0.243 S  |
| Range                                 | 18–20    | 18–20    |            |          |
| Preoperative catheter duration, days  |          |          |              |        |
| Mean (SD)                             | 13.17 (4.88)| 10.25 (5.11)| –1.52    | 0.139 S  |
| Range                                 | 5–20     | 3–21     |            |          |
| Previous urological interventions     |          |          |              |        |
| No, \( n \) (%)                       | 54 (73.0)| 20 (27.0)| 9.946       | 0.001 HS |
| Yes, \( n \) (%)                      | 10 (38.5)| 16 (61.5)|            |          |
| Past history of DM                    |          |          |              |        |
| No, \( n \) (%)                       | 52 (70.3)| 22 (29.7)| 4.86        | 0.028 S  |
| Yes, \( n \) (%)                      | 12 (46.2)| 14 (53.8)|            |          |
| Past history of IHD                   |          |          |              |        |
| No, \( n \) (%)                       | 54 (64.3)| 30 (35.7)| 0.02        | 0.890    |
| Yes, \( n \) (%)                      | 10 (62.5)| 6 (37.5) |            |          |
| Past history of HTN                   |          |          |              |        |
| No, \( n \) (%)                       | 56 (65.1)| 30 (34.9)| 0.33        | 0.564    |
| Yes, \( n \) (%)                      | 8 (57.1)| 6 (42.9) |            |          |
| Past history of HCV                   |          |          |              |        |
| No, \( n \) (%)                       | 58 (65.9)| 30 (34.1)| 1.16        | 0.281    |
| Yes, \( n \) (%)                      | 6 (50.0)| 6 (50.0) |            |          |

IHD, ischaemic heart diseases; HTN, hypertension; HCV, hepatitis C virus; S, significant; HS, highly significant.

* Independent \( t \)-test.
toms or PSA level were risk factors for postoperative infection. However, Ansari et al. [17] found that preoperative catheter duration was a significant risk factor for post-TURP UTI.

Evaluating the potential intraoperative risk factors, we found a statistically significant relationship between post-TURP persistent bacteriuria and the use of a large resectoscope sheath (26 vs 24 F) and a long duration of operation. Most studies, as well as our present study, agree that a longer operation (>60 min in the present study) is a major risk factor for postoperative UTI [4,8,9,18]. However, this has also been denied in another study [11].

Postoperative catheter events and postoperative manual wash were statistically highly significantly associated with post-TURP UTI. Many studies have shown that

### Table 3

The incidence of bacteriuria in relation to intraoperative variables of patients after TURP.

| Intraoperative variable          | Preoperative bacteriuria | Independent t-test |
|----------------------------------|--------------------------|--------------------|
|                                 | Negative     | Positive     | t  | P      |
| Surgeon experience, years       | Mean (SD)    | 22.94 (8.09) | 20.56 (6.34) | -1.44 | 0.311 |
|                                 | Range        | 15–39        | 15–37        |       |       |
| Surgeon number of previous TURPs| Mean (SD)    | 37.94 (8.09) | 35.56 (6.34) | -1.44 | 0.311 |
|                                 | Range        | 30–54        | 30–52        |       |       |
| Duration of activation of CIDEX, days | Mean (SD) | 6.13 (3.13) | 5.68 (2.61) | -1.04 | 0.512 |
|                                 | Range        | 1–13         | 1–12         |       |       |
| Volume of irrigating fluid, L   | Mean (SD)    | 17.88 (2.83) | 18.72 (3.64) | 1.30  | 0.198 |
|                                 | Range        | 13–25        | 14–26        |       |       |
| Size of sheath, F                | 24, n (%)    | 18 (90.0)    | 2 (10.0)     | 7.34  | 0.006* |
|                                 | 26, n (%)    | 46 (57.5)    | 34 (42.5)    |       |       |
| Coagulation power, W             | Mean (SD)    | 77.50 (11.55)| 74.22 (7.31) | -1.54 | 0.128 |
|                                 | Range        | 60–100       | 60–90        |       |       |
| Cutting power, W                 | Mean (SD)    | 101.88 (11.11)| 100.56 (8.60)| -0.62 | 0.539 |
|                                 | Range        | 90–150       | 90–150       |       |       |
| Duration of operation, min       | <60, n (%)   | 20 (63.6)    | 2 (36.4)     | 8.86  | 0.002* |
|                                 | >60, n (%)   | 44 (64.1)    | 34 (35.9)    |       |       |
| HS, highly significant.          |             |             |             |       |       |
| * Chi-squared test.              |             |             |             |       |       |

### Table 4

The incidence of bacteriuria in relation to postoperative variables of patients after TURP.

| Postoperative variable          | Postoperative bacteriuria | Independent t-test |
|----------------------------------|--------------------------|--------------------|
|                                 | Negative     | Positive     | t  | P      |
| Catheter size, F                | Mean (SD)    | 23.56 (0.83) | 23.44 (0.91) | -0.66 | 0.512 |
|                                 | Range        | 22–24        | 22–24        |       |       |
| Blood transfusion                | No, n (%)    | 58 (67.4)    | 28 (32.6)    | 3.16  | 0.076* |
|                                 | Yes, n (%)   | 6 (42.9)     | 8 (57.1)     |       |       |
| Antibiotics Type                 | 3rd G.CS, n (%)| 64 (64.0)  | 36 (36.0)    | NA    | NA*   |
| Antibiotics duration, days       | Mean (SD)    | 3.87 (0.79) | 4.12 (0.64) | 1.26  | 0.426 |
|                                 | Range        | 3–5          | 3–5          |       |       |
| Catheter events                  | No, n (%)    | 59 (73.8)    | 21 (26.3)    | 16.50 | <0.001* |
|                                 | Yes, n (%)   | 5 (25.0)     | 15 (75.0)    |       |       |
| Continuous irrigation fluid      | Normal saline, n (%)| 14 (53.8) | 12 (46.2)    | 1.57  | 0.210* |
|                                 | Sterile water, n (%)| 50 (67.6) | 24 (32.4)    |       |       |
| Continuous irrigation duration, h| Mean (SD)    | 31.56 (8.86)| 35.00 (12.29)| 1.62  | 0.109 |
|                                 | Range        | 20–48        | 2–48         |       |       |
| Manual wash                      | No, n (%)    | 56 (70.0)    | 24 (30.0)    | 6.25  | 0.012* |
|                                 | Yes, n (%)   | 8 (40.0)     | 12 (60.0)    |       |       |
| S, significant; HS, highly significant. |       |             |             |       |       |
| * Chi-squared test.              |             |             |             |       |       |
disconnection of the closed urinary catheterisation system was a major risk factor for infection, which corresponds with our present results [4,9,12,18].

We found that the interval to removal of the catheter had no influence on infection, as has also been reported by Irani et al. [19]. However, contradicting our present results, several studies identified long indwelling postoperative urethral catheters (for >3 days) as a risk factor for UTI after TURP [4,6,12,18].

Pourmand et al. [12] reported that longer irrigation duration was a risk factor for occurrence of bacteriuria, in disagreement with our present results. We did not find any previous studies assessing postoperative catheter size nor infusion set as risk factors for postoperative infection.

A larger resectoscope sheath was found to have a statistically significant impact on post-TURP bacteriuria. We screened the literature and similar studies that addressed the same issue and found nothing to justify the relationship. Any justification on our behalf would therefore be a mere guess with no scientific basis. One possible explanation is that urinary tract instrumentation may cause ‘trauma’ that renders the patient susceptible to UTI by triggering an inflammatory cascade.

Again, a similar relationship exists between post-TURP bacteriuria and previous urological surgery. One possible reason may be that previous urological surgery often implies urinary tract anatomical or pathological aberration, which may predispose to a higher incidence of UTI. However, this is merely conjecture and requires substantiation through further studies.

Study limitations included: (a) Some risk factors for UTI were observational, such as size of resectoscope sheath and previous urological surgeries; (b) Given the large number of risk factors, a larger cohort of patients would have defined them more accurately; (c) Short follow-up, the long-term outcome of these patients remains unknown; and (d) We did not correlate the mere presence of bacteriuria to the symptoms and complications.

In summary, independent risk factors for persistent post-TURP UTI in our present study were: old age, past history of DM, large prostatic size, positive preoperative urine analysis, preoperative catheter use, previous urological interventions, large resectoscope sheath, a long duration of operation, postoperative catheter events and postoperative manual wash. Our present results are in agreement with the findings of most similar studies.

Conclusion

We identified many avoidable preoperative, intraoperative and postoperative risk factors for post-TURP UTI. However, larger prospective studies are required to unify risk factors for post-TURP infection in order to improve the results of our ‘gold standard’ procedure for treatment of BPH.

Conflicts of interest

None declared.

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