Original Article

Assessment of posterior urethra in benign prostatic hyperplasia and after its surgery

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Abstract

Introduction: Surgical management of benign prostatic hyperplasia (BPH) primarily consists of transurethral resection of the prostate (TURP). Due to BPH and after surgical intervention, anatomic variations in the posterior urethra are expected. Due to the paucity of information regarding posterior urethral anatomic variations in these conditions and its aftermath, this study was undertaken to evaluate the anatomic variations in the posterior urethra after TURP.

Materials and Methods: This prospective observational study was conducted over 2 years at the Department of Surgery and Radiodiagnosis, University College of Medical Sciences, Delhi. All consenting patients undergoing TURP for BPH were included in the study. We assessed the posterior urethral changes in BPH before and 3 months after the procedure. Diagnostic modalities used were urethrocystoscopy, micturating cystourethrogram, and retrograde urethrogram. Furthermore, the prostate volume and postvoid residual volume of urine were compared before and after its surgery using ultrasonography. Urodynamic studies were used to calculate total voided volume (TVV), peak flow rate (PFR), voiding time (VT), and hesitancy.

Results: Mean age of the patients was 68.12 ± 7.83 years. Lengthening in posterior urethra was seen in BPH patients with a mean of 4.24 ± 1.012 cm. Postprocedure, there was a mean reduction of 2.6 ± 1.225 cm in length of the posterior urethra ($P < 0.0001$). Prostatic urethral angle was increased in patients suffering from BPH, and it decreased after undergoing surgical management ($P < 0.679$). All patients enrolled in our study had prostatic lobes enlargement, and after surgery, this enlargement was reduced in most of the patients with 21 having no prostatic enlargement, and in four patients, bilateral lateral lobe was not completely reduced ($P = 1.000$). Stricture in prostatic urethra was observed in 2 out of 25 (8%) patients operated for BPH. Evaluation of various parameters of urodynamic studies revealed the net improvement in the TVV of 157.746 ± 120.999 ml, as before the procedure, this value was 176.715 ± 72.272 ml, and after surgery, it was 334.46 ± 78.588 ml ($P < 0.001$). VT taken by patients before surgery was 57.377 ± 16.858 s, and postprocedure, this value was 33.31 ± 8.807 s. This net reduction of 24.069 ± 14.88 s was statistically significant ($P < 0.0001$). PFR before the procedure was 6.177 ± 3.5067, and postprocedure, this value was 26.43 ± 7.112 ml/s with a net improvement of 20.253 ± 9.226 ml/s ($P < 0.0001$). Hesitancy in BPH patients before the procedure was 23.908 ± 15.521 s. Postprocedure, hesitancy decreased to a value of 6.79 ± 4.435 s with a net reduction of mean 17.115 ± 15.817 s ($P < 0.002$).

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Conclusion: By our findings, we conclude that BPH is associated with anatomic variations in posterior urethra such as lengthening of the length of the posterior urethra and increased posterior urethral elevation, which is measured by an increase in posterior urethral angle (PUA). Whereas post-TURP, there is a shortening of posterior urethra, decrease in PUA, decrease in prostatic volume, postvoid residual urine volume, and improvement in uroflowmetric parameters.

Keywords: Anatomic variations, benign prostatic hyperplasia, posterior urethra, transurethral resection of the prostate

INTRODUCTION

Benign prostatic hyperplasia (BPH) affects nearly three in four men by the seventh decade of life.[1] It refers to the nonmalignant growth of prostate which is observed commonly in aging male.[2] BPH is a histological diagnosis that includes prostatic stromal and epithelial hyperplasia involving the transitional zone and periurethral glands.[3] Involvement of periurethral transitional zone by BPH causes compression of this part of the urethra leading to increased urethral resistance and changes in bladder function. These changes in urethral resistance and bladder function can present clinically as lower urinary tract symptoms (LUTS), bladder outlet obstruction, incomplete bladder emptying, acute and chronic urinary retention, recurrent urinary tract infections, and hematuria.[4]

Surgical management of BPH consists primarily of transurethral resection of the prostate (TURP). However, there are some specific indications for open prostatectomy.

Due to BPH and after TURP, anatomic variations in the posterior urethra are expected, and in both of these conditions, anatomic variation in the posterior urethra can have different clinical manifestations. Numerous studies have been done on common postprostatectomy complications such as urinary incontinence, retrograde ejaculation, vesical neck contracture, impotence, and others, but there is a paucity of information in existing literature regarding posterior urethral anatomic variations in cases of the BPH and after TURP. Therefore, this study was undertaken to assess anatomical variations in the posterior urethra and its aftermath in these conditions.

Aims and objectives

Aim

The aim is to study and assess the posterior urethra in BPH patients before and after prostate surgery.

Objectives

The main objective is to study and assess the posterior urethra in BPH patients before and after prostate surgery through uroflowmetry, ultrasonography, micturating cystourethrogram (MCU) (wherever necessary), retrograde urethrography (RGU) (wherever necessary), and cystoscopy.

MATERIALS AND METHODS

This prospective observational study was conducted over 2 years at the Department of Surgery and Department of Radiodiagnosis, University College of Medical Sciences and GTB Hospital, Dilshad Garden, Delhi. Informed consent was obtained from all the participants of this study. All the consenting patients undergoing TURP for BPH during this period were included in this study. Patients having a prior history of urethral instrumentation or intervention, bladder surgery, pelvic or urethral trauma, and documented cases of the sexually transmitted disease were excluded from the study. Although taking the incidence of postprostatectomy urethral complications 5%–15% at 95% confidence level, the calculated sample size was 139 patients. However, during this period, we were able to accommodate only 25 participants in this study which also included at least 3 months of following up.

Preprocedure evaluation included a complete history and examination as per the case record form as well as urethroscopy (performed using 16.5 Fr rigid scope), ultrasonography, uroflowmetry, MCU (wherever necessary), and RGU (wherever necessary). All these parameters were evaluated as a part of the postprostatectomy evaluation after 3 months.

Posterior urethra length was measured in this study using urethrocystoscopy. First marking was done on urethroscope when it was at the level of the bladder neck, second marking was done at the level of verumontanum, and third marking was done at the level of the external urethral sphincter. The distance between the first and second marking gave the length of the posterior part of prostatic urethra, and distance between the first and third marking gave the length of the whole posterior urethra. Posterior urethral angle (PUA) measurement was done in all patients using urethroscopy. At the level of verumontanum, the angle by which cystoscope was lowered to enter the bladder neck was measured using standard angle measuring scale. It was divided into the following categories: (1) <15°, (2) 15°–30°, (3) 30°–45°, and (4) >45°, while doing a cystoscopy, this angle was seen as elevation from verumontanum to bladder neck, i.e., posterior urethral elevation term is used in the text to describe this angle.

Statistical analysis was done using SPSS software version 20 (SPSS, Version-16, IBM, Chicago). Paired *t*-test was used for scoring and quantitative measures. McNemar test was used for assessment of qualitative measures.

RESULTS

In this study, we enrolled total of 25 patients suffering from BPH who underwent surgical management (TURP). The mean age of the patients was 68.12 ± 7.83 years. Lengthening in posterior urethra was seen in BPH patients with a mean of 4.24 ± 1.012 cm. After surgery, mean length was noted to be 1.64 ± 0.638 cm. Postprocedure, there was a mean reduction of 2.6 ± 1.225 cm in length of the posterior urethra. Using a paired *t*-test, this reduction in length was statistically significant ($P < 0.0001$). Prostatic urethral angulation was measured for each patient enrolled in a study using urethrocystoscopy, and the same measurement was done 3 months after the surgery. Prostatic urethral angle (PUA) was increased in patients suffering from BPH, and it decreased after undergoing surgical management, which was statistically not significant ($P = 0.679$) [Table 1]. All patients enrolled in our study had prostatic lobes enlargement, and after surgery, this enlargement was reduced in most of the patients with 21 having no prostatic enlargement, and in four patients, bilateral lateral lobe was not completely reduced ($P = 1.000$). Stricture in prostatic urethra was observed in 2 out of 25 (8%) patients operated for BPH. Presence of stricture was diagnosed after 3 months of follow-up on cystoscopy and confirmed in MCU/RGU. Out of these two, only one was symptomatic for urethral stricture showing LUTS. However, none of the patients operated was found to have urethral diverticulum or periurethral abscess after surgery in our follow-up 3 months. There were no changes observed in verumontanum using urethrocystoscopy in BPH patients after surgery.

Mean prostate volume measured using transabdominal ultrasonography before the procedure was 58.65 ± 24.037 cc. Postprocedure, this value was 13.81 ± 4.342 cc. Net mean reduction in prostate volume was 44.8480 ± 24.487 cc. Analysis of these values using paired *t*-test revealed to be statistically significant ($P < 0.0001$). Out of 25 patients, the preoperative postvoid residual volume could be determined in only 14 patients with a mean volume of 227.42 ± 105.07 ml and the remaining 11 patients were on Foley's catheter. Postprocedure, postvoid residual volume except for two patients who developed urinary incontinence was 28.78 ± 8.45 ml.

Evaluation of various parameters of urodynamic studies [Table 2] revealed the net improvement in the total voided volume (TVV) of 157.746 ± 120.999 ml, as before the procedure, this value was 176.715 ± 72.272 ml, and after surgery, it was 334.46 ± 78.588 ml ($P < 0.001$). Voiding time (VT) taken by patients before surgery was 57.377 ± 16.858 s, and postprocedure, this value was 33.31 ± 8.807 s. This net reduction of 24.069 ± 14.88 s was statistically significant ($P < 0.0001$). Peak flow rate (PFR) before the procedure was 6.177 ± 3.5067, and postprocedure, this value was 26.43 ± 7.112 ml/s with a net improvement of 20.253 ± 9.226 ml/s ($P < 0.0001$). Hesitancy in BPH patients before the procedure was 23.908 ± 15.521 s. Postprocedure, hesitancy decreased to a value of 6.79 ± 4.435 s with a net reduction of mean 17.115 ± 15.817 s ($P < 0.002$).

Although it was not our objective to have any serum prostate-specific antigen (PSA) correlation pre- and post-procedure from the data, we collected in our patients revealed a significant net reduction of serum PSA of 4.906 ± 8.262 after surgery ($P < 0.007$).

DISCUSSION

Most of the available studies about follow-up of patients who had undergone TURP or open prostatectomy have focused on improvement in the symptomatology of patients, improvement in urodynamic parameters after surgery, or complications arising after surgery. In both these surgical options, it is believed that posterior urethral integrity is disturbed. Therefore, in this study, we aimed to

Table 1: Illustrating the number of patients having different posterior urethral angle before and after the procedure

PUA	<15°	15°-30°	30°-45°	>45°	*P*
Preprocedure	0	3	14	8	
Postprocedure	21	4	0	0	0.679

PUA: Posterior urethral angle

Table 2: Urodynamic study parameters before and after surgery

	TVV (ml)	VT (s)	PFR (ml/s)	Hesitancy (s)
Preprocedure	176.715	57.377	6.177	23.9
Postprocedure	334.46	33.31	26.43	6.79
Mean change	157.74	24.06	20.25	17.11
P	<0.001	<0.0001	<0.0001	<0.002

TVV: Total voided volume, VT: Voiding time, PFR: Peak flow rate assess the variations in the normal anatomy of the urethra and prostatic fossa after the surgery along with other complications and parameters.

Posterior urethra consists of prostatic urethra (3 cm) and membranous urethra (1.5 cm). Babinski *et al.*[5] calculated the volume density of the prostatic urethra in 10 patients (mean age-66 years) with clinical symptoms of bladder outflow obstruction who had undergone open prostatectomy. They compared their results with 10 control participants, and they concluded that BPH causes a significant decrease in elastic fibers and collagen in the prostatic urethra. They also stated that BPH increases urethral resistance and lengthening of the prostatic urethra. Our study also showed lengthening of prostatic urethra with a mean length of 4.24 cm from verumontanum to bladder neck measured before surgical intervention by urethrocystoscopy. Three months after the surgery, mean length of the prostatic urethra was 1.64 cm with a mean reduction of 2.6 cm, and this change was statistically significant ($P < 0.0001$). This decreased in length can be explained by the subsequent healing and fibrosis which occurs after prostatic tissue or adenoma resection. Babinski *et al.* described that BPH increases urethral resistance, resulting in pressure of tissue expansion to the urethra and leads to an increase in outflow resistance, accompanied by characteristic lengthening of prostatic urethra.[5] They also concluded that BPH causes decrease in elastic fibers and collagen in prostatic urethra.[5]

Moreover, eliminating the obstruction decreases the outflow resistance in the urethra thus removing the additional factor for urethral lengthening in BPH. BPH as a disease process or surgery to cure it did not have any significant impact on a distal portion of prostatic urethra or membranous urethra as this portion of the urethra does not interfere with the disease process or its surgical management. Even after an extensive search, we could not find studies on postoperative length of the prostatic urethra in English literature.

Prostatic urethra runs through the prostate from base to the apex making an anterior angulation of 35° at the proximal part of verumontanum. This angulation is perceived urethrocystoscopically as elevation from the level of verumontanum toward the level of the bladder neck. For this reason, we have referred this as an elevation in the text. Ku *et al.*[6] did a retrospective analysis of 260 men with LUTS and BPH aged >50 years. They reported that patients with higher PUA (≥35°) had higher PSA levels ($P = 0.008$), larger prostate volume ($P < 0.001$), high maximal urethral closure pressure ($P = 0.004$), higher detrusor pressure at maximal flow rate ($P = 0.008$), and higher bladder outflow obstruction index ($P = 0.032$), in comparison with those who had lower PUA. They also postulated that PUA can be one of the methods to assess the presence of bladder outflow obstruction in men with LUTS and BPH. Park *et al.* conducted a retrospective analysis of 270 men with BPH/LUTS from July 2009 to June 2011 and reported that PUA had significant correlation with International Prostate Symptom Score (IPSS).[7] Patients with higher PUA had higher IPSS and symptom severity.[7] Cho *et al.* demonstrated that patients with PUA more than 35° were more likely to have equivocal or outlet obstruction than those with PUA <35°.[6]

Tan *et al.*[8] in their study of 342 patients noted 2.6% incidence (nine cases) post-TURP of the anterior urethral stricture. No posterior urethral stricture was noted in this study. Bhageria *et al.*[9] found that the incidence of urethral stricture after TURP varies between 2.2% and 9.8%. Varkarakis *et al.*[10] did a study on long-term results of open transvesical prostatectomy for prostate size >75 g and reported 0.6% incidence of urethral stricture after surgery. In this study, 2 out of 25 (8%) developed a posterior urethral stricture ($P = 1.000$). The stricture was diagnosed on urethroscopy 3 months after the surgery and later confirmed on MCU. This high percentage of urethral stricture noted in our study can be attributable to the small number of patients included in this study.

Kallenberg *et al.*[11] reported 80% reduction in the mean postvoid residual volume after TURP.($P < 0.001$). Varkarakis *et al.*[10] also reported significant improvement in postvoid residual volume after transvesical prostatectomy. In this study, we could compare PVR in only 14 patients as 11 patients were on Foley catheter before the surgery. Mean reduction in PVR in these patients was statistically significant.

Kallenberg *et al.*[11] noted 187% increase in mean PFR ($P < 0.001$), 69% significant improvement in TVV ($P < 0.001$) after TURP. In this study, we calculated TVV, VT, PFR, and hesitancy before and after surgery. TVV showed significant increase of 157.74 ml ($P < 0.001$), VT showed significant decrease of 27.06 s ($P < 0.0001$), and PFR showed significant increase of 20.25 ml ($P < 0.002$). These findings suggest that surgical management does significantly improve the urinary flow in BPH patients.

Retrograde ejaculation can occur after prostate surgery due to injury to bladder neck during surgery which can lead to a backward flow of all or part of semen into the bladder at the time of ejaculation. In a study conducted by Pavone *et al.*[12] on 264 patients of BPH after TURP, the incidence of retrograde ejaculation was 47.8%. In this study, we did not come across any case of complete retrograde ejaculation postoperatively.

Van Kampen *et al*. evaluated 489 patients, out of which 216 underwent TURP. Incontinence was observed in 19% patients immediately after catheter removal, 16% after 1 month, 8% after 3 months, 3% after 6 months, 2% after 9 months, 1.5% after 1 year, and 0.5% after 15 months of follow-up.[13] Nitti *et al*. evaluated 50 patients who underwent TURP out of which 20 (40%) developed incontinence.[14] Cause of incontinence was demonstrated in 19 out of 20 patients (95%), 4 (20%) had sphincteric insufficiency and 15 (75%) had detrusor instability.[14] In this study, we encountered two cases (8%) of urinary incontinence after TURP (P = 1.000). This high rate of urinary incontinence can be attributed to small sample size of this study.

ED is defined as the inability to achieve and maintain erection for satisfactory intercourse.[15] Wein *et al*. conducted a large EpiLUTS study and found that sexual activity decreased with increasing LUTS. Of 2954 patients who participated in this study, 28.8% said that their sexual activity is decreased because of LUTS while another 24.8% had decreased or stopped sexual activity.[16] Rosen *et al*. conducted multinational survey of aging male-7 and reported that severity of LUTS was a strong predictor of sexual dysfunction, with an odds ratio for erection problem of 8.9 in those with severe LUTS.[17] Pavone *et al*. conducted a retrospective longitudinal study on 264 patients suffering from who underwent TURP in a period of 2008–2012. 94.32% of sample reported being sexually active, with good ED in 41.3% of cases before TURP. After TURP, mild-to-moderate ED was observed in 51.5% of cases and complete ED was reported in 51.5% of cases and complete ED was reported in 1.5% of cases.[12] Contradictory to above-mentioned studies, Jaidane *et al*. concluded that TURP improves erectile function in BPH patients with severe urinary symptoms.[18] BPH is the significant cause of LUTS; hence, it can be inferred that ED is a significant problem in BPH patients which have a significant impact on their quality of life. One must confirm the presence of ED in BPH patients before planning intervention, and after TURP, it should be evaluated as intervention itself may cause this problem. In this study, we encountered four cases of ED after TURP.

CONCLUSION

On the basis of our findings, we conclude that BPH causes anatomic variations in posterior urethra such as lengthening of the length of the posterior urethra (specifically posterior part of prostatic urethra) and increased posterior urethral elevation, which is measured by an increase in PUA. TURP leads to shortening of the posterior urethra, decreased PUA, decrease in prostatic volume, postvoid residual urine volume, serum PSA levels, and improvement in uroflowmetric parameters. However, there is a need for more studies with larger number of patients to confirm these posterior urethral variations and its aftermath in both the conditions.

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Conflicts of interest

There are no conflicts of interest.

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