Post-void Residual Urinary Volume Is An Independent Predictor of Biopsy Results in Men at Risk for Prostate Cancer

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Abstract. *Aim: to determine whether peak flow rate (PFR) and post-void residual urinary volume (PVRUV) predict prostate biopsy outcome. Patients and Methods: The study population consisted of 1780 patients undergoing first prostate biopsy. Results: Patients with prostate cancer (PCa) had significantly greater prostate-specific antigen (PSA) and PFR but lower prostate volume (PVol) and PVRUV than those without PCa. Receiver operator characteristic curve analysis showed that PVol and PVRUV were the most accurate predictors of biopsy outcome. The addition of PVRUV to the multivariate logistic regression model based on standard clinical parameters (age, PSA, digital rectal examination, PVol) significantly increased the predictive accuracy of the model in both the population overall (79% vs. 77%; p=0.001) and patients with PSA levels up to 10 ng/ml (74.3% vs. 71.7%; p=0.005). Conclusion: PVRUV seems to be an accurate non-invasive test to predict biopsy outcome that can be used alone or in combination with PVol in the decision-making process for men potentially facing a prostate biopsy.*

Prostate biopsy (PB×) is the standard method for diagnosing prostate cancer (PCa) but the diagnostic yield of this procedure remains low. As a matter of fact, in current clinical practice, the diagnostic yield of a first extended PB× prompted by an elevated serum prostate-specific antigen (PSA) level or an abnormal digital rectal examination (DRE) is in the range of 40% (1); such a cancer detection rate drops to approximately 25% in the setting of screening programs, *i.e.* in patients with serum PSA between 2.5 and 10 ng/ml (2).

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Efforts to improve the diagnostic yield of PB× have been oriented towards the construction of predictive models that combine PSA with other readily available clinical information such as age, DRE findings, and prostate volume (PVol), as well as towards the identification of novel diagnostic tools, including novel biomarkers (3-5), or imaging techniques such as transrectal elastosonography (6) and magnetic resonance imaging. The incorporation of such novel diagnostic tools into nomograms (7, 8) has further, but not dramatically, increased the accuracy of these predictive models. Moreover, novel diagnostic tools are expensive or may be invasive and thus not easily applicable to everyday clinical practice. The identification of cheap, non-invasive and readily available predictive tools that can be used either alone or in the context of a nomogram therefore remains a major clinical issue.

PSA is significantly associated with benign prostatic obstruction (BPO) as patients with BPO have higher serum PSA levels than those without BPO (9, 10). Nevertheless, to our knowledge, no attempt has been made to determine whether uroflowmetry (UFM) and post-void residual urinary volume (PVRUV), the standard tools for initial BPO diagnosis, correlate with PSA levels and the diagnosis of Pca.

In view of the association between BPO and increased PSA levels, in the present study, we tested whether UFM and ultrasound measurement of PVRUV predicts PB× outcome.

Patients and Methods

Data of patients scheduled for ultrasound-guided transrectal PB× because of increased serum PSA (≥4 ng/ml) or abnormal DRE were prospectively entered into our Institutional Review Board-approved database. All patients underwent PSA measurement before DRE and transrectal ultrasound (TRUS). UFM was carried out before PB×, waiting for the patient to report a strong sensation to void; PVRUV was measured immediately after UFM by abdominal scanning. Following local anesthesia (11, 12), TRUS was used to determine the prostate and transition zone volume, and to guide transrectal prostate sampling according to our systematic 18-core biopsy scheme (13).

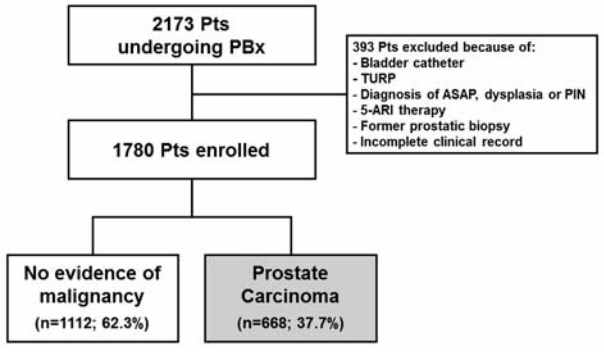


Figure 1. *Algorithm showing patient selection and exclusion criteria for the present study. PB×, Prostate biopsy; TURP, transurethral resection of the prostate; PIN, prostatic intraepithelial neoplasia; ASAP, atypical small acinar proliferation; 5-ARI, 5-alpha-reductase inhibitor.*

Men receiving medical therapy known to affect PSA levels, or who had previously undergone PB× or invasive treatment for benign prostatic hyperplasia, or with dwelling urethral catheters, or with a voided volume of less than 150 ml were excluded from the present case-control study.

Two senior uropathologists blind to UFM and PVRUV data evaluated the specimens according to contemporary diagnostic criteria for high-grade prostatic intraepithelial neoplasia, atypical small acinar proliferation of the prostate and PCa. Patients diagnosed with high-grade prostatic intraepithelial neoplasia or atypical small acinar proliferation of the prostate were excluded from the present analysis.

The protocol for the study was approved by University of Foggia Ethics Committee (n. 0125/14) and it conforms to the provisions of the Declaration of Helsinki. Written informed consent to take part was given by all participants.

Statistical analysis. The primary study endpoint was to determine the diagnostic accuracy of PFR and PVRUV in predicting PCa and to compare it with that of the commonly used predictive clinical factors such as age, PSA, DRE and PVol. The secondary endpoint was to look for cut-offs that would allow identification of patients in whom PB× could potentially be avoided.

Clinical characteristics were considered continuous variables and reported as means; those with normal distribution, according to the Skewness and Kurtosis test, were compared by Student's *t*-test for paired or unpaired data, whereas those with a non-parametric distribution were compared by the Mann-Whitney U-test for independent groups. Spearman's correlation was used to evaluate the association between two variables, whereas frequencies were compared by the χ^2 test. The combined predictive effect of the covariates was tested by logistic regression analysis, performing a backward selection procedure with a removal criterion of $p>0.10$ based on the likelihood ratio test. Model calibration was measured by the Hosmer-Lemeshow goodness of fit test, with $p<0.05$ considered statistically significant. Finally, receiver operator characteristic (ROC) curves analysis was used to test the diagnostic performance of the different clinical parameters, as well as the predictive accuracy of multivariate logistic regression models including only standard clinical parameters (age, PSA, DRE, PVol) or also the novel parameters (PVRUV and PFR). An operational cut-off level was defined in order to differentiate the risk of PCa between the two groups. A two-sided value of $p<0.05$ was considered statistically significant. Statistical calculations were carried out using MedCalc 9.2.0.1 (MedCalc Software, Ostend, Belgium) and PASW 18 (SPSS®, Chicago, IL, USA).

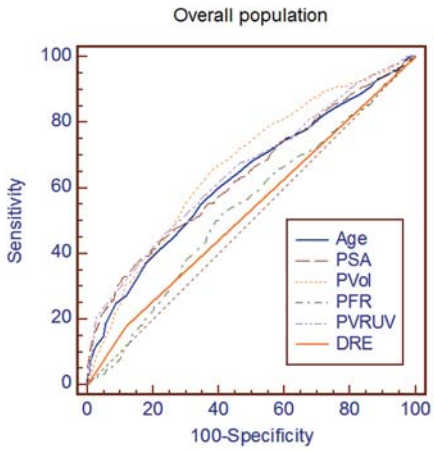
Table I. *Patients' clinical and pathological characteristics.*

Characteristic	PCa (n=668)	NEM (n=1112)	*p*-Value
Age (years)			
Mean	69	66	<0.001
Range	48-90	34-86	
PSA (ng/ml)			
Mean	19.0	7.8	<0.001
95% CI	15.6-22.4	7.5-8.1	
Prostate volume (ml)			
Mean	47.5	63.4	<0.001
95% CI	45.7-49.2	61.7-65.1	
Abnormal DRE	188 (28.1%)	255 (22.9%)	0.01
Peak flow rate (ml/min)			
Mean	13.3	12.6	<0.001
95% CI	12.9-13.8	12.2-12.9	
PVRUV (ml/min)			
Mean	36.7	58.3	<0.001
95% CI	34.2-39.3	55.5-61.1	
Gleason score			
<7	180 (27%)		
7	201 (30%)		
>7	287 (43%)		

PCa, Prostate cancer; NEM, no evidence of malignancy; PSA, prostate-specific antigen; DRE, digital rectal examination; PVRUV, post-void residual urinary volume; CI: confidence interval.

Results

Between January 2006 and December 2012, a total of 2173 patients underwent TRUS-guided PB× at our Institution; 1780 patients met the inclusion criteria and were enrolled in the present study (Figure 1). Their descriptive characteristics are summarized in Table I. PCa was found in 668 patients (37.7%), while the remaining 1112 (62.3%) had no evidence of malignancy; there was a statistically significant difference in all tested variables (age, PSA, DRE, PVol, PFR and PVRUV) between patients with and without PCa (Table I). As expected, PVRUV was directly related to PVol (rs=0.346, $p<0.0001$) and inversely related to PFR (rs=–0.495, $p<0.001$). Multivariate logistic regression analysis showed that age, PSA, PVol and PVRUV were the most significant predictors of PB× outcome, with the Hosmer-Lemeshow statistics showing adequate model calibration (Table III). ROC curve analysis (Figure 2) showed that PVol and PVRUV had the best predictive values [Area under the curve (AUC)=0.670, $p<0.001$ and AUC=0.655, $p<0.001$, respectively], outperforming both age and PSA (AUC =0.631, $p<0.001$ and AUC=0.638, $p<0.001$, respectively).



Variable	AUC	*p*-Value	95% CI
Age	0.631	<0.001	0.606 – 0.656
PSA	0.638	<0.001	0.612 – 0.663
PVol	0.670	<0.001	0.645 – 0.694
PFR	0.538	<0.001	0.512 – 0.564
PVRUV	0.655	<0.001	0.630 – 0.680
DRE	0.529	0.06	0.503 – 0.555

AUC comparison	*p*-Value
Age *vs.* PSA	0.74
Age *vs.* PVol	0.05
Age *vs.* PFR	<0.001
Age *vs.* PVRUV	0.24
Age *vs.* DRE	<0.001
PSA *vs.* PVol	0.09
PSA *vs.* PFR	<0.001
PSA *vs.* PVRUV	0.40
PSA *vs.* DRE	<0.001
PVol *vs.* PFR	<0.001
PVol *vs.* PVRUV	0.39
PVol *vs.* DRE	<0.001
PFR *vs.* PVRUV	<0.001
PFR *vs.* DRE	0.69
PVRUV *vs.* DRE	<0.001

Figure 2. *Receiver operating characteristic (ROC) curves for age, prostate-specific antigen (PSA), prostate volume (PVol), peak flow rate (PFR), postvoid residual urinary volume (PVRUV) and digital rectal examination (DRE), and the risk of prostate cancer (PCa) in differentiating between patients with PCa and those with with no evidence of malignancy. AUC: Area under the ROC curve; CI: confidence interval.*

The predictive value of the clinical variables was then tested in the subset of patients with PSA levels up to 10 ng/ml, as they are those who could potentially be spared from PB× if reliable predictors of procedure outcome were available. Interestingly, there was no difference in DRE status and mean PSA levels between patients with and those without PCa (6.2 *vs* 6.1 ng/ml; $p=0.2$); conversely, there was a statistically significant difference in all the other clinical variables (Table II). Multivariate logistic regression analysis showed that in this subset of patients, age, PVol and PVRUV were the only significant predictors of PB× outcome, with the Hosmer-Lemeshow statistics showing adequate model calibration (Table III). Again, ROC curve analysis showed that PVol and PVRUV had the best predictive values (AUC=0.671, $p<0.001$ and AUC=0.668, $p<0.001$, respectively), significantly outperforming all the other clinical variables (Figure 3a).

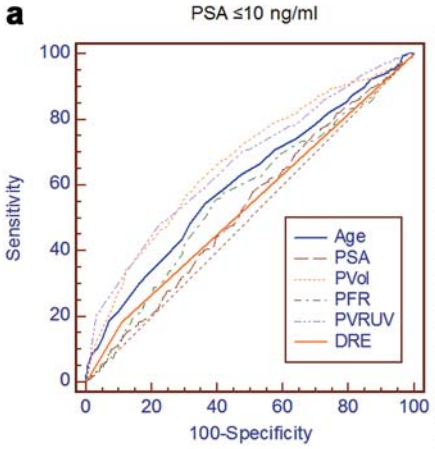
In patients with PSA>10 ng/ml, there was a statistically significant difference between those with and those without PCa in all variables but PFR (Table II). Multivariate logistic regression analysis showed that in this population, the most significant predictors of PB× outcome were age, PSA, PVol and PVRUV (Table III). ROC curve analysis (Figure 3b) showed that PVol, PSA and PVRUV had the best predictive values (AUC=0.717, $p<0.001$, AUC=0.682, $p<0.001$ and AUC=0.668, $p<0.001$, respectively); interestingly, the AUC for PVRUV was exactly the same (0.668) for patients with PSA up to 10 ng/ml and with PSA>10 ng/ml (Figure 3).

The addition of PVRUV to the multivariate logistic regression model based on standard clinical parameters (age, PSA, DRE, PVol) significantly increased the predictive accuracy of the model in the overall patient population (79% *vs*. 77%; $p=0.001$; Figure 4a) as well as in the subset of patients with PSA levels up to 10 ng/ml (74.3% *vs*. 71.7%; $p=0.005$; Figure 4b); conversely, the addition of PFR failed to increase the predictive accuracy of the model based on standard parameters

Finally, since PVol and PVRUV were found to be the most reliable predictors of PB× outcome in patients with PSA levels up to 10 ng/ml, attempts were made to identify cut-offs for these parameters that could have allowed some of these patients to be spared from PB×. Using 80 ml as cut-off for PVol, 256 (19%) biopsies could have been avoided while missing 33 (7.9%) tumors, including only two cases of high-risk (Gleason >7) cancer; using 85 ml as cut-off for PVRUV, 215 (15.9%) biopsies could have been avoided while missing 35 (8.4%) tumors, including 10 high-risk cancer cases (Table IV). Interestingly, using the mean values of PVol and PVRUV as cut-offs in patients without PCa (60 ml for both of them *i.e.* "rule of 60"), 260 (19.2%) PB×s could have been avoided while missing 33 (7.9%) tumors, including six high-risk cases cancer (Table IV).

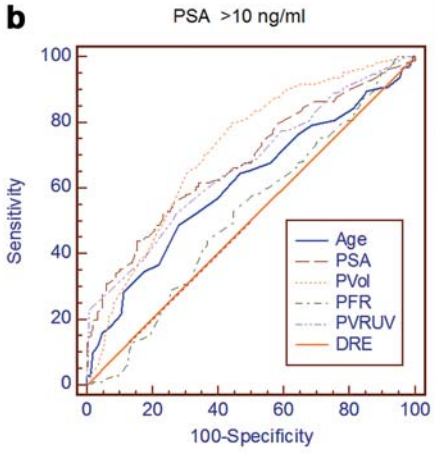
Discussion

The present study confirmed that patients with PCa were older, had higher PSA levels and smaller PVol than those without PCa; the novel finding of our study was that men with PCa had significantly greater PFR and lower PVRUV than those without PCa. When the combined predictive effect of the covariates



Variable	AUC	*p*-Value	95% CI
Age	0.608	<0.001	0.578 – 0.637
PSA	0.532	0.31	0.501 – 0.561
PVol	0.671	<0.001	0.642 – 0.699
PFR	0.536	<0.001	0.533 – 0.593
PVRUV	0.668	<0.001	0.639 – 0.696
DRE	0.536	0.07	0.506 – 0.566

AUC comparison	*p*-Value
Age *vs.* PSA	0.003
Age *vs.* PVol	0.01
Age *vs.* PFR	0.08
Age *vs.* PVRUV	0.01
Age *vs.* DRE	0.008
PSA *vs.* PVol	<0.001
PSA *vs.* PFR	0.24
PSA *vs.* PVRUV	<0.001
PSA *vs.* DRE	0.86
PVol *vs.* PFR	<0.001
PVol *vs.* PVRUV	0.87
PVol *vs.* DRE	<0.001
PFR *vs.* PVRUV	<0.001
PFR *vs.* DRE	0.31
PVRUV *vs.* DRE	<0.001



Variable	AUC	*p*-Value	95% CI
Age	0.612	<0.001	0.558 – 0.664
PSA	0.682	<0.001	0.630 – 0.731
Pvol	0.717	<0.001	0.666 – 0.764
PFR	0.522	0.35	0.467 – 0.576
PVRUV	0.668	<0.001	0.616 – 0.718
DRE	0.502	0.94	0.448 – 0.556

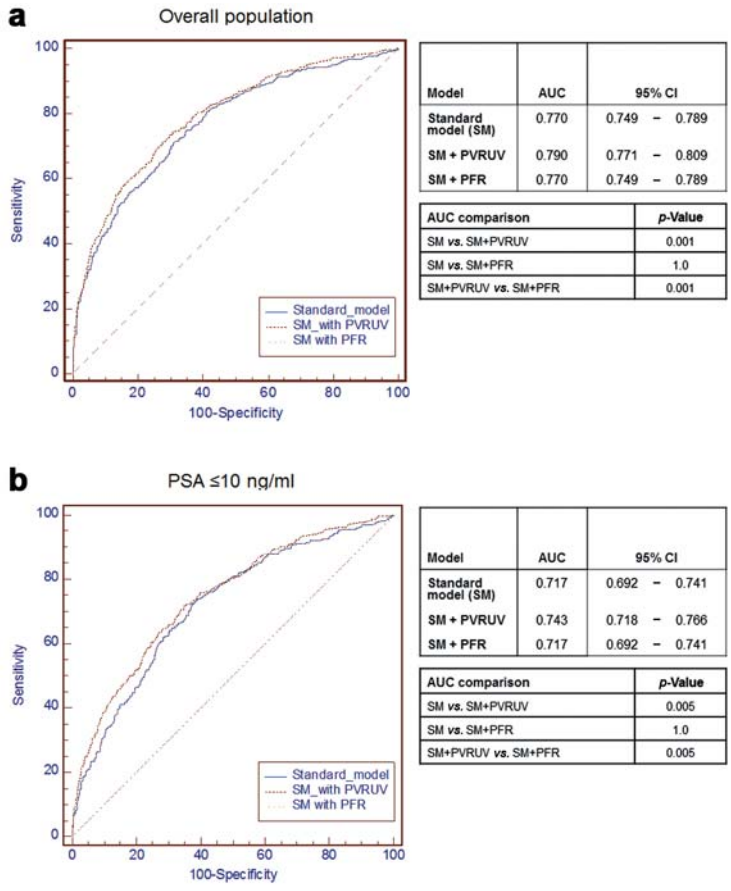
AUC comparison	*p*-Value
Age *vs.* PSA	0.07
Age *vs.* PVol	0.007
Age *vs.* PFR	0.02
Age *vs.* PVRUV	0.16
Age *vs.* DRE	0.009
PSA *vs.* PVol	0.39
PSA *vs.* PFR	<0.001
PSA *vs.* PVRUV	0.73
PSA *vs.* DRE	<0.001
PVol *vs.* PFR	<0.001
PVol *vs.* PVRUV	0.16
PVol *vs.* DRE	<0.001
PFR *vs.* PVRUV	<0.001
PFR *vs.* DRE	0.65
PVRUV *vs.* DRE	<0.001

Figure 3. *Receiver operating characteristic (ROC), prostate volume (PVol), peak flow rate (PFR), postvoid residual urinary volume (PVRUV) and digital rectal examination (DRE), in predicting prostate cancer in patients with total prostate-specific antigen (PSA) ≤10 ng/ml (a) and >10 ng/ml (b). AUC: Area under the ROC curve; CI: confidence interval.*

was tested by logistic regression analysis, it was found that age, PSA, PVol and PVRUV were the most significant predictors of PB× outcome; ROC curve analysis, however, showed that PVol and PVRUV had the best predictive value.

PVol has already been shown to be more accurate than age and PSA in predicting PB× outcome (14-16); the finding of PVRUV having almost the same predictive accuracy as PVol is novel and seems to us particularly interesting in view of the fact that differently from PVol, PVRUV measurement is a non-invasive test. Moreover, the cancer detection rate of a standardized PB× scheme may be affected by PVol, as the greater the PVol, the greater the chances of a standard number of cores missing the focus of PCa (17-19); conversely, PVRUV does not have such potential bias.

Turning findings into clinical practice, all clinical parameters mentioned above are used to identify patients at risk of harboring PCa, who are thus candidates to PB×, but can also be used to identify those that because of their low risk of harboring PCa



Model	AUC	95% CI
Standard model (SM)	0.770	0.749 – 0.789
SM + PVRUV	0.790	0.771 – 0.809
SM + PFR	0.770	0.749 – 0.789

AUC comparison	*p*-Value
SM *vs.* SM+PVRUV	0.001
SM *vs.* SM+PFR	1.0
SM+PVRUV *vs.* SM+PFR	0.001

Model	AUC	95% CI
Standard model (SM)	0.717	0.692 – 0.741
SM + PVRUV	0.743	0.718 – 0.766
SM + PFR	0.717	0.692 – 0.741

AUC comparison	*p*-Value
SM *vs.* SM+PVRUV	0.005
SM *vs.* SM+PFR	1.0
SM+PVRUV *vs.* SM+PFR	0.005

Figure 4. *Receiver operating characteristic (ROC) curves comparing multivariate logistic regression models based on standard clinical parameters ['standard' model including age, prostate-specific antigen (PSA), and digital rectal examination (DRE) and prostate volume (PVol)] with models incorporating post-void residual urinary volume (PVRUV) or peak flow rate (PFR) for the entire patient cohort (a) and for patients with total PSA ≤10 ng/ml (b). AUC: Area under the ROC curve; CI: confidence interval.*

could potentially be spared from a PB×. Due to a lower cancer detection rate, patients with PSA levels up to 10 ng/ml are those who could potentially be spared from PB× if reliable predictors of procedure outcome were available. The present study confirmed that in this patient population, there was no difference in mean PSA levels between those with and those without PCa. This finding is in agreement with previous studies (7, 20) and somewhat suggests that in men with PSA up to 10 ng/ml, there are clinical factors more relevant than PSA in determining PB× outcome. According to multivariate logistic regression analysis, age, PVol and PVRUV were the most significant predictors of PB× outcome; ROC curve analysis, however, showed that PVol and PVRUV had the best predictive value (AUC=0.671, $p<0.001$ and AUC=0.668, $p<0.001$, respectively), significantly outperforming all the other clinical variables.

PVol and PVRUV also kept their predictive value in the subset of patients with PSA>10 ng/ml, whereby PSA returned, as expected, as a significant predictor of PB× outcome in both multivariate logistic regression and ROC curve analysis. An interesting finding was that the AUC for PVRUV was exactly the same (0.668) for patients with PSA up to 10 ng/ml and those with PSA >10 ng/ml, somewhat confirming the predictive value of this parameter being independent on PSA level.

In the present study, we did not evaluate other non-invasive tests such as serum free PSA, serum PSA isoform [-2]proPSA (p2PSA), the gene-based urinary marker prostate cancer antigen 3 (PCA3), or their combination such as free-to-total PSA ratio and prostate health index (PHI), a mathematical combination of PSA, free PSA and p2PSA. Previous studies addressing this issue showed that PHI performed better than free PSA, free-to-total PSA ratio and PCA3 (AUC 0.70, 0.62, 0.60 and 0.59, respectively) (7, 21); interestingly, PVol had a similar AUC to that found in our study population (0.68 and 0.62 *vs.* 0.67), somewhat providing indirect external data validation.

Table II. *Clinical and pathological characteristics according to total prostate-specific antigen (PSA).*

Characteristic	PCa (n=417)	NEM (n=933)	*p*-Value
PSA ≤10 ng/ml			
Age (years)			
Mean	67	65	0.0001
Range	48-86	34-86	
PSA (ng/ml)			
Mean	6.2	6.1	0.2
95% CI	6.1-6.4	6.0-6.3	
Prostate volume (ml)			
Mean	45.9	60.1	0.0001
95% CI	43.7-48.2	59.8-63.2	
Abnormal DRE	121 (29%)	232 (24.8%)	0.1
Peak flow rate (ml/min)			
Mean	14.1	12.7	0.0001
95% CI	13.4-14.7	12.3-13.1	
PVRUV (ml/min)			
Mean	34.2	60.0	0.0001
95% CI	31.2-37.2	54.1-60.1	
Age (years)			
Mean	71	68	0.0001
Range	50 - 90	43-85	
PSA >10 ng/ml			
PSA (ng/ml)			
Mean	40.2	16.4	0.0001
95% CI	31.7-48.6	15.1-17.6	
Prostate volume (ml)			
Mean	50.0	73.1	0.0001
95% CI	47.2-52.8	68.2-78.1	
Abnormal DRE	67 (26.6%)	23 (12.8%)	0.0008
Peak flow rate (ml/min)			
Mean	12.2	11.9	0.3
95% CI	11.4-12.8	11.0-12.8	
PVRUV (ml/min)			
Mean	41.0	64.2	0.0001
95% CI	36.4-45.4	57.2-71.3	

PCa, Prostate cancer; NEM, no evidence of malignancy; PSA, prostate-specific antigen; DRE, digital rectal examination; PVRUV, post-void residual urinary volume; CI: confidence interval.

Table III. *Logistic regression model results.*

Population	Variable	*p*-Value	OR	95% CI
Overall population	Age	<0.0001	1.067	1.049-1. 085
	PSA	<0.0001	1.070	1.049-1.091
	PVol	<0.0001	0.975	0.970-0.981
	PVRUV	<0.0001	0.984	0.980-0.988
	PFR	0.01	0.973	0.952-0.995
	DRE	0.47		
				Hosmer-Lemeshow test= 9.5 (*p*=0.1)
PSA ≤10 ng/ml	Age	0.0001	1.065	1.044-1.087
	PSA	0.08		
	PVol	0.0001	0.981	0.974-0.987
	PVRUV	0.0001	0.985	0.980-0.990
	PFR	0.2		
	DRE	0.3		
				Hosmer-Lemeshow test= 12.2 (*p*=0.1)
PSA >10 ng/ml	Age	0.0001	1.078	1.039-1.117
	PSA	0.0001	1.061	1.032-1.090
	PVol	0.0001	0.960	0.948-0.973
	PVRUV	0.0001	0.984	0.976-0.986
	PFR	0.1		
	DRE	0.03	0.449	0.216-0.935
				Hosmer-Lemeshow test= 13.7 (*p*=0.8)

PSA, Prostate-specific antigen; PVol, prostate volume; PVRUV, post-void residual urinary volume; PFR, peak flow rate; DRE, digital rectal examination; OR: odds ratio; CI: confidence interval.

When a potential predictive or prognostic marker is analyzed for its efficacy, it is not sufficient to show that it is significantly linked to the outcome or even that it is the 'strongest' predictor of outcome (*i.e.* has the best AUC). To be useful in clinical practice, a novel marker should be proven to add information that significantly improves that provided by standard markers. The present study shows that the addition of PVRUV to the multivariate model based on standard clinical factors (age, PSA, DRE and PVol) significantly increased the predictive performance of the model in both the overall population and the subset of patients with total PSA ≤10 ng/ml.

As mentioned above, the secondary endpoint of our study was to determine whether simple cut-offs of the tested parameters could readily be used in clinical practice to identify patients in whom PB× could potentially be avoided; this analysis was carried out in patients with PSA levels up to 10 ng/ml, due to their lower risk of harboring PCa. In this subset, PVol outperformed PVRUV in terms of the ratio between number of PB× avoided and number of missed tumors, as well as in terms of missed high-grade tumors (Table IV). Interestingly, using the mean values of PVol and PVRUV as cut-offs in patients without PCa (60 ml for both), 260 (19.2%) PB×s could have been avoided while missing 33 (7.9%) tumors, including 6 high-risk ones. If confirmed in other large prospective studies, these findings would suggest that these simple clinical parameters (PVol ≥80 ml or the 'rule of 60') could readily be used in clinical practice to counsel patients about the possibility of being spared from PB× and simply scheduled for a strict follow-up.

The strengths of our study include its prospective nature, the use of a standardized extended PB× scheme, as well as a standardized protocol for UFM and PVRUV

Table IV. *Diagnostic accuracy of different cut-offs for prostate volume (PVol) and post-void residual urinary volume (PVRUV) in patients with total PSA ≤10 ng/ml*

Cut-off	Avoided biopsies, n (%)	Missed PCa, n (%)	No. of missed PCa with Gleason score >7
[1]PVol ≥80 ml	256/1350 (19%)	33/417 (7.9%)	2
[1]PVRUV ≥85 ml	215/1350 (15.9%)	35/417 (8.4%)	10
[2]PVol ≥60 ml and [2]PVRUV ≥60 ml	260/1350 (19.2%)	33/417 (7.9%)	6

[1]Cut-offs with >90% sensitivity; [2]based on mean values of patients with no evidence of malignancy. PCa: Prostate cancer.

measurement and pathologists being blind to UFM and PVRUV data. A potential study limitation is not having attempted to construct a nomogram including PVRUV, but we felt this was beyond the scope of a study testing this parameter for the first time and exploring its performance in everyday clinical practice. Other potential limitations include single measurement of PVRUV, although this test is widely considered accurate (22), a study population consisting of white men only, thus limiting finding applicability to other ethnicities and lack of external pathological review.

In conclusion, the present study showed that PVRUV is a novel accurate non-invasive test for predicting PB× outcome that can easily be used by clinicians, alone or in combination with PVol, in the decision-making process of men potentially facing a PB×. It also provided grounds for this new parameter being externally validated in other populations, as well as being incorporated into more sophisticated prognostic models.

Conflicts of interest

The Authors declare that there is no conflict of interests regarding the publication of this article.

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