(RESEARCH ARTICLE)

Comparison of the effect of prostate volume and prostate specific antigen on severity of lower urinary tract symptoms among adult men in the community

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Abstract

Background: Baseline prostate volume(PV) and Prostate specific antigen(PSA) level are important variables in the progression of lower urinary tract symptoms(LUTS) in benign prostatic hyperplasia(BPH) patients and have correlations to urine flow. Both determine response to medical therapy and predict the incidence of acute urinary retention. In this study, we compared the influence of prostate volume against that of PSA on LUTS.

Method: This was a prospective community-based study among men 40 years and above between 2023 and 2024. We assessed LUTS with international prostate symptoms score(IPSS). The quantitative PSA of participants was determined using ELISA method. PV was determined using 3.5MHz USS-probe. Chi-square test and multiple-logistics-regression and odds ratio were used to determine the relationship and strength of association between PV and PSA with various categories of LUTS respectively. Correlation between PV and PSA was also done using Spearman's correlation coefficient. Statistical significance was determined at p-value ≤0.05.

Result: PSA distribution showed significant difference across severity levels of LUTS ($\chi2$=18.52, p=0.005), most participants with mild LUTS having PSA<4 compared to those with moderate and severe LUTS. Similarly, there was significant discrepancy in the distribution of PV ($\chi2$=35.81, p< 0.0001), with higher proportion of participants in severe LUTS category exhibiting severely enlarged prostates. After adjusting for other variables there was greater increase on the influence of PSA on LUTS.

Conclusion; Both PSA and PV significantly determine severity of LUTS however PSA is a greater influencer of LUTS than PV. PV positively correlates PSA value.

Keywords: PSA; Prostate-volume; LUTS; Correlation; Community-men

1. Introduction

BPH is a chronic pathologic process that is one of the causes of LUTS[1]. It is a common cause of urologic disease in West Africa [2,3]. PV and PSA value are important predictors of the disease progression of BPH and the development of acute urinary retention (AUR)[4,5]. Transrectal ultrasound scan (TRUSS) and magnetic resonance imaging (MRI) measurements are preferred in estimating PV, although MRI is expensive. 3-dimensional TRUSS gives a more accurate assessment of PV[1]. Trans abdominal USS is a favored simple, non-invasive, cost-effective, readily available method of measuring PV compared to digital rectal examination (DRE) alone. The development, validation, and translation with

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cultural and linguistic validation of the standardized, self-administered seven-item American Urological Association Symptom-score Index (AUASI) or IPSS is useful in several clinical research to assess LUTS. This often determines the treatment modality of BPH. Except for age, correlations between various measures of LUTS and BPH are modest in community-based population studies and weak in BPH clinic and trial populations [1].

Many community-based studies assessing the correlation of prostate size to LUTS have been studied in the Caucasian and Asian populations [1,5-7]. Most of the studies in Africa were hospital-based studies limited in study cohort[8-14]. Few African studies have analyzed relationship of serum PSA to LUTS [15.16]. Our prospective community-based study used simple, cost-effective tools to compare the cause-effect of prostate volume versus lower urinary tract symptoms and that of prostate-specific antigen versus lower urinary tract symptoms among adult men.

2. Material and methods

This was a prospective analytical community-based study among men 40 years and above living in two communities in Rivers State, one of the communities was in Obio-Akpor and the other in Port Harcourt LGAs, between January 2023 and May 2024. We obtained personal consent for the study from every participant and institutional consent from the ethical committee of the tertiary educational institution located in the area. Every male who fulfilled the inclusion criteria and gave consent was included. LUTS were assessed with IPSS modified from America urological association symptom index, AUASI. History of lower urinary tract symptoms was obtained from participants. Participants who reported urinary tract infection(UTI), or treatment for UTI were excluded. Using 4 voiding and 3 storage symptoms, scores of 0 to 5 were given to each symptom according to severity. A total score of 35 were assigned to an individual. Respondents with scores of 0-7 were designated as having mild LUTS, 8-19 moderate and 20-35 severe. Venous blood was obtained from participants by venipuncture, centrifuged, separated and supernatant preserved for serum PSA. The PSA was determined using Accubind ELISA kit manufactured by Monobind Inc. USA. Serum PSA was classified as 0-4ng/ml, 5-10ng/ml, 11-20ng/ml, >20ng/ml and designated as normal, mild increase, moderate increase and severe increase respectively. Prostate volume of all participants was assayed with 3.5Mhz curvillinear USS probe and calculated using the equation length x weight x depth x 0.52 and classified as normal ≤30cm^3, mildly enlarged 31-45cm^3, moderately enlarged 46-75cm^3, and severely enlarged >75cm^3. Digital rectal examination, DRE was done for all participants. Participants with DRE findings of asymmetrical, hard or nodular prostate and those with serum PSA level >4ng/ml had prostate biopsy. Participants who were histologically diagnosed to have prostate cancer were excluded from the study. The data analysis was done with the Statistical Package for Social Sciences (SPSS) version 25. The data was summarized using Mean and standard deviation for continuous variables, while frequencies and percentages was used for categorical variables. The chi-square test was used to assess the distribution of prostrate volume and serum PSA across different severity levels of LUTS. Multivariate logistic regression was used to compare the severity levels of LUTS between respondents with enlarge prostates and those with non-enlarged prostates and between those with normal PSA and those with elevated PSA, respectively. Odds ratio was used to test the degree of association between prostate enlargement on the one hand and PSA level on the other hand against various degrees of severity of LUTS. All analysis was done at a 95% confidence level and a p-value less than 0.05 was considered statistically significant.

3. Results

A total of 377 participants were included. The mean age of participants was 58.4±9 years. Mean PSA value was 5.1ng/ml. Mean prostate volume was 39.5±32.1.

Table 1 Distribution of PSA

Distribution of PSA	Frequency (n=377)	Percentage(%)
<4ng/ml	297	78.8
4-10ng/ml	53	14.1
11-20ng/ml	13	3.4
>20ng/ml	14	3.7

Table 2 Distribution of prostate size

Mildly enlarged (<45cm³)	282	74.8%
Moderately enlarged (45-70 cm³)	65	17.2%
Severely enlarged (>70 cm³)	30	8.0%

Distribution of PSA against severity of LUTS shows that 86.7%, 9.9%, 2.2% and 1.1% with mild LUTS had PSA <4ng/ml, 4-10ng/ml, 11-20ng/ml and >20ng/ml respectively; 74.2%, 16.1%, 3.9%, and 5.8% with moderate LUTS had PSA <4ng/ml, 4-10ng/ml, 11-20ng/ml and >20ng/ml respectively; 61%, 24.4%, 7.3%, and 7.3% with severe LUTS had PSA <4ng/ml, 4-10ng/ml, 11-20ng/ml and >20ng/ml respectively. Chi square analysis for the distribution of PSA against severity of LUTS was 18.52 with p-value of 0.005.

Distribution of prostate size against severity of LUTS shows that 82.9%, 14.4%, and 2.8% with mild LUTS had mildly enlarged, moderately enlarged and severely enlarged prostate respectively. Also 71.0%, %, 20.6% and 8.4% with moderate LUTS had mildly enlarged, moderately enlarged and severely enlarged prostates respectively; 53.7%, 17.1%, 29.3% with severe LUTS had mildly enlarged, moderately enlarged and severely enlarged prostates respectively. Chi square distribution of prostate volume against severity of LUTS was 35.81 with p-value of 0.0001.

Table 3 Distribution of PSA and Prostate size against severity levels of LUTS

	Mild LUTS n= 181(%)	Moderate LUTS n=155(%)	Severe LUTS n=82 (%)	Chi-square (p-value)
Distribution of PSA				
<4ng/ml	157(86.7)	115(74.2)	25(61.0)	
4-10ng/ml	18(9.9)	25(16.1)	10(24.4)	18.2
11-20ng/ml	4(2.2)	6(3.9)	3(7.3)	0.005
>20ng/ml	2(1.1)	9(5.8)	3(7.3)	
Distribution of prostate volume				
Mildly enlarged	150(82.9)	110(71.0)	22(53.7)	35.81
Moderately enlarged	26(14.4)	32(20.6)	7(17.1)	0.0001
Severely enlarged	5(2.8)	13(8.4)	12(29.3)	

Multivariate logistic regression for the two variables and LUTS severity shows that 28.1% of participants with moderate/severe LUTS had PSA greater than 4ng/ml as compared to 13.3% of participants with mild enlargement/normal prostate who also had PSA greater than 4ng/ml. Again, 86.7% of those with mild/normal LUTS who had PSA between 0-4ng/ml as against 71.9% of those with moderate/severe LUTS with PSA 0-4ng/ml (X^2= 24.8, p=0001, OR 2.5, CI (1.7-3.7). This was adjusted for prostate size (OR 3.1, CI1.2-4.5) (Table 4). Similarly, 35.7% of participants with moderate/severe LUTS had moderately/severely enlarged prostate in comparison to 44.2% of participants with mild /normal LUTS who had similar grade of prostate enlargement. In the same vein, 64.3% of those with severe LUTS had normal or mildly enlarge prostate while 55.8% of those with mild/normal LUTS had normal or mildly enlarged prostate. {X^2=5.6, p=0.017, OR 0.7, CI (0.5-0.9)}. This was adjusted for influence of PSA {OR 0.8, CI (0.5-1.1)}.

Table 4 Multivariable logistic regression for LUTS Severity

Variables	Moderate/Severe LUTS n =196, (%)	Mild/Normal n = 181, (%)	Chi-square p-value	Odd Ratio (95% C.I)	Adjusted Odds ratio (95% C.I)
PSA (ng/ml)					
≥4	55(28.1)	24(13.3)	24.8 (0.0001)	2.5 (1.7 - 3.7)	3.1 (1.2 – 4.5)
0 – 4	141(71.9)	157(86.7)			
Prostate Size					
Moderately/Severely Enlarged	70(35.7)	80(44.2)	5.6 (0.017)	0.7 (0.5- 0.9)	0.8 (0.5 – 1.1)
Normal/Mildly enlarged	126(64.3)	101(55.8)			

4. Discussion

In this study, we examined 377 participants. Their mean age was 58.4±9 years, similar to those in prior community-based studies [12,15,16]; a younger population compared to prior African hospital-based studies[8-11,13,14]. The age disparity brings to the fore a known correlation between advancing age with LUTS[1] and the likelihood of hospital presentation. The mean prostate volume was 39.5 cm^3 ±32.1, similar in size to the mean PV in an African community-based study in Ghana by Asare et al[12], the MTOPS study by Crawford et al[5], and a large community-based study by Rhodes et al[17], Chicharro-Molero et al[18], Park et al[20]. However, it was lower than the mean PV from African hospital-based studies[9,10,11,13,14]. Our relatively larger sample size may have accounted for the difference. The majority of participants (74.8%) in our study had mild prostate enlargement (31-45cm^3)(table 2), consistent with reports by Udo et al[14]. This may be because our population was predominantly normal men in the community. A higher proportion of participants in the severe LUTS category had severely enlarged prostates compared to those with mild and moderate symptoms.

The mean PSA in our study was 5.1ng/ml. In the largest study correlating PSA and IPSS, Park et al[20]. showed a mean PSA of 1.49ng/ml, which was widely deviant from ours. The fact that our population were apparently normal men in the community raises a question of the possible cause of high mean PSA value in a community in the Niger Delta region of Nigeria; could this be related to decades of oil and gas exploration and exploitation in the region? There may be a need to determine this in a larger population study. In our study, IPSS had a significant linear correlation with PSA, demonstrating high scores at high PSA levels. This was seen from PSA distribution which showed significant differences across severity levels of LUTS (x^2 =18.52, p = 0.005); participants with mild LUTS having PSA values <4 compared to those with moderate and severe LUTS (Table 3). Similarly, there was a significant discrepancy in the distribution of prostate size (x^2=35.81, p < 0.0001), with a higher proportion of participants in the severe LUTS category exhibiting severely enlarged prostates compared to those with mild and moderate symptoms (Table 3). This positive correlation was consistent with findings by Udo et al[14], and Park et al[20] but at variance with other studies, which showed no correlation of prostate size with LUTS(IPSS)[11,13].

Multivariate logistic regression in considering these associations revealed that individuals with moderate/severe LUTS had 28.1% in PSA levels ≥4 ng/ml category compared to 13.3% of those with mild/normal LUTS with similar PSA levels (Table 4). This difference is statistically significant, with a chi-square value of 24.8 and a p-value of 0.0001, indicating a strong association. The odds ratio (OR) of 2.5 shows that individuals with PSA levels ≥4 ng/ml are 2.5 times more likely to have moderate/severe LUTS (95% CI: 1.7 - 3.7). After adjusting for PV, the adjusted odds ratio (AOR) is 3.1 (95% CI: 1.2 - 4.5) suggesting the association between PSA and severity of LUTS increased after the influence of PV was removed. For prostate volume, 35.7% of those with moderate/severe LUTS had a moderately/severely enlarged prostate, while 44.2% of those with mild/normal LUTS had a similar enlargement. This difference is statistically significant, with a chi-square value of 5.6 and a p-value of 0.017. The odds ratio of 0.7 however shows a weak association, indicating that individuals with a moderately/severely enlarged prostate are 0.7 times as likely to have moderate/severe LUTS which is a negative association (95% CI: 0.5 - 0.9). After adjusting for other PSA, the adjusted odds ratio was 0.8 (95% CI: 0.5 - 1.1), a negligible change.

Although this study did not specifically relate increased PSA with acute urinary retention(AUR), a significant association was established between increased PSA and severe LUTS which is a forerunner of AUR. El-Adawy et al[8], in an Egyptian

multicentric study of 437 patients, reported a significant association between AUR and higher baseline PSA levels ($p < 0.001$), but further statistical analysis showed no significant correlation between baseline serum PSA and the improvement in IPSS ($r = -0.02$, $p = 0.684$) or Qmax ($r = -0.06$, $p = 0.267$). Prior African hospital-based study reported similar findings of weak correlation between baseline PSA and IPSS[19,20]

The differences between the results obtained in Egypt [8], Nnewi[13], Calabar[15], Trinidad[16] and our study can be explained in two points. First, our study population was a community-based screening, so men in our study had smaller prostates than men who visited the hospital. Second, some of these studies were limited in sample size.

5. Conclusion

Both PSA and prostate size independently significantly affect the severity of LUTS. When adjusted for other factors, PSA is a greater contributor to the severity of LUTS than prostate size. The import of this finding is to say that greater attention should be paid to patients with elevated PSA at presentation in terms of prospects of LUTS or future development of acute urinary retention irrespective of the size of the prostate at that point of presentation. This emphasis should not undermine the primary utility of PSA in excluding prostate cancer.

Compliance with ethical standards

Acknowledgments

Disclosure of conflict of interest

The authors declare there are no conflicts of interest in this study.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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