ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 12 | December - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CORRELATION BETWEEN PRESUMED CIRCLE AREA RATIO AND LOWER URINARY TRACT SYMPTOMS: AN OBSERVATIONAL STUDY

Urology

Sharang Kulkarni* Department of Urology, MGM Medical College and Hospital, Kamothe, Navi Mumbai. *Corresponding Author

Piyush Singhania Professor and Head, Department of Urology, MGM Medical College and Hospital, Kamothe, Navi Mumbai.

ABSTRACT

Introduction: Lower urinary tract symptoms (LUTS) in men, often linked to benign prostatic hyperplasia (BPH), show an inconsistent correlation with prostate size. This suggests anatomical configuration, such as prostate shape, may be significant. The Presumed Circle Area Ratio (PCAR) quantifies prostate roundness; a ratio approaching one signifies a rounder gland. Previous studies show ethnic variations, with limited data in the South Asian populations. This study evaluated the correlation between PCAR and LUTS, measured by the International Prostate Symptom Score (IPSS) and maximum urinary flow rate (Qmax), in an Indian population. **Methodology:** The study included 39 male patients aged more than 40 years with LUTS. Exclusion criteria included prior prostatic surgery, neurogenic bladder dysfunction, and active urinary tract pathologies. Participants provided IPSS scores and underwent uroflowmetry for Qmax. Transrectal ultrasound (TRUS) was used to measure the prostate's circumference and semi-axes at its largest transverse diameter. PCAR was calculated as the ratio of the prostate's cross-sectional area to the area of a circle with an equal circumference. Pearson correlation coefficients were used for statistical analysis. **Results:** A strong, statistically significant negative correlation was found between PCAR and Qmax ($r = -0.72$, $p < 0.01$). A moderate positive correlation was observed between PCAR and IPSS ($r = +0.43$, $p \approx 0.07$). These results indicate that as the prostate becomes rounder (higher PCAR), the urinary flow rate significantly decreases and symptom scores tend to increase. **Conclusion:** In this Indian cohort, PCAR correlated significantly with LUTS, especially the objective measure of Qmax. This supports the hypothesis that prostate shape, not just volume, influences LUTS severity. PCAR can be utilized as a predictive factor for LUTS. Despite a small sample size, the findings suggest PCAR measurement could be valuable in routine LUTS evaluation, warranting further large-scale studies.

KEYWORDS

Presumed Circle Area Ratio (PCAR), Lower Urinary Tract Symptoms (LUTS), Transrectal Ultrasonography (TRUS), International Prostate Symptom Score (IPSS)

INTRODUCTION

Lower urinary tract symptoms (LUTS) are a very common phenomenon encountered by urologists in their daily practice. LUTS are encountered predominantly in adult males aged more than 40 years due to underlying benign prostatic hypertrophy (BPH). These symptoms pose a major impact on the quality of life of patients, on their families and society. Numerous studies have been performed and documented in the literature and the correlation between the size of the prostate gland and the incidence of LUTS remains modest [1,2]. Since the volume of the prostate gland is an inconsistent factor responsible for severity of LUTS, many hypotheses have been proposed over a period of time. Various authors have performed studies trying to establish the correlation of LUTS with various factors of lower urinary tract such as the size of prostate gland, the presumed circle area ratio (PCAR), transitional zone volume (TZV), etc. Many studies previously performed have shown modest correlations with variations based on the location of the study performed and the race of the patients included in the study.

Recently, the anatomical factors such as prostatic urethral angle (PUA), intravesical urethral projection (IPP), transitional zone index have been under investigation in relation to LUTS. Previously, our understanding of BPH was centered on bladder outlet obstruction being secondary to benign prostatic enlargement. However, prostate size itself is not correlated with the urine flow rate and symptomatology. [3]. Therefore, it is prudent to consider alternative theories to explain the pathogenesis of lower urinary tract symptoms in benign prostatic hyperplasia. The causal relation of the anatomical configuration of a hyperplastic prostate on the symptoms needs exploration. One of the important aspects of anatomical configuration has been the shape of the prostate gland. The effect of the roundness of prostate gland on the severity of the symptoms is explored with help of a quantitative measure like PCAR (presumed circle area ratio). It is the ratio of area of the prostate gland section at the largest diameter to the area of a presumed circle having equal circumference as the prostate at the corresponding section. As the ratio approaches the value of one, the prostate gland is considered to be round.

Previous studies exploring similar concepts have also mentioned the deviation of results based on the population ethnicity and locality. There have not been many large-scale studies focusing on the PCAR in correlation with the development and severity of LUTS on south Asian population. Therefore, we have conducted a study focusing on PCAR, being a major causative factor for LUTS in Indian population and have concluded with evidence of correlation between the two. Although establishing strong evidence warrants extensive multicentric and randomized studies to be performed, our study aims at establishing correlation between PCAR and LUTS. The objective of our study is to evaluate the PCAR and correlate it with symptoms and urinary flow rate. Based on our research, we wish to establish PCAR and thereby anatomical configuration as major components of the pathophysiology of LUTS. It can be considered prudent to incorporate PCAR measurement as a part of routine evaluation of the BPH/LUTS complex.

MATERIALS AND METHODS:

Male patients presenting with LUTS were examined clinically and a standard questionnaire was provided to calculate the IPSS score. Patients were examined using transabdominal ultrasonography to evaluate the urinary tract. Information leaflets were presented to the patients in their native languages and verbal information was provided about the study. Patients willing to undergo the procedures of TRUS (Siemens Acuson X300 ultrasound with EC9-4 Endocavitary probe and CH5-2 convex probe) and uroflowmetry (UROCOMP 2000, gravimetric type Vmic sensor - Weight type method) were included.

With due consent acquired, the patient underwent TRUS and uroflowmetry. Maximum urine flow rate, i.e., Qmax, was derived. On TRUS, the circumference (C) of the prostate gland was measured at the section with the largest transverse diameter. Considering a normal prostate to be an ellipse, area of that section of the prostate was calculated using the semi-major(a) and semi-minor axes(b). We presume a circle having equal circumference (C) and calculate area. The ratio of these areas gives the PCAR (Figure 1,2).

Formulae:

Area of ellipse: $A = \pi ab$

Area of circle: $A' = \frac{C^2}{4\pi}$

$$PCAR = \frac{A}{A'} = \frac{4ab}{C^2}$$

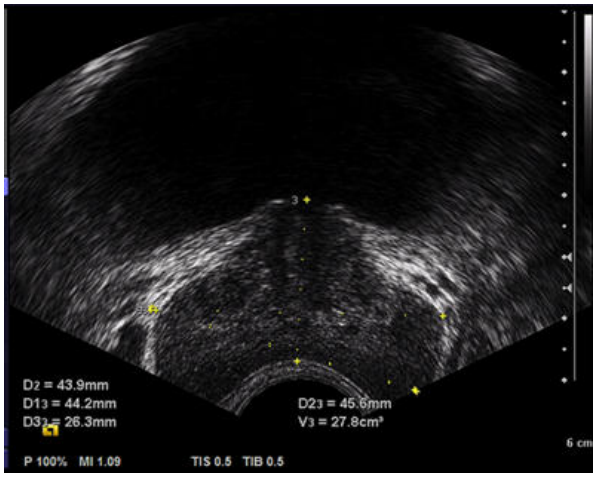

Figure 1: *Calculation of semi-major and semi-minor axes (a,b)*

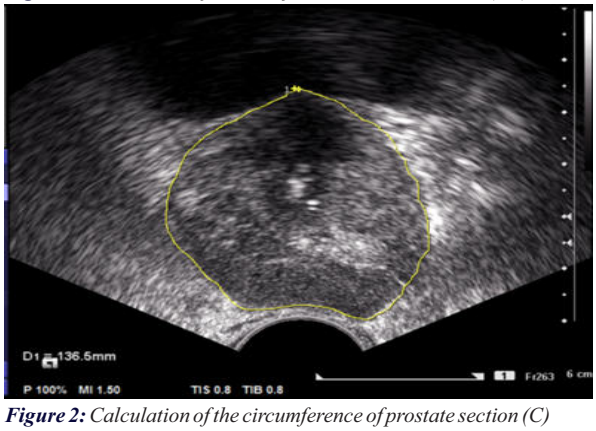

Figure 2: *Calculation of the circumference of prostate section (C)*

The data were collected in a pre-validated pro-forma. On completion of the study, the data was processed using the SPSS24 tool. For the statistical analysis, we employed techniques including linear regression and Pearson correlation coefficients, which are standard for evaluating relationships in clinical studies. In all statistical tests, a p-value of <0.05 was considered significant.

Inclusion Criteria:

Men aged more than 40 years presenting to the outpatient department with lower urinary tract symptoms, agreeing to undergo TRUS and uroflowmetry, along with routine clinical examination and trans-abdominal ultrasonography

Exclusion Criteria:

- Men with a history of prostatic surgeries, established neurologic bladder dysfunction, uncontrolled type II diabetes mellitus and malignancies
- Men with concomitant pathologies of the urinary tract, like active urinary infections, calculus disease and urethral strictures
- Men already undergoing treatment with alpha blockers or having an indwelling urinary catheter.

RESULTS:

Our study includes total of 39 patients for the analysis. An increase in IPSS score and a decrease in urinary flow (Qmax) was observed with an increased PCAR. The mean age of the included participants was 64.5 years. Mean prostate volume was found to be 44.3mL. (Table 1)

Table 1: Statistical Test Results Showing Correlation In PCAR With Qmax and IPSS

Correlation	r value	Direction	Significance
PCAR vs Qmax	–0.72	Strong negative	$p < 0.01$
PCAR vs IPSS	+0.43	Moderate positive	$p \approx 0.07$ (trend)

In our study, we analysed the correlation between PCAR and LUTS. For analysing the presence and severity of LUTS, the IPSS scoring and Qmax was taken into consideration.

1. Correlation between PCAR and Qmax

As per the data obtained in our study a negative correlation was observed between PCAR and Qmax and thus has a positive correlation with the severity of LUTS. This can be interpreted as with higher PCAR, there is more compression over the urethra leading to poor urinary flow. This supports the idea that prostatic shape distortion and not only volume, influences the severity of LUTS. Our study gives a strong negative correlation between PCAR and Qmax ($r = –0.72$, $p < 0.01$). (Figure 3)

2. Correlation between PCAR and IPSS

In our study, we observed that a positive correlation exists between PCAR and IPSS thus a positive correlation with severity of LUTS. This can be interpreted as the higher the PCAR value, the greater the severity of symptoms, suggesting a functional impact of PCAR. Our study gives a moderate positive correlation between PCAR and IPSS ($r = 0.43$, $p \approx 0.07$) (Figure 3).

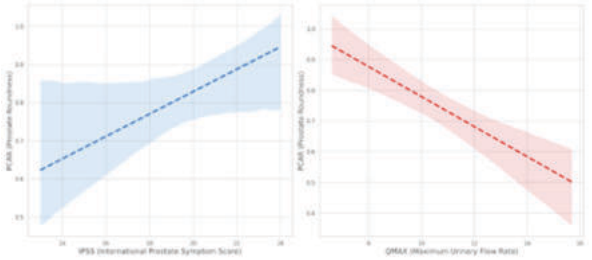

Figure 3: *Correlation of PCAR with IPSS and Qmax*

DISCUSSION:

LUTS is a clinical entity commonly encountered by practicing urologists include storage symptoms and voiding symptoms. This has been historically mentioned to be secondary to the increased overall size of the prostate gland by many authors. The increased prostate gland size has been attributed to benign prostatic hyperplasia (BPH). There have been many discussions over the basic causative factor of the development of LUTS and the factors affecting the severity of LUTS. There is no established evidence for one particular factor. Previously published studies have also documented variations in the findings based on the difference in study location and ethnicity of the population under investigation.

Secondary to the increased overall size of prostate gland, impingement over the urethra causes LUTS, but the evidence of correlation between overall prostatic growth and the development of LUTS is modest [1,2]. As proposed by Watanabe, the anatomical configuration of prostate gland, approximating a circle around the urethra with the increasing size, is a more potent factor for development of LUTS [4]. The fundamental thought behind this is that, with increasing size of prostate, the pressure over the surrounding surgical capsule also increases. Beyond a certain limit the prostate capsule starts approximating in a circle. As the circle is completely formed it puts maximum pressure over the capsule and urethra producing significant LUTS [4].

Associations between PCAR and LUTS were moderate in a Japanese urological referral population [5], while it was less significant when mass-screening for prostate diseases was carried out[6]. However, it lacks the clarity as PCAR is more significantly associated with LUTS than TZV and other standard measures. Various studies have been performed in the past focusing on this particular question but there have been significant disparities among the results. Kurita et al. [5] have documented in their study that TZV has more association while Taneike et al. [7], through their study mentioned that PCAR had more significant correlation. It has also been mentioned that due to difference in the average normal stature and size and length of urethra, the results in different locations have given skewed numbers.

The routine investigation for LUTS is flow studies, but the results are affected by presence of BPH. This has initiated many studies investigating the correlation of severity of LUTS with uroflowmetric parameters, prostatic anatomical parameters using ultrasound, TZV, etc. In their study Kaplan et al. documented that for severity of LUTS and bladder function, regardless of TZV, measurement of trans-rectal ultrasound (TRUS) guided transition zone index (TZI) shows significant correlation [8]. Though various other studies published do not agree with this hypothesis. St Sauver et al. found out that the changes in TZI or TZV do not affect the severity of LUTS significantly [2]. Lepor et al. indicated that TPV, TZV, and TZI were not directly

related to the symptom scores [9].

Based on these, we have conducted a study on the Indian population. In our study, we have observed a correlation between PCAR and LUTS. The limitations of this study are it is not a multicentric study and small sample size. However, we want to put forward our findings so that we can draw the attention of fellow practitioners and researchers towards the question. Further wide scale randomized studies are needed for it to give more evident correlation which might change the view of looking at LUTS leading to change in the approach towards such commonly encountered patients.

CONCLUSION:

From the findings of our study, we conclude that there is a correlation between PCAR and LUTS in the Indian population. PCAR can be utilized as predictive factor for development and severity of LUTS. We also appeal to fellow researchers and practitioners that keeping these findings in mind, wide scale randomized studies should be carried out for the same and TRUS should be included as a routine investigation practice for evaluating such patients.

REFERENCES:

1. Bosch, J. L., Bangma, C. H., Groeneveld, F. P., & Bohnen, A. M. (2008). The long-term relationship between a real change in prostate volume and a significant change in lower urinary tract symptom severity in population-based men: The Krimpen study. *European Urology, 53*(4), 819–825. https://pubmed.ncbi.nlm.nih.gov/17826889/
2. Cho, K. S., Kim, J., Choi, Y. D., Kim, J. H., & Hong, S. J. (2008). The overlooked cause of benign prostatic hyperplasia: Prostatic urethral angulation. *Medical Hypotheses, 70(3), 532–535.*
3. Kaplan, S. A., Te, A. E., Pressler, L. B., & Olsson, C. A. (1995). Transition zone index as a method of assessing benign prostatic hyperplasia: Correlation with symptoms, urine flow and detrusor pressure. *The Journal of Urology, 154*(5), 1764–1769.
4. Kojima, M., Ochiai, A., Naya, Y., Ukimura, O., Watanabe, M., & Watanabe, H. (1997). Correlation of presumed circle area ratio with infravesical obstruction in men with lower urinary tract symptoms. *Urology, 50*(4), 548–555. https://pubmed.ncbi.nlm.nih.gov/9338730/
5. Kurita, Y., Masuda, H., Terada, H., Suzuki, K., & Fujita, K. (1998). Transition zone index as a risk factor for acute urinary retention in benign prostatic hyperplasia. *Urology, 51*(4), 595–600. https://pubmed.ncbi.nlm.nih.gov/9586613/
6. Lepor, H., Nieder, A., Feser, J., O'Connell, C., & Dixon, C. (1997). Total prostate and transition zone volumes, and transition zone index are poorly correlated with objective measures of clinical benign prostatic hyperplasia. *The Journal of Urology, 158*(1), 85–88.
7. St Sauver, J. L., Jacobson, D. J., Girman, C. J., Lieber, M. M., McGree, M. E., & Jacobsen, S. J. (2006). Tracking of longitudinal changes in measures of benign prostatic hyperplasia in a population-based cohort. *The Journal of Urology, 175*(3), 1018–1022. https://pubmed.ncbi.nlm.nih.gov/16469608/
8. Taneike, R., Kojima, M., & Saitoh, M. (1997). Transrectal ultrasonic planimetry of the prostate in relation to age and lower urinary tract symptoms among elderly men in Japan. *The Tohoku Journal of Experimental Medicine, 183*(2), 135–150. https://pubmed.ncbi.nlm.nih.gov/9526804/
9. Watanabe, H. (1998). New concept of BPH: PCAR theory. *The Prostate, 37*(2), 116–125. https://pubmed.ncbi.nlm.nih.gov/9759706/