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Association of *Taila Bindu Pariksha* Patterns with Clinical Severity Indicators in Benign Prostatic Hyperplasia: A Cross-Sectional Observational Pilot Study

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KEYWORDS

Benign prostatic hyperplasia, *Sadhya-Asadhyata, Taila Bindu Pariksha.*

ABSTRACT:

Introduction: *Taila Bindu Pariksha* (Oil Drop Test or TBP), a component of *Mutra Pariksha*, is described in classical Ayurveda texts as a method for understanding *Sadhya* (curable) - *Asadhyata* (incurable) prognosis of disease. Benign Prostatic Hyperplasia (BPH) is a prevalent urological disorder characterised by urinary obstruction leading to Lower Urinary Tract Symptoms (LUTS). The evaluation of BPH, such as Transabdominal Ultrasonography (TAUS), the International Prostate Symptom Score (IPSS), and Prostate-Specific Antigen (PSA), demonstrates variable sensitivity and specificity, highlighting the need for a revalidated Prognostic approach. The present study aims to re-evaluate and validate the prognostic significance of TBP in patients with BPH.

Methods: A cross-sectional observational pilot study was conducted at the institutional OPD, enrolling 30 men aged 40–85 years with BPH. Participants were selected based on predefined inclusion and exclusion criteria. Early morning midstream urine samples were collected and evaluated using TBP, TAUS, IPSS and PSA were assessed. Comparison and Associations were analysed using statistical tests, including t-tests, Kruskal–Wallis, Chi-square, and Fisher's exact test.

Results: TBP direction and spread were significantly associated with TAUS and IPSS, while shape and PSA showed no significant effect; TBP patterns were influenced predominantly by *Vata dosha*.

Conclusions: TBP parameters such as direction and spread showed significant associations with TAUS and IPSS, indicating their prognostic relevance in assessing urinary disorders. While shape and PSA exhibited no significant effect. Overall, TBP patterns were predominantly influenced by Vata dosha, suggesting that functional disturbances governed by Vata play a major role in the pathophysiology of urinary alterations.

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1. Introduction

Mutra Pariksha (urine examination) is one of the components of *Astavidha Rogi Pariksha* (eight-fold examination) [SAT-C.154]. [1] It incorporates the *Taila Bindu Pariksha* (Oil Drop Test or TBP), a prognostic method used by ancient Ayurvedic sages such as *Yogratnakar*, *Basavarajeyam*, and *Vangasena*. Its purpose is to evaluate whether diseases are *Sadhya* (curable), *Kashtasadhya* (difficult to cure), or *Asadhya* (incurable) for guiding treatment planning. [2]

Mutra (urine) [SAT-B.460] is considered one of the *Ahara-mala* (waste products of digestion), and its main function is to carry away *Kleda* (watery waste) from the body. *Kleda* refers to the *Shareera (body)* with a predominance of wet or moist qualities (*ardri bhava*) or the water element / body fluids (*ap dhatu*). [3] The formation and elimination of urine take place in the *Basti* (urinary bladder) [SAT-B.218], which serves as the reservoir for urine. Excess *Kleda* accumulates in the urinary bladder and is eventually excreted from the body in the form of urine. [4] This process helps eliminate toxins, metabolic waste products, and excess ions from the body. When normal urinary physiology is impaired, this mechanism is disrupted, predisposing to pathological conditions. Enlargement of the prostate gland disrupts the normal excretion of urine and causes urinary retention with suppression of flow leading to stagnation of *Kleda* (watery waste) in the Basti (urinary bladder). [5] This concept correlates with the pathophysiology of Benign Prostatic Hyperplasia (BPH, ICD-10 code N40.1). The condition arises in the transition (periurethral) zone of the prostate, where glandular enlargement encircles the urethra, restricting urinary flow and causing lower urinary tract symptoms (LUTS) that significantly impair quality of life in aging men. [6,7]

Epidemiological studies show that nearly half of men in their 50s, about 60% by the age of 60, and up to 80% by 80 years are affected by BPH. [8] In India, its prevalence is about 50% in men aged 40–79 years. [9] In contemporary clinical practice, the diagnostic evaluation of BPH involves several tools, each with varying sensitivity and specificity. Transabdominal ultrasonography (TAUS), the first-line imaging investigation, shows 85.3% sensitivity and 87.1% specificity [9]. The International Prostate Symptom Score (IPSS) demonstrates 58% sensitivity and 59% specificity [10], while prostate-specific antigen (PSA) testing shows high sensitivity of 93% but low specificity of 20% [11]. Despite their widespread use, these meta-analytic findings highlight significant variability and cost in existing methods, underscoring the need for complementary and reliable diagnostic approaches.

Previous research in Ayurveda has demonstrated the prognostic relevance of *Taila Bindu Pariksha* in conditions such as cancer, ascites, rheumatic heart disease, and diabetes mellitus [12–15]. As BPH is a highly prevalent condition among aging males, exploring TBP in this context holds significant clinical value. However, TBP has not been systematically explored in BPH and may yield more accurate and reliable results. Despite its potential, there is a clear methodological gap due to the lack of standardized and comparative approaches. This study seeks to address this gap by revalidating the clinical utility of TBP as a tool for the prognostic evaluation of BPH.

2. Objectives

The primary objective of this study is to correlate TBP findings with TAUS, IPSS, and PSA levels in BPH. The secondary objectives are to study the directions of oil dispersion in BPH patients through TBP, to study the rate of spread of oil drop in BPH patients through TBP, to see any specific shapes found in the urine of BPH patients through TBP, and to study the predominance of dosha in subjects of BPH through TBP.

3. Methods

Study design

This pilot study is a cross-sectional observational study conducted between February to March 2025 at the institutional OPD. Videographic and Photographic documentation of the TBP analysis was performed in the institutional laboratory.

Eligibility Criteria

The study included patients aged 40–85 years [9] who had been diagnosed with BPH (ICD-10 code N40.1). Patients were excluded if they had been diagnosed with kidney stones (N20.0), acute or chronic prostatitis (N41.0, N41.1), type 2 diabetes mellitus (E11), or prostate cancer (C61).

Ethical consideration

Prior to participation, informed consent was obtained from all individuals after explaining the purpose of the study. Participants were assured that their personal information would remain confidential and their identities would not be disclosed at any stage of the research.

Variables

In this study, the dependent variable was the prognosis of patients with BPH. Independent variables included diagnostic measures hypothesized to influence outcomes: IPSS, TAUS, PSA, and TBP parameters.

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Confounding variables such as kidney stones, prostatitis, diabetes mellitus, and prostate cancer, which could influence symptom severity or TBP findings, were excluded. Environmental artifacts, including factors such as temperature, airflow, and sample collection timing, and procedural artifacts, such as Petri dish cleaning and camera alignment, were identified as potential sources of measurement variability. These artifacts were minimized through controlled experimental conditions and adherence to protocols to ensure consistency and reliability in TBP measurements.

Data Sources

The experimental analysis was carried out using a standardised prototype system. [Figure 1] The setup comprised a micro-pipette for precise placement of oil droplets, a glass Petri dish for urine sample holding, and an LED illumination unit to provide consistent lighting. A magnetic compass was integrated to facilitate directional assessment, while all components were enclosed within a specially designed cabinet that minimized external influences such as airflow and uncontrolled illumination. A fixed high-resolution camera was attached to the chamber for real-time recording of the oil–urine interaction, enabling subsequent image analysis. To further ensure consistency across trials, the system was equipped with balancing and labelling provisions.

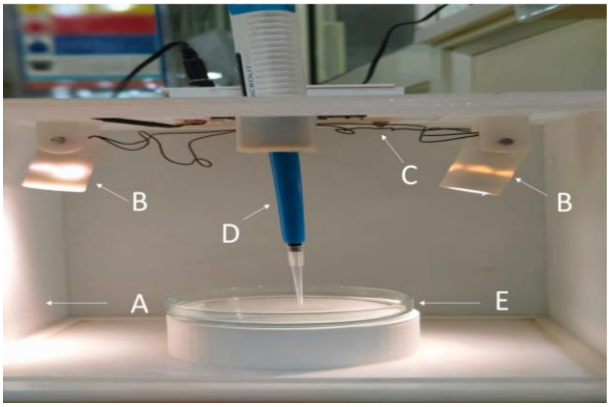

Figure 1: Device used in the experiment. A: Cabinet; B: LED light; C: Camera; D: Pipette; E: Petri dish.

All data for the processing of TBP were fixed and detailed in [Table 1].

Table 1: Standardized Parameters for *Taila Bindu Pariksha* (TBP)

Parameter		Standardization Details
Selection of Container	4-inch glass Petri dish	Ideal shape allows full camera coverage of the Petri dish inside the cabinet, ensuring even urine spread for clear pattern observation.
Choice of Oil	Black sesame (Til) oil	Selected for its high viscosity and specific gravity, which are essential for different pattern formation. [33]
Oil Droplet Measurement	12 µl droplets	A calibrated micropipette (12 µL), standardised as per ISO 8655 guidelines, was used to dispense a drop from a height of 1 cm above the urine surface to prevent airwave interference and ensure stable testing conditions. [35]
Urine Sample Volume	Minimum 30 ml	Required for each test to ensure adequate observation.
Observation Protocol	2-minute recording	Oil–urine interaction was recorded using a centrally aligned 5-megapixel stationary camera with dual LED illumination inside the cabinet for a fixed duration of 2 minutes to ensure clear recording.
		LED lighting, which produces less heat than incandescent, halogen, or fluorescent bulbs by converting more electricity into light rather than heat, was used to maintain a consistent temperature during observation.[36]
Preparation & Cleaning of Apparatus	Petri dish cleaning process	The Petri dish was soaked in chromic acid for 24 hours, rinsed first with tap water and then with distilled water, and finally dried in an oven to maintain reproducibility and prevent contamination. [37]

Measurement

All measurements and procedures were based on predefined standardised protocols to ensure accuracy, reproducibility, and reliability in both sample collection and evaluation. [16,17]

The IPSS is standardised by the American Urological Association, is a cost-effective, sensitive, and specific screening tool for BPH. In this study, both the original English version and the Punjabi version of the IPSS were used. The original English version used in this study consists of a total of 7 questions referring to symptoms over the past month, with severity graded, as summarised in [Table 2]. [18,19] The Punjabi version of the IPSS demonstrated high validity and reliability in a test-retest

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study, confirming it as a simple and effective instrument for BPH in Punjabi-speaking populations. [20] TAUS has become crucial for clinical assessment and decision-making, with advancements in ultrasonography now allowing clear visualisation of zonal anatomy. [21] TAUS provides accurate measurements of prostate volume and post-void residual urine, while also allowing evaluation of the bladder, kidneys, and ureters. Prostate enlargement is categorised using a grading system, helping clinicians stratify patients and guide management [Table 2]. [18] PSA is a protein produced by normal and malignant prostate cells and serves as a sensitive and specific marker for prostatic conditions, including BPH, prostatitis, and cancer. PSA levels are categorised using standard grading [22], and Age-related prostate changes and BPH can cause slight PSA elevations, making PSA measurement important for BPH diagnosis and management [Table 2]. [23,24]

TBP was performed using morning urine samples of clinically diagnosed patients with BPH. A single drop of sesame oil was dropped on the surface of the urine sample. The directional movement and the spread of the oil drop were monitored immediately and recorded video graphically to ensure accurate evaluation of droplet behaviour. The rate of spread (fast, slow, or sinking) and directional dispersion (uniform or non-uniform flow patterns) was later determined by analysing these recordings. The shape of the oil drop was documented photographically as even or uneven, with predominance of dosha patterns shown in the [Figure 3-5]. The details of prognostic interpretation of TBP, contemporary clinical variables and predominance of dosha are compiled from classical literature and previous studies are summarised in [Tables 2 and 3]. [14,25-34]

Table 2: Prognostic Interpretation of TBP and Contemporary Clinical Variables

Severity	Clinical variables (TAUS / IPSS / PSA)	Directions of Oil Dispersion [14,27,28]	Rate of Spread of Oil Drop [25,26]	Shape of Oil Drop [14]	Prognosis	Interpretation
Mild	TAUS: Grade 1–2 (>30–50 cc) IPSS: 1–7% PSA: <4.0 ng/ml	Uniform (Evenly spread to all the directions or takes a particular direction towards the North /East /West direction)	Fast Spread (Instant Spread) <10 seconds	Even (Circular Shape, oval, or semi-circular shapes)	*Sadhya* (Curable)	Mild enlargement, Mild PSA, mild symptom score, and TBP parameters indicate a curable condition.
Moderate	TAUS: Grade 3 (51–80 cc) IPSS: 8–19 % PSA: 4–10 ng/ml	-	Slow spread (Spread Slowly) >10 seconds	-	*Kashta sadhya* (Difficult to cure)	Moderate enlargement, moderate symptom score, moderate PSA; TBP parameters indicate the condition is difficult to cure.
Severe	TAUS: Grade 4 (>80 cc) IPSS: 20–35% PSA: >10 ng/ml	Non uniform (Unevenly spread to multiple directions or takes a particular direction towards the South /(North-East) /(South-East) /(South-West) /(North-West)	Sink (Settle Down in the Bottom after spread or No spread)	Uneven (Irregular, linear, or dot-shaped drops)	*Asadhya* (Incurable)	Severe enlargement, high PSA, severe symptoms; TBP parameters indicate an incurable condition.

Table 3: Doshic predominance in TBP

Doshic Predominance	*Yogaratnakara* [32]	*Basavarajeeyam* [33]	*Vangasena* [34]
Vata	*Sarpakara* (snakelike droplet)	*Mandalakara* (circular)	*Ruksha/ Kshara* appearance of urine
Pitta	*Chatrakara* (umbrellalike droplet)	*Budbudakara* (bubble-like formation)	*Budbudakara* (bubble-like formation)
Kapha	*Muktakara* (pearl-like droplet)	*Bindu* (dot-like) or (Spherical)	An oil droplet floats steadily over the urine surface, similar to moss on stagnant water.
Vata-Pitta	-	-	*mutren sardham milita tailabindu* (Oil drop mixes with urine)
	-	-	*siddhatha taila sadrisham* (appearing similarto mustard oil).
Tridoshaj	-	*Nimajjati* (Sink)	-

Bias

Potential sources of bias and the mitigation strategies employed in this study are outlined in [Supplementary Table 1] to ensure the accuracy, reliability, validity, and generalizability of the study findings.

Study size justification

The study size was limited to 30 patients, determined on the basis of feasibility and the exploratory nature of the pilot study, with the intention of generating preliminary data to inform future large-scale research.

Statistical methods

Descriptive statistics (mean, median, standard deviation, and standard error) were computed to summarise continuous variables, while categorical variables were

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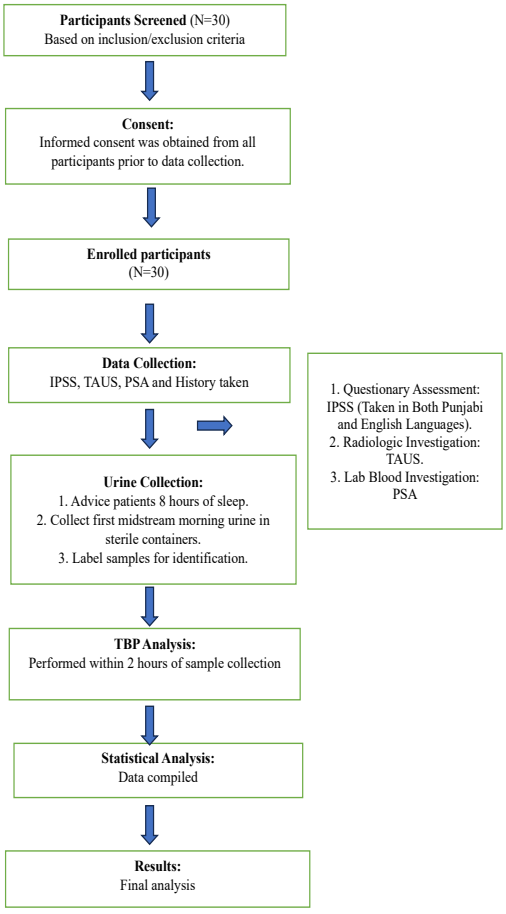
expressed as frequencies and percentages. For group comparisons of continuous data, parametric tests such as the Independent Samples t-test were employed, along with non-parametric alternatives (Mann–Whitney U test) where normality assumptions were not fulfilled. Associations between categorical variables were assessed using the Chi-square test of independence, with Fisher's Exact Test applied in cases of small expected cell counts. For multi-group comparisons, the Kruskal Wallis test was used as a non-parametric alternative to ANOVA. All analyses were performed using Jamovi 2.6.2 and R version 4.4. A p-value of <0.05 was considered statistically significant.

4. Results

Participants

The study included 30 male patients aged 40 to 85 years, selected based on inclusion and exclusion criteria. The complete methodological flow chart is presented in [Figure 2].

Figure 2: Flow Chart



Outcome data

This study analysed the descriptive statistics of TAUS, IPSS, and PSA values in relation to TBP parameters - direction, shape, and spread.

TBP with TAUS

Participants with a uniform spread (n = 18) had a mean volume of 38.6 cc (SD = 6.36), while those with a non-uniform spread (n = 9) had a slightly higher mean of 40.2 cc (SD = 6.38). Regarding shape, participants with an even distribution (n = 19) recorded a mean of 39.8 cc (SD = 6.18), compared to 37.8 cc (SD = 6.69) for those with an uneven distribution (n = 11). Fast spread cases (n = 20) showed a higher mean of 44.8 cc (SD = 17.24), whereas sink cases (n = 9) had a mean of 56.56 cc (SD = 22.82). Only one participant in the slow spread category had a volume of 85 cc.

TBP with IPSS

For IPSS scores, individuals with a uniform spread (n = 19) had a mean score of 8.88 (SD = 1.73), whereas those with a non-uniform spread (n = 11) had a higher mean of 10.0 (SD = 3.08). Even shape cases (n = 19) had a mean of 9.50 (SD = 3.10), and uneven shape cases (n = 11) had a mean of 9.43 (SD = 1.62). Fast spread participants (n = 20) showed lower symptom severity with a mean score of 7.40 (SD = 4.26), while sink cases (n = 9) had a mean of 9.00 (SD = 4.53). Only one slow spread participant had a score of 17.

TBP with PSA

In the PSA analysis, uniform spread participants (n = 19) had a mean of 1.29 ng/mL (SD = 0.87), and non-uniform spread participants (n = 11) had a higher mean of 1.64 ng/mL (SD = 1.02). Similarly, even shape participants (n = 19) recorded a mean of 1.31 ng/mL (SD = 0.80), whereas uneven shape participants (n = 11) had a mean of 1.60 ng/mL (SD = 1.14). Fast spread cases (n = 20) had a mean PSA level of 2.78 ng/mL (SD = 6.74), and sink cases (n = 9) had a mean of 3.82 ng/mL (SD = 6.18). The single slow spread participant had a PSA level of 0.90 ng/mL. These findings suggest variability in TAUS, IPSS, and PSA values across different TBP parameters. [Table 4] Detailed categories-wise distributions for all TBP parameters are provided in [Supplementary Table 2].

Inferential analysis of TBP parameters showed that direction and spread were significantly associated with TAUS (direction: $t = 2.127$, $p = 0.042$; spread: $\chi^2 = 10.87$, $p = 0.012$) and IPSS (direction: $t = 2.188$, $p = 0.037$), while shape was not significant. PSA levels did not show significant associations with any TBP parameter. Chi-square and Fisher's exact tests confirmed that spread

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influenced TAUS (χ^2 = 13.9, p = 0.031) and direction influenced IPSS (p = 0.038), but PSA remained unaffected. Overall, direction and spread appear to influence BPH measurements, whereas PSA values are not significantly affected. [Table 5]

Frequency distributions of TBP parameters showed a clear Vata predominance: uniform direction (43.3%) and non-uniform direction (30.0%), even shape (56.6%), and fast spread (66.6%). Tridoshaj patterns appeared mainly in non-uniform direction (3.3%), uneven shape (16.7%), and sink (20.0%). Contributions from Pitta (3.3%) and Kapha (0%). These findings suggest that in TBP, Vata is the dominant dosha influencing the oil-urine interaction, as shown in [Table 6] and the photographic records of oil drop shapes shown in [Figures 3–5].

Table 4. Descriptive Statistics of Spread, Shape, and Direction with TAUS, IPSS, and PSA

Variable	TBP parameter	N	Mean	SE	SD	Min	Max
TAUS-direction	Uniform	18	38.6	2.01	6.36	31	50
	Non-uniform	9	40.2	2.85	6.38	33	48
TAUS-shape	Even	19	39.8	1.95	6.18	33	50
	Uneven	11	37.8	2.99	6.69	31	48
TAUS-spread	Fast Spread	20	44.80	3.86	17.24	25	80
	Slow Spread	1	85.00	-	-	85	85
	Sink	9	56.56	7.61	22.82	27	100
IPSS-direction	Uniform	19	8.88	0.61	1.73	7	12
	Non-uniform	11	10.0	1.03	3.08	7	20
IPSS-Shape	Even	19	9.50	0.98	3.10	7	17
	Uneven	11	9.43	0.61	1.62	8	12
IPSS-Spread	Fast Spread	20	7.40	0.95	4.26	2	12
	Slow Spread	1	17.00	-	-	17	17
	Sink	9	9.00	1.51	4.53	5	20
PSA-Direction	Uniform	19	1.29	0.21	0.87	0.14	3.50
	Non-uniform	11	1.64	0.32	1.02	0.24	3.11
PSA-Shape	Even	19	1.31	0.19	0.80	0.14	2.78
	Uneven	11	1.60	0.36	1.14	0.40	3.50
PSA-spread	Fast Spread	20	2.78	1.51	6.74	0.14	20.10
	Slow Spread	1	0.90	-	-	0.90	0.90
	Sink	9	3.82	2.06	6.18	0.51	31.16

Table 5: Comparative and Association Analysis of Spread, Shape, and Direction with TAUS, IPSS, and PSA

Variable	TBP parameters	Test	Statistic	df	p-value	Significant
TAUS	Direction	t-test	t = 2.127	28	0.042 *	Significant
TAUS	Shape	t-test	t = 1.111	28	0.276	Not significant
TAUS	Spread	Kruskal–Wallis	χ^2 = 10.87	3	0.012 *	Significant
IPSS	Direction	t-test	t = 2.188	28	0.037 *	Significant
IPSS	Shape	t-test	t = –0.557	28	0.582	Not significant
IPSS	Spread	Kruskal–Wallis	χ^2 = 8.93	3	0.030 *	Significant
PSA	Direction	t-test	t = 0.843	28	0.406	Not significant
PSA	Shape	t-test	t = –0.819	28	0.420	Not significant
PSA	Spread	Kruskal–Wallis	χ^2 = 4.50	3	0.212	Not significant
TAUS	Direction	Chi-square	χ^2 = 4.16	3	0.244	Not Significant
TAUS	Shape	Chi-square	χ^2 = 3.09	3	0.379	Not Significant
TAUS	Spread	Chi-square	χ^2 = 13.9	6	0.031	Significant
IPSS	Direction	Fisher's Exact Test	-	-	0.038	Significant
IPSS	Shape	Chi-square	χ^2 = 0.72	2	0.698	Not Significant
IPSS	Spread	Chi-square	χ^2 = 1.64	4	0.801	Not Significant
PSA	Direction	Chi-square	χ^2 = 0.164	1	0.685	Not Significant
PSA	Shape	Chi-square	χ^2 = 0.164	1	0.685	Not Significant

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PSA	Spread	Chi-square	χ^2 = 0.647	2	0.723	Not Significant

Table 6: Frequency distributions of Predominance of *dosha* in TBP

TBP Parameter		*Dosha*	count	% of total
Direction	uniform	*vata*	13	43.3%
		pitta	1	3.3%
		Kapha, Vata-pitta	0	0.0%
		tridoshaj	5	16.7%
	Non-Uniform	*vata*	9	30.0%
		pitta	1	3.3%
		Kapha, Vata-pitta	0	0.0%
		tridoshaj	1	3.3%
Shape	even	*vata*	17	56.6%
		Pitta	1	3.3%
		Kapha, Vata-pitta	0	0.0%
		Tridoshaj	1	3.3%
	uneven	*vata*	5	16.7%
		Pitta, Kapha, Vata-pitta	0	0.0%
		Tridoshaj	5	16.7%
Spread	fast spread	*vata*	20	66.6%
		pitta	2	6.6%
		Kapha, Vata-pitta, tridoshaj	0	0.0%
	Slow spread	*Vata, pitta, Kapha, Vata-pitta, tridoshaj*	0	0.0%
	Sink	*vata*	2	6.7%
		Pitta, Kapha, Vata-pitta	0	0.0%
		tridoshaj	6	20.0%

Figure 3: *Mandalakara* (circular) shape of oil drop with even, well-defined margins on the urine surface

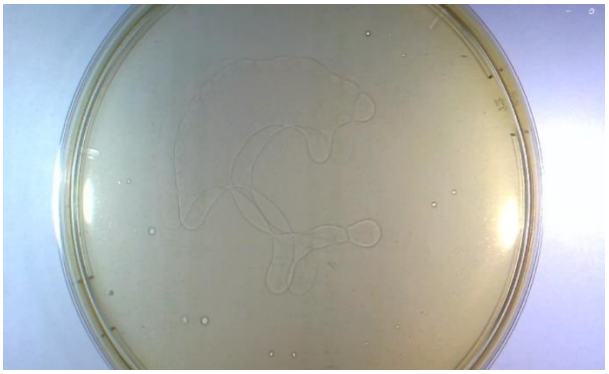

Figure 4: *Chatrakara* (Umbrella) and *Budbudakara* (bubble) shapes of oil drops with even, well-defined margins on the urine surface

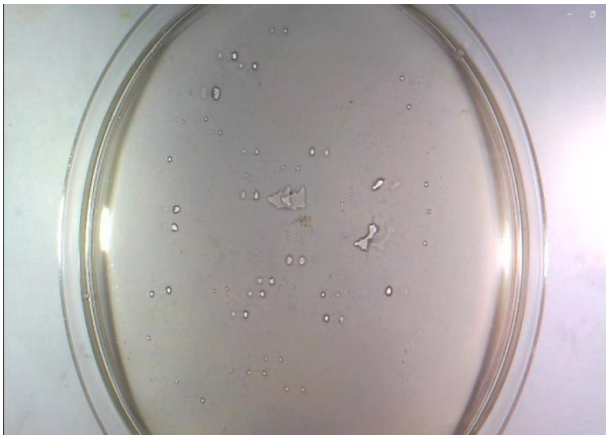

Figure 5: *Nimajjati* (Sink) oil drop with Uneven, ill-defined margins on the urine surface

5. Discussion

Among 30 male BPH patients, the spread and direction of the oil droplet showed a significant comparison and association with TAUS and IPSS. whereas PSA showed no significant findings with any of the parameters, including direction, shape, or spread. Similarly, no significant relationship was observed between TAUS, IPSS, or PSA and the droplet shape.

Interpretation and Contextualization

Physicochemical Factors Influencing Oil Droplet Direction, Shape, and Spread

The spreading behaviour of an oil droplet on urine is governed by surface tension, viscosity, and the spreading coefficient (S). Surface tension is the tendency of a liquid's surface to resist external forces and minimise its area due to cohesive forces between molecules, which determines the droplet's pattern and shape. Viscosity measures a liquid's resistance to flow and influences how

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quickly a droplet spreads under applied forces. [38] Liquids with strong intermolecular forces have high viscosity and flow slowly, whereas those with weaker intermolecular forces have low viscosity and flow more easily. The spreading coefficient is expressed as:

$S = \gamma LA - (\gamma OA + \gamma LO)$

where γLA is the surface tension of the sublayer liquid (air–liquid interface), γOA is the surface tension of the oil (oil–air interface), and γLO is the interfacial tension between the oil and urine. A positive S allows the oil droplet to spread into a thin layer spontaneously, whereas a negative S results in bead-like droplets. [39]

Dynamic factors, such as the Marangoni effect, which arises from surface tension gradients, also influence directional spreading. In this phenomenon, the liquid flows from regions of lower surface tension (γ) toward regions of higher surface tension, and the directional flow can be expressed as:

$\text{Flow direction} = \nabla\gamma$

Where γ is the surface tension and ∇γ signifies the gradient of the surface tension. [39]

Several factors modulate this behaviour, including surface tensions at interfaces, viscosity of sesame oil and urine, temperature, and urine chemical composition, which contains dissolved salts, proteins, and other solutes. [40,41]

Normal urine is composed of about 95% water and 5% solutes, primarily including urea (9.3 g/L), chloride (1.87 g/L), sodium (1.17 g/L), potassium (0.75 g/L), and creatinine (0.67 g/L), along with various dissolved ions, proteins, hormones, and metabolites. [42] Its composition reflects the physiological state of the body and serves as an important indicator of health. Normal urine also has a relatively low viscosity of 0.8293 cSt at 37°C, which contributes to its fluidity and efficient excretion. [43]

In BPH, changes occur due to incomplete voiding, urinary stasis, infection, and inflammation. Urinary viscosity increases (0.9447 cSt), and microbial alterations such as Escherichia coli colonisation can contribute to inflammation and tissue damage. [43] Accumulated solutes, proteins, bacteria, and debris alter urine's physical properties, disrupting surface and interfacial tension and affecting oil droplet spreading. [44]

No Significant Findings observed between PSA and TBP Parameters

PSA, although a highly sensitive biomarker, is relatively nonspecific and imprecise as a screening tool and does not show a significant association with oil behaviour. [45] PSA reflects prostate cell activity biochemically but may not directly represent changes in urine. Therefore, PSA indicates biological disease presence or progression. The TBP reflects physical and chemical alteration in urine caused by mechanical obstruction and stasis, which influences oil behaviour.

No Significant Findings Observed Between Shape and TAUS, IPSS, and PSA

In TBP, shape is considered a prognostic parameter for *Sadhya* (curable) and *Asadhya* (incurable) conditions. However, no significant correlation with shape was observed with TAUS, IPSS, and PSA in this study. This may be attributed to the limited sample size, observer variability, and physicochemical factors that influence droplet behaviour.

Droplet Shape also provides information about the predominance of *dosha* in urine, and it may primarily reflect *doshic* characteristics rather than disease prognosis. The *Mandalakara* (circular) droplet, which reflects *Vata* predominance, was the most commonly observed pattern among BPH patients. This observation is consistent with Ayurveda principles, where *Vata*, particularly *Apana Vata,* is regarded as central to the pathogenesis of *Basti Vyadhi* (urinary disorders). Its vitiation manifest as urinary hesitancy, weak flow, incomplete voiding, and retention, symptoms. [46] *Tridoshj* involvement indicates chronicity, relative incurability, and the likelihood of requiring surgical intervention. Pitta predominance, on the other hand, was rarely observed. In these cases, the droplet displayed a *Budbudakara* (bubble) droplet, a pattern associated with irritative or inflammatory changes rather than obstructive pathology.

Strength of the study

The main advantage of this study is the integration of Ayurveda prognostic TBP with contemporary clinical variables (TAUS, IPSS, PSA), offering an evaluation of BPH. The study maintained methodological rigour by systematically recording TBP under controlled conditions and refining assessment procedures using standardised frameworks, ensuring accurate, reliable, and sensitive data capture. This combined approach allowed for meaningful insights into the relationship between TBP and disease severity, highlighting the potential of merging traditional and modern Prognostic strategies.

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Limitations

Sample Size and Representation

Only 30 male patients were included in the study, and the number of participants with severe categories was very low. This limits statistical power, reduces the ability to detect differences across severity levels, and may affect the reliability of subgroup analyses.

Generalizability

The single-centre design restricts the external validity of the findings. Differences in demographic parameters, lifestyle modification, and local clinical management, observer variability in TBP assessment, and physicochemical properties of urine and oil might have influenced the TBP outcomes and BPH severity across groups.

Future Research Recommendations.

Future studies using prospective cohort designs and correlation analysis are recommended to validate and strengthen these findings. Since direction and spread measurements are seconds-based, the integration of AI could enhance the accuracy. Additionally, clinical tools such as Digital rectal examination (DRE), Uroflowmetry, Transrectal ultrasonography (TRUS) and Multiparametric MRI (mpMRI) were utilised.

6. Conclusion

The results of this study indicate that TBP parameters, especially the spread and direction, showed a significant association with BPH. On the contrary, PSA did not show a significant effect on the behaviour of oil droplets. These findings show that TBP is a reflection of physicochemical changes in urine due to obstruction. Being an exploratory study, these findings can be used to generate a hypothesis, implying that TBP can further develop as a prognostic indicator. More extensive and diversified studies will be justified to optimise TBP measurement and define its prognostic and clinical utility.

Declaration of generative AI in scientific writing

We have used the AI writing tools to improve the language and readability. The content was reviewed and revised as necessary after using these AI tools.

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Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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