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A Comparative Study of Levels of Calcium, Phosphorus, Uric Acid and Albumin in Benign Prostatic Hyperplasia and Carcinoma Prostate

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ABSTRACT

Background: Benign prostatic hyperplasia (BPH) and carcinoma prostate are common disorders in elderly men. Prostate-specific antigen (PSA), though widely used, lacks specificity in differentiating benign from malignant conditions. Hence, additional biochemical markers are needed.
Aim: To compare serum levels of calcium, phosphorus (PO_4), uric acid, and albumin in patients with BPH and carcinoma prostate.
Materials and Methods: This hospital-based comparative cross-sectional study was conducted on 105 subjects divided into three groups: BPH (n=35), carcinoma prostate (n=35), and age-matched controls (n=35). Serum levels of uric acid, calcium, phosphorus, and albumin were estimated using standard biochemical methods. Data were analyzed using ANOVA, and p-value <0.05 was considered significant.
Results: Serum uric acid levels were significantly higher in BPH (10.6 ± 2.03 mg/dL) and carcinoma prostate (8.1 ± 1.54 mg/dL) compared to controls (4.9 ± 1.19 mg/dL) ($p < 0.01$). Serum calcium, phosphorus, and albumin levels showed a significant decrease from controls to BPH to carcinoma prostate ($p < 0.01$). PSA levels were markedly elevated in carcinoma prostate but also increased in BPH.
Conclusion: Serum uric acid, calcium, phosphorus, and albumin show significant alterations in prostate disorders. Their combined assessment, along with PSA, may improve differentiation between BPH and carcinoma prostate.

Keywords*: Benign prostatic hyperplasia, carcinoma prostate, uric acid, calcium, phosphorus, albumin, PSA.*

INTRODUCTION

Benign prostatic hyperplasia (BPH) and carcinoma of the prostate are among the most common urological disorders affecting elderly men worldwide. BPH is a non-malignant enlargement of the prostate gland caused by hyperplasia of stromal and epithelial components, leading to lower urinary tract symptoms (LUTS), whereas carcinoma prostate represents a malignant condition associated with significant morbidity and mortality (1).

The incidence of both BPH and prostate cancer increases with advancing age, particularly after 50 years. Prostate cancer is one of the leading causes of cancer-related deaths among men globally, while BPH significantly affects quality of life (2). Early differentiation between these two conditions is essential for appropriate management and prognosis.

Prostate-specific antigen (PSA) is widely used as a diagnostic marker for prostate disorders; however, it lacks specificity as elevated levels are observed in both BPH and carcinoma prostate as well as in inflammatory conditions (3). Hence, there is a need to identify additional biochemical markers that can aid in differentiating benign from malignant conditions.

Uric acid, the end product of purine metabolism, has been implicated in oxidative stress and inflammation, both of which are important in carcinogenesis. Elevated serum uric acid levels have been reported in various malignancies including prostate cancer (4,5).

Calcium plays an essential role in cellular proliferation, differentiation, and apoptosis. Alterations in calcium metabolism have been associated with tumor progression and metastasis in prostate cancer (6).

Phosphorus is a key component of nucleic acids and cellular energy metabolism. Changes in phosphorus levels may reflect increased cellular turnover and metabolic activity in neoplastic conditions (7).

Albumin, a major plasma protein, is an important indicator of nutritional status and systemic inflammation. Hypoalbuminemia has been associated with poor prognosis and increased disease severity in cancer patients (8).

Recent studies suggest that combined evaluation of these biochemical parameters may provide better insight into the pathophysiology of prostate disorders and help differentiate benign and malignant conditions (9). However, limited data are available comparing these parameters simultaneously in BPH and carcinoma prostate.

Therefore, the present study was undertaken to compare serum levels of calcium, phosphorus, uric acid, and albumin in patients with benign prostatic hypertrophy and carcinoma prostate, and to evaluate their potential diagnostic significance.

MATERIAL AND METHODS

Study Design and Setting

This study was a hospital-based comparative cross-sectional study conducted in the Department of Biochemistry and Central Laboratory in collaboration with the Department of Urology at S.M.S. Medical College, Jaipur. Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study, and informed written consent was obtained from all participants.

Study Period

The study was carried out over a period of five months from July 2020 to November 2020.

Sample Size

The sample size was calculated at a study power of 80%, based on previously published data on serum uric acid levels in patients with benign prostatic hyperplasia (BPH) and carcinoma prostate. A total of 35 subjects were included in each group.

Study Population

The study population comprised three groups:

- **Group I (BPH cases):** Newly diagnosed patients of benign prostatic hyperplasia
- **Group II (Carcinoma prostate cases):** Newly diagnosed patients of carcinoma prostate
- **Group III (Controls):** Age-matched healthy male individuals

Controls were selected from patient attendants and hospital staff who were willing to participate.

Inclusion Criteria

- Male patients aged 40–75 years
- Diagnosed cases of BPH or carcinoma prostate
- Serum PSA levels >4 ng/mL
- Willingness to participate with written informed consent

For controls:

- Age-matched healthy males without known prostatic disease

Exclusion Criteria

- Advanced carcinoma prostate
- Prostatitis or prior urological procedures/biopsy
- Gout
- Chronic kidney disease
- Chronic liver disease
- Hemolytic or myeloproliferative disorders
- Patients on drugs affecting serum calcium, phosphorus, uric acid, or albumin levels

Clinical Evaluation
All participants underwent:

- Detailed clinical history
- General physical examination
- Relevant urological assessment including PSA, digital rectal examination (DRE), transrectal ultrasonography (TRUS), and biopsy where indicated

Sample Collection
Venous blood samples were collected in the morning after overnight fasting under aseptic conditions.

- Blood was collected without anticoagulant for biochemical analysis
- Samples were allowed to clot and centrifuged at 2500 rpm for serum separation

Biochemical Parameters Studied
The following parameters were analysed:

- Serum calcium
- Serum phosphorus (PO_4)
- Serum uric acid
- Serum albumin

Methods of Estimation
1. Serum Uric Acid

- **Method:** Uricase–Peroxidase (Enzymatic colorimetric method)
- **Principle:** Uric acid is oxidized by uricase to allantoin and hydrogen peroxide. The hydrogen peroxide reacts with chromogen in the presence of peroxidase to form a colored compound measured spectrophotometrically at 500 nm.
- **Instrument:** Fully automated chemistry analyzer

2. Serum Calcium

- **Method:** Arsenazo III method
- **Principle:** Calcium forms a colored complex with Arsenazo III dye at neutral pH. The intensity of the color, measured at 650 nm, is directly proportional to calcium concentration.

3. Serum Phosphorus

- **Method:** UV Molybdate method
- **Principle:** Inorganic phosphate reacts with ammonium molybdate in an acidic medium to form a phosphomolybdate complex measured at 340 nm.

4. Serum Albumin

- **Method:** Bromocresol Green (BCG) method
- **Principle:** Albumin binds with bromocresol green dye to form a green-colored complex, the intensity of which is proportional to the albumin concentration.

Quality Control
Internal quality control sera were run daily. If values deviated beyond ±2 standard deviations, corrective measures were undertaken before processing study samples.

Statistical Analysis
Data were expressed as mean ± standard deviation. Statistical comparison between groups was performed using appropriate tests (Student's t-test/ANOVA). A p-value <0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

Table 1: Comparison of Mean Age and Serum PSA Levels among Controls, BPH and Prostate Cancer Cases

Parameter	Controls (n = 35)	BPH (n = 35)	Prostate Cancer (n = 35)	P-value
Age (years)	63.1 ± 7.75	62.1 ± 7.67	63.5 ± 7.75	0.723 (NS)
PSA (ng/mL)	2.2 ± 1.09	10.4 ± 3.18	65.7 ± 12.22	< 0.001 (HS)

***ANOVA test applied**

NS = Not Significant; HS = Highly Significant

Table 2: Comparison of Mean Serum Uric Acid, Calcium and Phosphorus among Controls, BPH and Prostate Cancer Cases

Parameter	Controls (n = 35)	BPH (n = 35)	Prostate Cancer (n = 35)	P-value
Uric Acid (mg/dL)	4.9 ± 1.19	10.6 ± 2.03	8.1 ± 1.54	< 0.01 (S)
Calcium (mg/dL)	10.0 ± 0.72	8.6 ± 0.44	7.7 ± 0.42	< 0.01 (S)
Phosphorus (mg/dL)	3.7 ± 0.45	3.0 ± 0.30	2.5 ± 0.39	< 0.01 (S)

Table 3: Comparison of Mean Serum Uric Acid, Calcium and Phosphorus between Controls and Prostate Disorders

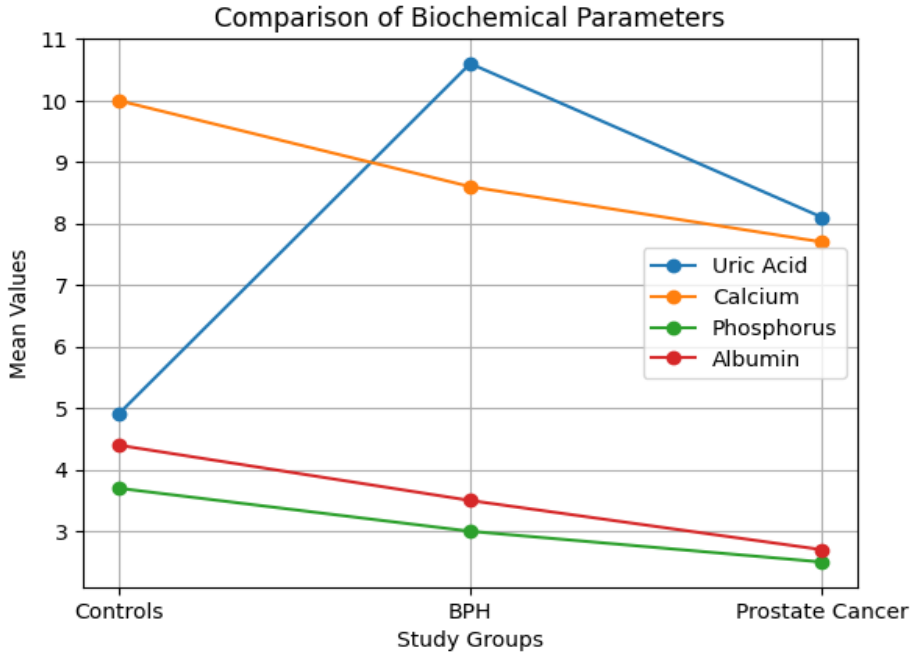
Parameter	Controls (n = 35)	Prostate Disorders (n = 70)	P-value
Uric Acid (mg/dL)	4.9 ± 1.19	9.4 ± 2.18	< 0.00001 (HS)
Calcium (mg/dL)	10.0 ± 0.72	8.1 ± 0.64	< 0.0001 (HS)
Phosphorus (mg/dL)	3.7 ± 0.45	2.7 ± 0.43	< 0.00001 (HS)

Table 4: Comparative Analysis of Serum Uric Acid, Calcium, Phosphorus, Total Protein and Albumin among Controls, BPH and Prostate Cancer Cases

Parameter	Controls (n = 35)	BPH (n = 35)	Prostate Cancer (n = 35)	P-value (ANOVA)
Uric Acid (mg/dL)	4.9 ± 1.19	10.6 ± 2.03	8.1 ± 1.54	< 0.01 (S)
Calcium (mg/dL)	10.0 ± 0.72	8.6 ± 0.44	7.7 ± 0.42	< 0.01 (S)
Phosphorus (mg/dL)	3.7 ± 0.45	3.0 ± 0.30	2.5 ± 0.39	< 0.01 (S)
Total Protein (g/dL)	7.1 ± 0.84	5.8 ± 0.52	4.9 ± 0.54	< 0.00001 (HS)
Albumin (g/dL)	4.4 ± 0.56	3.5 ± 0.37	2.7 ± 0.37	< 0.00001 (HS)

Table 5: Overall Comparison of Biochemical Parameters among Controls, BPH and Prostate Cancer Cases

Parameter	Controls (n = 35)	BPH (n = 35)	Prostate Cancer (n = 35)	Trend	P-value
Uric Acid (mg/dL)	4.9 ± 1.19	10.6 ± 2.03	8.1 ± 1.54	↑ (BPH > PCa > Control)	< 0.01 (S)
Calcium (mg/dL)	10.0 ± 0.72	8.6 ± 0.44	7.7 ± 0.42	↓ (Control > BPH > PCa)	< 0.01 (S)
Phosphorus (mg/dL)	3.7 ± 0.45	3.0 ± 0.30	2.5 ± 0.39	↓ (Control > BPH > PCa)	< 0.01 (S)
Albumin (g/dL)	4.4 ± 0.56	3.5 ± 0.37	2.7 ± 0.37	↓ (Control > BPH > PCa)	< 0.00001 (HS)



showing comparison of mean serum uric acid, calcium, phosphorus and albumin levels among controls, BPH and prostate cancer cases

DISCUSSION

The present study evaluated serum levels of calcium, phosphorus, uric acid, and albumin in patients with BPH, carcinoma prostate, and healthy controls. The findings demonstrate significant alterations in these biochemical parameters, suggesting their potential role in differentiating benign and malignant prostatic conditions.

The mean age of participants in all three groups showed no statistically significant difference, indicating appropriate age matching. Since prostate disorders are strongly age-related, matching reduces confounding and improves the reliability of comparisons (1).

Serum PSA levels were significantly elevated in prostate cancer patients compared to BPH and controls. However, PSA levels were also increased in BPH cases, confirming its limited specificity in differentiating benign and malignant conditions (3). This highlights the need for additional biochemical markers.

Serum uric acid levels were significantly higher in BPH and prostate cancer patients compared to controls, with the highest levels observed in BPH. Uric acid is known to be associated with oxidative stress and inflammatory processes that contribute to both benign hyperplasia and carcinogenesis (4,5). Elevated uric acid levels have been reported in malignancies and may promote tumor development through pro-oxidant mechanisms.

Serum calcium levels showed a significant decline from controls to BPH and further to prostate cancer. Calcium plays a vital role in cellular signaling and apoptosis, and its dysregulation may contribute to tumor progression (6). Reduced calcium levels in prostate cancer may reflect increased utilization and altered metabolism.

Similarly, serum phosphorus levels were significantly decreased in BPH and prostate cancer patients compared to controls. This may be due to increased cellular uptake and metabolic demand in proliferative conditions (7). Altered phosphorus metabolism has been observed in various malignancies.

Serum albumin levels were markedly reduced in prostate cancer patients compared to BPH and controls, with highly significant differences. Albumin is a marker of nutritional and inflammatory status, and hypoalbuminemia is associated with poor prognosis in cancer patients (8). This reduction reflects systemic inflammation and disease burden.

The overall trend observed in this study showed that uric acid levels increased in prostate disorders, while calcium, phosphorus, and albumin levels progressively decreased from controls to BPH to carcinoma prostate. These findings suggest that metabolic alterations are more pronounced in malignant conditions and may serve as supportive markers in diagnosis.

The findings of the present study are consistent with previous studies that reported the role of uric acid and phosphate in differentiating prostate disorders (9,10). Additionally, recent studies have highlighted the importance of albumin and metabolic markers in cancer prognosis (11,12).

CONCLUSION

The present study demonstrates that serum uric acid levels are significantly increased, while calcium, phosphorus, and albumin levels are significantly decreased in patients with BPH and carcinoma prostate compared to controls. These alterations are more pronounced in carcinoma prostate.

Thus, in addition to PSA, the combined assessment of these biochemical parameters may serve as useful supportive markers in differentiating benign and malignant prostate disorders. Further large-scale studies are recommended to validate these findings.

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