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Assessment of Prostatic Specific Antigen, Calcium and Serum Uric Acid among Benign Prostatic Hyperplasia- A case control study

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Abstract

Background: Benign prostatic hyperplasia (BPH) in older men can lead to acute or chronic urinary retention, resulting in increased resistance at the bladder outlet.

Objective: To assess prostate-specific antigen (PSA), plasma calcium (Ca^{2+}), and serum uric acid levels in patients with BPH at Kosti Teaching Hospital, White Nile State, Sudan.

Materials and Methods: Case-control hospital based study was conducted at Kosti Teaching Hospital between January and October 2024. The study included 200 participants, with 100 BPH patients serving as the case group and 100 healthy individuals as the control group. PSA levels were measured using the fine care technique, while plasma calcium and serum uric acid were assessed using spectrophotometric methods. Data analysis was using SPSS version (25).

Results: Age, BMI, and prostate volume were significantly higher in the BPH group compared to the control group ($p < 0.05$). Plasma PSA, calcium, and serum uric acid levels were also significantly elevated in the BPH group ($p < 0.05$). Plasma calcium showed a strong positive correlation with age and PSA ($r = 0.189$, $p = 0.005$; $r = 0.197$, $p = 0.005$) and a weak correlation

with prostate volume (r = 0.204, p = 0.004). Serum uric acid demonstrated weak positive correlations with age and prostate volume (r = 0.216, p = 0.002; r = 0.266, p = 0.001).

Conclusion: Patients with BPH exhibited increased levels of plasma calcium and serum uric acid. These elevations were associated with higher prostate volume and PSA levels, suggesting a potential link between these biomarkers and BPH progression.

Keywords: plasma calcium, hyperurceima, benign prostatic hyperplasia, prostate volume

Introduction

Benign prostatic hyperplasia (BPH) is a significant global health issue among men, particularly in developed countries, and represents the most prevalent urological condition in men over 50 years of age(1,2). Histological BPH is observed in over 70% of men at age 60 and exceeds 90% by age 70 (1, 3). Despite advances, the precise biochemical, cellular, and molecular mechanisms driving BPH remain unclear. While androgens and estrogens play a role, hormonal factors alone do not fully explain its development(4,5). Both prostate cancer (PCa) and BPH are common urological conditions in adult males, and evidence from systematic reviews indicates a significant association between them (6, 7). Elevated prostate-specific antigen (PSA) levels can occur in BPH (8). Lifestyle and dietary factors, including trace element intake, may influence the risk of PCa and BPH (9, 10). Previous studies have highlighted the involvement of certain minerals in prostate function (11, 12), with intracellular calcium (Ca^{2+}) excess identified as a key factor in prostate cancer etiology (10, 11, 13 14). The prostate gland's primary function involves producing prostatic fluid (15), which contains high concentrations of specific chemical elements. Increased reactive oxygen species (ROS) production is associated with inflammatory conditions, aging, and age-related diseases like BPH and PCa (16, 17). Uric acid, an extracellular antioxidant, has been linked to inflammation, with hyperuricemia in cancer patients potentially stemming from increased nucleic acid turnover in rapidly proliferating tissues (18). Acute and chronic inflammation may contribute to prostate hyperplasia or cancer. Prostate cells activated by chemokines trigger processes such as angiogenesis, cellular growth, extravasation, and neoplasia (19). Experimental and clinical data suggest calcium as a potential risk factor for prostate cancer, with serum calcium levels correlating with PSA (20). Supporting the hypothesis that hypercalcemia may stimulate prostate growth or malignancy (21). This study aimed to assess PSA, plasma calcium (Ca^{2+}), and serum uric acid levels in patients with BPH at Kosti Teaching Hospital, White Nile State, Sudan.

Materials and Methods

Study Population: case-control hospital based study was conducted at Kosti Teaching Hospital, White Nile State, Sudan, from January to October 2024. Kosti, located approximately 270 km south of Khartoum, is one of Sudan's major cities, situated on the western bank of the White Nile River opposite Rabak. The study included 200 participants, comprising 100 BPH patients as the case group and 100 healthy individuals as the control group.

Inclusion and Exclusion Criteria: The study included Sudanese men aged 45 to 80 years diagnosed with BPH. Exclusion criteria included individuals older than 80 years and those with renal or liver diseases, diabetes mellitus, muscle disorders, hypertension, cardiovascular diseases, or gout.

Blood Sampling and Data Collection: Patients attending Kosti Teaching Hospital during the study period were recruited. Primary data were collected using structured questionnaires aligned with the study objectives. Blood samples (2.5 ml) were drawn from fasting participants (8–10 hours) into plain containers, centrifuged at 3000 rpm for 5 minutes, and the serum analyzed for PSA, uric acid, and calcium levels. Additional 2.5 ml blood samples were collected in lithium heparin containers, centrifuged, and the plasma was analyzed for calcium. Patient data included age, prostate volume, and BMI (calculated as weight (kg)/height (m^2)). Dependent variables were PSA, calcium, and uric acid, while independent variables included age, prostate volume, and BMI. PSA levels were measured using the fine care technique, and plasma calcium and serum uric acid were assessed using spectrophotometric methods.

Ethical Considerations: The study was approved by the Research Board of the Faculty of Medical Laboratory Sciences, White Nile University. Ethical clearance was obtained from the Kosti Teaching Hospital Ethical Committee, and verbal informed consent was secured from all participants.

Data Analysis: Data were analyzed using SPSS version 25. Results were expressed as (mean ± SD), and a p-value of <0.05 was considered statistically significant.

Results

The mean values and standard deviations (SD) for age, body mass index (BMI), and prostate volume in the patient group were recorded as (57.86±11.412, 23.872±3.3492, 45.06±11.089). In comparison, the control group exhibited mean values and SD of (47.50±5.223, 20.820±2.0762, 22.09±13.774). Statistical analysis revealed that the age, BMI, and prostate volume in the patient group were significantly higher than those in the control group, with p-values of 0.000, 0.000, and 0.007, respectively. (Table 1).

For the parameters of prostate-specific antigen (PSA), calcium (Ca^{2+}), and serum uric acid, the patient group showed mean values and SD of (2.148±0.826, 9.56±0.581, 4.648±1.1145). Conversely, the control group had mean values and SD of (1.462±0.467, 9.06±0.522, 3.8±1.07). The plasma levels of PSA, Ca^{2+}, and serum uric acid were significantly elevated in the patient group compared to the control group, with a p-value of 0.000 (Table 2).

Additionally, a strong positive correlation was observed between plasma Ca^{2+} and both age and PSA, with correlation coefficients of r = 0.189 (p = 0.005) and r = 0.197 (p = 0.005), respectively, while a weak correlation with prostate volume was noted (r = 0.204, p = 0.004). In contrast, serum uric acid exhibited a weak positive correlation with age and prostate volume, with correlation coefficients of r = 0.216 (p = 0.002) and r = 0.266 (p = 0.001), respectively, and a correlation of r = 0.087 (p = 0.001) (Table 3).

Table 1: (Mean ±SD) of age and BMI and prostate volume among study population

Variable	**Case group (Mean ±SD) N=100**	**Control group (Mean ±SD) N=100**	***P value***
Age (years)	57.86±11.412	47.50± 5.223	0.000
BMI (kg/m2	23.872±3.3492	20.820±2.0762	0.000
Prostate volume (mm)	45.06±11.089	22.09±13.774	0.007

Table 2: (Mean ±SD) of PSA, Ca 2+and serum uric acid among study population

Parameters	**Case group (Mean ±SD) N=100**	**Control group (Mean ±SD) N=100**	***P value***
PSA(ng /ml)	2.148±0.826	1.462±0.467	0.000
Ca 2+	9.56±0.581	9.06±0.522	0.000
Uric acid (mg/dl)	4.648±1.1145	3.8±1.07	0.000

Table 3: Correlations between study variables and parameters among study population

Parameters	Variable	r	*P-value*
Plasma Ca 2+	Age	.189	.005
	PSA	.197	.005
	Prostate volume	.204	. 004
Serum uric acid	Age	.216	.002
	PSA	.087	.001
	Prostate volume	.266	.001

Discussion

The current study sought to assess blood uric acid and plasma calcium levels in order to potentially assist in the identification of BPH and its related acid, which has been linked to elevated prostate volume and PSA. Prostate epithelial cells and prostate cancer cells generate PSA, an androgen-regulated protease that is elevated in BPH, acute urine retention, and renal failure (22). According to the current study, BPH patients had noticeably higher PSA levels than usual. In BPH, PSA levels were noticeably higher. Oxidative stress, an inherent critical event marked by supraphysiological reactive oxygen species, has been recognized as one of the hallmarks of disease development in inflammatory diseases and cancer (23). According to studies, cellular cascades and inflammatory processes are important in the etiopathogenesis of BPH (24). According to our research, BPH patients had noticeably higher blood uric acid levels. As an extracellular antioxidant, uric acid promotes healthy cell division (25). Uric acid's function as a growth factor is suggested by elevated levels in BPH. Hammarsten et al. (26), who also noted hyperuricemia in BPH patients, provide credence to this observation by pointing out its possible involvement in the development of BPH. Additionally, BPH patients had considerably greater plasma calcium levels than controls. BPH may be exacerbated by calcium buildup in the prostate, which can result in lower urinary tract symptoms (LUTs), such weak urine or trouble urinating. Because its frequency rises with age, BPH is a serious public health problem. There are several established risk factors for BPH, including age, ethnicity, genetic susceptibility, family history, environment, lifestyle, and food (27, 28, 29, 30). The risk of disease development is increased by a diet heavy in calories, saturated fat, red meat, dairy products, and calcium. Another significant risk factor is a high BMI, especially abdominal fat (31). According to earlier research, calcium has a major impact on prostate function (32, 33) and may be involved in the development of prostate cancer (34). Prostate diseases have been linked to elevated PSA and calcium levels as biomarkers (35, 36).Increased uric acid in BPH patients may indicate decreased excretion by the kidneys, suggesting a risk of progression to renal dysfunction. Consequently, individuals with prostate disorders should also be screened for renal diseases and vice versa (37). The uric acid in BPH had reported higher due to decreased excretion of uric acid in renal diseases and prostate disorders (38). Our results also demonstrated a significant increase in BMI and prostate volume among BPH patients compared to controls. This finding is consistent with studies by Jong Min Kim et al. (39), who observed higher BMI, larger prostate volumes, and elevated International Prostate Symptom Scores (IPSS) in BPH patients (40). Study showed significant increase in plasma calcium among cases compered to control due to reabsorption of Ca

is not altered in Mg deficiency; However, elevations of extracellular Mg results in a specific inhibition of Ca reabsorption within the loop of Henle (41). Because of their impaired calcium reabsorption, BPH patients had considerably higher plasma calcium levels. This result is consistent with that of Halthur et al. (42), who found that BPH patients had higher plasma calcium levels. Furthermore, because BPH patients secrete more prostate tissue, their PSA levels were noticeably higher (43, 44). Mario Bo et al. (45) corroborate this observation. Additionally, the study discovered that patients with poor nutritional status had higher plasma calcium levels, most likely as a result of inadequate nutrition, age-related changes in skin and renal function, and decreased sunshine exposure. This result aligns with the findings of Lips P et al. (46). Additionally, plasma calcium levels exhibited a positive correlation with PSA levels, potentially attributable to fluctuations in testosterone levels, dietary practices, and environmental influences. This correlation is consistent with the findings of Kim et al. (47). Plasma calcium exhibited a positive correlation with age and prostate volume, indicating the pathological relevance of elevated intracellular calcium in relation to advancing age and prostate growth disorders. Tvedt K et al. provided evidence for this association (48).

Conclusion

Patients with BPH exhibit higher plasma calcium and serum uric acid levels, which are associated with increased prostate volume and PSA. Monitoring renal function is crucial in predicting the severity of BPH.

Competing Interests

No conflicting interests are disclosed by the author.

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