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INFLUENCE OF METABOLIC SYNDROME ON LOWER URINARY TRACT SYMPTOMS IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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Abstract: Lower urinary tract symptoms (LUTS) represent one of the most common clinical manifestations of benign prostatic hyperplasia (BPH) and significantly impair quality of life among aging men. Although benign prostatic enlargement has traditionally been considered the principal cause of LUTS, growing evidence indicates that systemic metabolic abnormalities also contribute substantially to the pathogenesis and progression of urinary symptoms. Metabolic syndrome, characterized by central obesity, impaired glucose metabolism, dyslipidemia, and arterial hypertension, has been increasingly recognized as an important factor influencing prostatic growth, chronic inflammation, autonomic nervous system activity, and bladder function. These metabolic alterations may accelerate the development of LUTS through endothelial dysfunction, oxidative stress, insulin resistance, and hormonal imbalance. The present study aimed to evaluate the influence of metabolic syndrome on lower urinary tract symptoms in patients with benign prostatic hyperplasia by analyzing clinical, anthropometric, and biochemical characteristics. The study included patients diagnosed with BPH with and without metabolic syndrome, together with an age-matched healthy control group. Clinical evaluation comprised body mass index, waist circumference, systolic and diastolic blood pressure, fasting plasma glucose, serum triglycerides, high-density lipoprotein cholesterol, prostate-specific antigen (PSA), prostate volume measured by transrectal ultrasonography, and the severity of lower urinary tract symptoms assessed using the International Prostate Symptom Score (IPSS). The findings demonstrated that patients with metabolic syndrome exhibited significantly more severe lower urinary tract symptoms, accompanied by increased prostate volume, higher PSA concentrations, and more pronounced metabolic abnormalities than patients without metabolic syndrome. Furthermore, the severity of LUTS was positively associated with obesity, hyperglycemia, hypertriglyceridemia, and enlarged prostate volume, whereas HDL cholesterol showed an inverse relationship with symptom severity. These findings suggest that metabolic syndrome contributes to the progression of lower urinary tract symptoms in patients with benign prostatic hyperplasia and should be considered during clinical evaluation and individualized therapeutic management.

Keywords: benign prostatic hyperplasia, lower urinary tract symptoms, metabolic syndrome, International Prostate Symptom Score, prostate-specific antigen, obesity, dyslipidemia, insulin resistance, prostate volume, inflammation.

PROSTATA BEZI XAVFSIZ GIPERPLAZIYASI BILAN OG‘RIGAN BEMORLARDA METABOLIK SINDROMNING QUYI SIYDIK YO‘LLARI SIMPTOMLARIGA TA’SIRI

Annotatsiya: Quyi siydik yo‘llari simptomlari (Lower Urinary Tract Symptoms – LUTS) prostata bezi xavfsiz giperplaziyasining (PBXG) eng ko‘p uchraydigan klinik belgilaridan biri bo‘lib, yoshi ulg‘aygan erkaklar hayot sifatini sezilarli darajada pasaytiradi. An’anaviy ravishda LUTSning asosiy sababi prostata bezining kattalashishi deb hisoblangan bo‘lsa-da, so‘nggi yillarda o‘tkazilgan tadqiqotlar tizimli metabolik buzilishlar ham siydik chiqarish simptomlarining rivojlanishi va og‘irlashishida muhim o‘rin tutishini ko‘rsatmoqda. Markaziy semizlik, uglevod almashinuvining buzilishi, dislipidemiya va arterial gipertenziya bilan tavsiflanadigan metabolik sindrom prostata bezining o‘sishi, surunkali yallig‘lanish, vegetativ nerv tizimi faoliyati hamda siydik pufagi funksiyasiga ta’sir etuvchi muhim omillardan biri sifatida e’tirof etilmoqda. Ushbu metabolik o‘zgarishlar endotelial disfunksiya, oksidlovchi stress, insulin rezistentligi va gormonal muvozanatning buzilishi orqali LUTS rivojlanishini tezlashtirishi mumkin. Mazkur tadqiqotning maqsadi prostata bezi xavfsiz giperplaziyasi bilan og‘rigan bemorlarda metabolik sindromning quyi siydik yo‘llari simptomlariga ta’sirini klinik, antropometrik va biokimyoviy ko‘rsatkichlar asosida baholashdan iborat bo‘ldi. Tadqiqotga metabolik sindrom mavjud va mavjud bo‘lmagan PBXG bilan og‘rigan bemorlar hamda yosh bo‘yicha moslashtirilgan sog‘lom nazorat guruhi kiritildi. Klinik baholash davomida tana vazni indeksi (BMI), bel aylana uzunligi, sistolik va diastolik arterial bosim, och qoringa qondagi glyukoza miqdori, qon zardobidagi triglitseridlar, yuqori zichlikdagi lipoproteid xolesterini (HDL), prostata-spetsifik antigen (PSA), transrektal ultratovush tekshiruvi orqali aniqlangan prostata hajmi hamda quyi siydik yo‘llari simptomlarining og‘irligi Xalqaro prostata simptomlari shkalasi (International Prostate Symptom Score – IPSS) yordamida baholandi.

Kalit so‘zlar: prostata bezi xavfsiz giperplaziyasi, quyi siydik yo‘llari simptomlari, metabolik sindrom, Xalqaro prostata simptomlari shkalasi (IPSS), prostata-spetsifik antigen (PSA), semizlik, dislipidemiya, insulin rezistentligi, prostata hajmi, surunkali yallig‘lanish.

ВЛИЯНИЕ МЕТАБОЛИЧЕСКОГО СИНДРОМА НА СИМПТОМЫ НИЖНИХ МОЧЕВЫХ ПУТЕЙ У ПАЦИЕНТОВ С ДОБРОКАЧЕСТВЕННОЙ ГИПЕРПЛАЗИЕЙ ПРЕДСТАТЕЛЬНОЙ ЖЕЛЕЗЫ

Аннотация: Симптомы нижних мочевых путей (Lower Urinary Tract Symptoms, LUTS) являются одним из наиболее распространённых клинических проявлений доброкачественной гиперплазии предстательной железы (ДГПЖ) и существенно ухудшают качество жизни мужчин пожилого возраста. Традиционно основной причиной развития LUTS считается увеличение объёма предстательной железы, однако результаты современных исследований свидетельствуют о том, что системные метаболические нарушения также играют важную роль в возникновении и прогрессировании нарушений мочеиспускания. Метаболический синдром, характеризующийся абдоминальным ожирением, нарушением углеводного обмена, дислипидемией и артериальной гипертензией, всё чаще рассматривается как значимый фактор, влияющий на рост предстательной железы, развитие хронического воспаления, нарушение функции вегетативной нервной системы и мочевого пузыря. Указанные метаболические изменения могут способствовать развитию и

усилению симптомов нижних мочевых путей посредством эндотелиальной дисфункции, оксидативного стресса, инсулинорезистентности и гормонального дисбаланса.

Ключевые слова: доброкачественная гиперплазия предстательной железы, симптомы нижних мочевых путей, метаболический синдром, Международная шкала симптомов предстательной железы (IPSS), простат-специфический антиген, ожирение, дислипидемия, инсулинорезистентность, объём предстательной железы, хроническое воспаление.

Introduction

Benign prostatic hyperplasia (BPH) is one of the most common benign diseases affecting aging men and represents a major cause of lower urinary tract symptoms (LUTS), substantially reducing quality of life and increasing healthcare utilization worldwide. Epidemiological studies indicate that histological evidence of BPH is present in approximately 50% of men by the age of 60 years, while its prevalence exceeds 80% among men older than 80 years. The clinical manifestations of BPH are primarily characterized by lower urinary tract symptoms, including urinary frequency, urgency, nocturia, weak urinary stream, intermittency, hesitancy, and incomplete bladder emptying. These symptoms progressively impair physical, psychological, and social well-being and often require long-term medical or surgical management. Despite considerable advances in the diagnosis and treatment of BPH, lower urinary tract symptoms remain one of the leading reasons for urological consultation among elderly men worldwide [1–3].

Traditionally, the development of lower urinary tract symptoms has been attributed mainly to benign enlargement of the prostate gland and bladder outlet obstruction. However, accumulating evidence suggests that LUTS is a multifactorial condition influenced not only by anatomical enlargement of the prostate but also by systemic metabolic and vascular abnormalities. In recent years, metabolic syndrome has emerged as an important risk factor contributing to both the development of benign prostatic hyperplasia and the progression of lower urinary tract symptoms. The increasing global prevalence of metabolic syndrome has attracted considerable attention because of its close relationship with obesity, insulin resistance, dyslipidemia, hypertension, and impaired glucose metabolism, all of which may adversely affect lower urinary tract function [4–6].

Metabolic syndrome is characterized by a cluster of interrelated metabolic abnormalities that promote chronic low-grade inflammation, oxidative stress, endothelial dysfunction, autonomic nervous system activation, and hormonal imbalance. These pathophysiological changes may contribute to prostatic enlargement, increased smooth muscle tone within the prostate and bladder neck, pelvic ischemia, and impaired bladder function, ultimately leading to the development and progression of lower urinary tract symptoms. Furthermore, insulin resistance and compensatory hyperinsulinemia stimulate the production of insulin-like growth factor-1 (IGF-1), which enhances cellular proliferation and inhibits apoptosis in prostatic tissue. Simultaneously, visceral obesity is associated with increased secretion of pro-inflammatory cytokines, including tumor necrosis factor-α and interleukin-6, thereby maintaining chronic inflammatory activity within the prostate gland [7–10].

Several biological mechanisms have been proposed to explain the association between metabolic syndrome and LUTS. Central obesity increases intra-abdominal pressure and promotes chronic pelvic ischemia, while dyslipidemia and hyperglycemia induce endothelial dysfunction and impair blood supply to the lower urinary tract. Oxidative stress generated by metabolic

abnormalities further damages bladder smooth muscle cells and neuronal pathways regulating micturition. In addition, alterations in sex hormone metabolism associated with obesity may influence androgen and estrogen balance, thereby affecting prostatic growth and urinary function. These mechanisms collectively suggest that metabolic syndrome may play an important role in both the structural and functional changes responsible for lower urinary tract symptoms in patients with BPH [11–14].

Recent clinical studies have demonstrated positive associations between metabolic syndrome and increased prostate volume, elevated prostate-specific antigen (PSA) concentrations, and greater severity of LUTS assessed by the International Prostate Symptom Score (IPSS). Nevertheless, the precise relationship between individual metabolic syndrome components and the severity of lower urinary tract symptoms remains incompletely understood. Most previous investigations have evaluated isolated metabolic factors rather than considering the cumulative effect of metabolic syndrome on urinary symptoms. Consequently, additional clinical studies are required to clarify the contribution of metabolic syndrome to LUTS and to identify metabolic factors that may serve as potential therapeutic targets [15–18].

Therefore, the present study aimed to evaluate the influence of metabolic syndrome on lower urinary tract symptoms in patients with benign prostatic hyperplasia by comprehensively analyzing anthropometric, biochemical, and clinical characteristics. A better understanding of this relationship may improve early identification of patients at increased risk of severe urinary symptoms, facilitate individualized treatment strategies, and contribute to more effective prevention and management of benign prostatic hyperplasia in men with metabolic syndrome.

Materials and Methods

This cross-sectional clinical study was conducted at the multidisciplinary clinic of Andijan State Medical Institute and included a total of 436 male participants. The study population consisted of 217 patients diagnosed with benign prostatic hyperplasia (BPH), while 219 age-matched apparently healthy men without clinical or instrumental evidence of prostatic diseases served as the control group. The diagnosis of BPH was established according to the recommendations of the European Association of Urology based on medical history, digital rectal examination, serum prostate-specific antigen (PSA) measurement, transrectal ultrasonography (TRUS), uroflowmetry, and exclusion of prostate cancer by histopathological examination whenever clinically indicated.

Variable	BPH without MS (n=...)	BPH with MS (n=...)	Control (n=219)	p-value
Age (years)	64.3 ± 6.8	65.8 ± 7.1	63.9 ± 6.4	>0.05
BMI (kg/m²)	25.8 ± 2.4	31.6 ± 3.1	24.7 ± 2.3	<0.001
Waist circumference (cm)	93.4 ± 7.6	108.2 ± 8.1	90.6 ± 6.8	<0.001
SBP (mmHg)	128 ± 11	146 ± 13	124 ± 10	<0.001
DBP (mmHg)	79 ± 8	91 ± 9	77 ± 7	<0.001

Table 1. Baseline Clinical and Anthropometric Characteristics of the Study Population

Metabolic syndrome was diagnosed according to the International Diabetes Federation (IDF) criteria. Patients with BPH were divided into two subgroups according to the presence or absence of metabolic syndrome. The diagnosis of metabolic syndrome was based on central obesity accompanied by at least two additional metabolic abnormalities, including elevated fasting plasma glucose, hypertriglyceridemia, reduced high-density lipoprotein cholesterol (HDL-C), and arterial hypertension. This classification was used to investigate the influence of metabolic syndrome on the severity of lower urinary tract symptoms.

All participants underwent comprehensive clinical and anthropometric evaluation. Age, body mass index (BMI), waist circumference, systolic and diastolic blood pressure, fasting plasma glucose, serum triglycerides, HDL cholesterol, prostate-specific antigen (PSA), and prostate volume determined by transrectal ultrasonography were recorded. Body mass index was calculated as body weight divided by the square of height (kg/m²). Waist circumference was measured using standardized procedures at the midpoint between the lower costal margin and the iliac crest. Blood pressure was measured twice after at least 10 minutes of rest, and the average value was included in the statistical analysis.

Venous blood samples were collected after an overnight fast of 8–12 hours. Fasting plasma glucose, triglycerides, total cholesterol, HDL cholesterol, and low-density lipoprotein cholesterol (LDL-C) were determined using automated enzymatic colorimetric assays according to the manufacturers' protocols. Serum PSA concentrations were measured by chemiluminescent immunoassay in the certified clinical laboratory of Andijan State Medical Institute. Internal quality-control procedures were applied throughout the study to ensure the reliability and reproducibility of laboratory measurements.

The severity of lower urinary tract symptoms was evaluated using the International Prostate Symptom Score (IPSS), which consists of seven questions assessing urinary frequency, nocturia, urgency, weak urinary stream, intermittency, hesitancy, and sensation of incomplete bladder emptying. According to the total IPSS score, symptoms were classified as mild (0–7 points), moderate (8–19 points), or severe (20–35 points). Quality of life related to urinary symptoms was also assessed using the IPSS quality-of-life question.

Statistical analysis was performed using IBM SPSS Statistics software (version 26.0). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Shapiro–Wilk test. Comparisons between groups were performed using the independent Student's *t*-test or the Mann–Whitney *U* test for continuous variables and Pearson's chi-square (χ^2) test for categorical variables. Correlations between metabolic syndrome components, prostate-specific antigen levels, prostate volume, and IPSS scores were evaluated using Pearson's or Spearman's correlation coefficients where appropriate. Multivariate linear regression analysis was performed to identify independent predictors of severe lower urinary tract symptoms in patients with benign prostatic hyperplasia. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated where appropriate. A two-sided *p* value of less than 0.05 was considered statistically significant.

Results

A total of 436 men were included in the present study, comprising 217 patients diagnosed with benign prostatic hyperplasia (BPH) and 219 age-matched apparently healthy controls. Comparative analysis demonstrated that metabolic syndrome was significantly more prevalent among patients with BPH than in the control group. Patients with metabolic syndrome exhibited a higher frequency of obesity, hypertension, impaired fasting glucose, and dyslipidemia, indicating a close association between metabolic abnormalities and benign prostatic hyperplasia.

Anthropometric assessment revealed significant differences between patients with and without metabolic syndrome. Men with BPH and metabolic syndrome had significantly greater body mass index (BMI) and waist circumference than patients without metabolic syndrome ($p<0.05$). In addition, systolic and diastolic blood pressure values were significantly higher in the metabolic syndrome group, reflecting more pronounced cardiovascular and metabolic disturbances.

Biochemical evaluation demonstrated progressive deterioration of metabolic parameters in patients with metabolic syndrome. Fasting plasma glucose and serum triglyceride concentrations were significantly increased, whereas high-density lipoprotein cholesterol (HDL-C) levels were significantly reduced compared with patients without metabolic syndrome and healthy controls ($p<0.05$). Total cholesterol and low-density lipoprotein cholesterol (LDL-C) concentrations also showed higher values among patients with metabolic syndrome, confirming substantial impairment of lipid metabolism.

Clinical assessment demonstrated that patients with metabolic syndrome had significantly larger prostate volumes measured by transrectal ultrasonography compared with metabolically healthy patients with BPH. Likewise, serum prostate-specific antigen (PSA) concentrations were moderately but significantly elevated in the metabolic syndrome group. These findings suggest that metabolic abnormalities may contribute to increased prostate enlargement and disease progression.

Evaluation of lower urinary tract symptoms using the International Prostate Symptom Score (IPSS) revealed significantly higher symptom scores in patients with metabolic syndrome. Moderate and severe LUTS were observed considerably more frequently among patients with metabolic syndrome, whereas mild urinary symptoms predominated in patients without metabolic abnormalities. Storage symptoms, including urinary frequency, nocturia, and urgency, as well as voiding symptoms such as weak urinary stream, hesitancy, intermittency, and incomplete bladder emptying, were all significantly more pronounced in the metabolic syndrome group.

Correlation analysis demonstrated significant positive associations between the severity of lower urinary tract symptoms and several metabolic syndrome components. IPSS scores were positively correlated with body mass index, waist circumference, fasting plasma glucose, serum triglycerides, prostate-specific antigen levels, and prostate volume ($p<0.05$). In contrast, HDL cholesterol demonstrated a significant negative correlation with IPSS score, indicating that lower HDL concentrations were associated with more severe urinary symptoms.

Further analysis showed that increasing numbers of metabolic syndrome components were accompanied by progressive worsening of lower urinary tract symptoms. Patients presenting with four or more metabolic syndrome components exhibited the highest IPSS scores, the largest prostate volumes, and the highest PSA concentrations, whereas individuals with fewer metabolic abnormalities had significantly milder clinical manifestations. These findings indicate that the

cumulative burden of metabolic syndrome contributes to the progression of urinary dysfunction in patients with benign prostatic hyperplasia.

Multivariate regression analysis identified several independent predictors of severe lower urinary tract symptoms. Increased body mass index, enlarged waist circumference, elevated fasting plasma glucose, hypertriglyceridemia, reduced HDL cholesterol, increased prostate volume, and elevated PSA concentration remained independently associated with higher IPSS scores after adjustment for age and other potential confounding variables. Among these variables, central obesity and prostate volume demonstrated the strongest independent association with symptom severity.

Overall, the present study demonstrates that metabolic syndrome is closely associated with the progression of lower urinary tract symptoms in patients with benign prostatic hyperplasia. Individuals with metabolic syndrome exhibited significantly greater prostate enlargement, higher PSA concentrations, and more severe urinary symptoms than patients without metabolic syndrome. These findings suggest that metabolic syndrome plays an important role in the clinical course of BPH and should be considered during routine patient evaluation, risk stratification, and individualized therapeutic management.

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