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Others Section

Prevalence of Microalbuminuria in Essential Hypertension and its Association with Coronary Artery Disease: A Cross-sectional Study

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ABSTRACT

Introduction: Hypertension is a leading aetiology of cardiovascular and renal diseases. Microalbuminuria, an indicator of endothelial dysfunction, has been linked with hypertensive nephropathy as well as cardiovascular disease. Tests to detect microalbuminuria, like the spot urine albumin-creatinine ratio, are easily accessible and not expensive.

Aim: To determine the prevalence of microalbuminuria in essential hypertension and its association with Coronary Artery Disease (CAD) based on Electrocardiogram (ECG) and Echocardiographic (2D-ECHO) findings.

Materials and Methods: The present cross-sectional survey of 150 patients with hypertension was was performed in the Department of General Medicine at Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pune,India during an 18-month period from October 2023 to March 2025 and assessment of blood pressure, Body Mass Index (BMI), and biochemical parameters was done. Microalbuminuria was assessed and its association with cardiovascular abnormalities was checked by ECG and 2D-ECHO findings. Statistical association (done using Chi-square tests or Fisher's-exact test for categorical data; Logistic regression analysis for establishing microalbuminuria as a predictor of cardiovascular disease) was checked to ascertain whether microalbuminuria has any prognostic value in stratifying cardiovascular risk.

Results: The incidence of microalbuminuria in patients with hypertension was 67 (44.6%) and there was a significant relationship between microalbuminuria and systolic (p=0.041) and diastolic blood pressure (p=0.019). Left Ventricular Hypertrophy (LVH) was seen in 32 (21.3%) of the patients. It is a marker of long standing, uncontrolled hypertension and was significantly associated with microalbuminuria (p=0.014). Logistic regression analysis detected microalbuminuria (OR=3.759, p=0.006) as independent predictor of cardiovascular abnormalities.

Conclusion: Hypertension is a major healthcare burden with increasing prevalence. It can lead to several complications. Microalbuminuria was found to be present in about 44% of the study population. This study shows a positive association between microalbuminuria and cardiovascular disease {Odds Ratio (OR) of 3.759}.

Keywords: 2D Echocardiography, Blood pressure, Electrocardiography, Ischaemic heart disease, Proteinuria

INTRODUCTION

Non-communicable diseases are now a global public health burden, and one of the leading causes of this growing burden is hypertension. Hypertension is a prevalent condition that carries a high-risk of developing cardiovascular, renal, and cerebrovascular diseases, and therefore it is a relevant focus for early detection and control [1]. In India, the incidence of hypertension has been estimated to be 30-40%, i.e., roughly one in three Indians suffers from this condition [2]. Hypertension is also responsible for approximately 10.8% of all deaths in India, and thus measures for effective prevention and treatment are needed [3].

Because it is a reversible risk factor, hypertension can be controlled with appropriate lifestyle changes, antihypertensive medications, and follow-up, thereby avoiding the risk of severe complications such as end-stage renal disease, CAD, and peripheral vascular disease [4,5]. Early detection is an issue as the majority of individuals remain undiagnosed or undertreated and hence continue to have an increased risk of target organ damage [6]. One of the earliest and most reliable clinical markers of hypertensive complications is microalbuminuria, an early marker of both nephropathy and cardiovascular disease [7].

Microalbuminuria refers to the detection of small amounts of albumin in urine, which is a prelude to renal impairment and endothelial damage [8]. Microalbuminuria is not only a predictor of progressive renal disease but also an independent potent risk factor for cardiovascular morbidity and mortality. Microalbuminuria is an indicator of diffuse endothelial dysfunction, which lies at the root of the pathogenesis of hypertensive complications [9]. Microalbuminuria has been reported to pose a risk for the development of LVH, ischaemic heart disease, and stroke in patients with hypertension [10].

Early recognition of microalbuminuria facilitates early intervention through strict blood pressure control and lifestyle modifications, which can slow disease progression and reduce cardiovascular risk [10]. Although with predictive and diagnostic utility, screening for microalbuminuria is not yet formally included in guidelines for hypertension management, thereby leaving the potential for early risk assessment and intervention untapped [11]. Increasing burden of hypertension and its consequences necessitates more vigorous disease prevention and control. Thus, the aim of the current study was to examine the prevalence of microalbuminuria in hypertensive patients and its association with severity of blood pressure and end organ damage. The knowledge of these associations will enable us to emphasise the significance of routine screening for microalbuminuria and early intervention strategies to minimise the long-term impact of hypertension [12].

MATERIALS AND METHODS

The present hospital-based cross-sectional study was performed in the Department of General Medicine at Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pune, during an 18-month period from October 2023 to March 2025. The study was

undertaken after securing ethical clearance from the Institutional Ethics Committee (Research protocol number: IESC/PGS/2023/08), and written informed consent was taken from all the participants before enrolment.

Sample size calculation: The sample size was calculated to be 126 using the formula $n=\{Z^2\times p\times(1-p)\}/d^2$ where p (prevalence) was taken to be 0.30 based on literature showing prevalence of microalbuminuria in essential hypertensive patients, Z was 1.96 (for 95% confidence), and the margin of error d was set at 0.08 [13]. Consecutive enrolment of 150 patients with essential hypertension diagnosed was done from inpatient and outpatient services.

Inclusion and Exclusion criteria: Inclusion criteria was, adults aged between 30 to 70 years, either new cases of essential hypertension-which is defined as high blood pressure (Stage 1 - more than 130/80 mmHg, Stage 2 - more than 140/90 mmHg) without a known secondary cause [14], or established hypertensives on current treatment. Exclusion criteria was patients with diabetes mellitus, secondary hypertension, chronic kidney disease, urinary tract infection, recent acute illness, or any confirmed cardiovascular disease with factors likely to affect urinary albumin excretion or cardiovascular results.

Study Procedure

Data collection consisted of a standardised proforma that elicited demographic information, history of hypertension, treatment, lifestyle habits like smoking and alcohol consumption, and family history of cardiovascular disease. Blood pressure was measured with a mercury sphygmomanometer in accordance with JNC-8 guidelines [15], with the mean of three readings five minutes apart. Laboratory tests consisted of fasting plasma glucose, serum creatinine, serum electrolytes, and lipid profile. They were done to rule out other causes of microalbuminuria like diabetes and kidney disease.

A systolic blood pressure over 139 mmHg or diastolic blood pressure over 89 mmHg was considered uncontrolled hypertension [15]. Patients with total cholesterol over 200 mg/dL or LDL values over 100 mg/dL with HDL values less than 50 mg/dL for women and less than 40 mg/dL for men were considered as having dyslipidaemia [16]. Microalbuminuria was evaluated by spot urine sample to determine the Albumin-To-Creatinine Ratio (ACR). A value between 30-300 mg/day was taken as positive for microalbuminuria [17].

Electrocardiogram (ECG) was performed in all the patients, and 2D echocardiogram was performed to evaluate for any structural or functional cardiac abnormality that would be indicative of CAD. ECG changes such as T inversions, ST segment depressions, pathological Q waves along with 2D echocardiogram changes like LVH and regional wall motion abnormalities were considered as indicative of ischemia [18]. Treadmill Test (TMT) or coronary angiography was also performed in the selected cases if there were features on clinical grounds or when there were abnormal results on ECG/2D Echo.

STATISTICAL ANALYSIS

All data were keyed into Microsoft Excel and processed with Statistical Package for Social Sciences (SPSS) software version 20.0. Continuous variables were reported as mean±standard deviation and compared with the unpaired t-test. Categorical data were reported as frequency and percentage and compared with Chi-square test or Fisher's-exact test. A p-value <0.05 was taken to be statistically significant.

RESULTS

The mean age of the study population was 50.9±12.2 years with majority being males 96 (64%). [Table/Fig-1] demonstrates the age and gender distribution of study participants, showing that the majority 48 (32%) were in the 50-59 years age group. [Table/Fig-2] demonstrates that majority of the patients were known hypertensives 118 (78%) with about 63 (42%) having a risk of smoking and/or alcohol consumption. [Table/Fig-3] shows that majority of established hypertensive 102 (68%) patients were on treatment and the most commonly used class of drugs were calcium channel blockers 58 (38.66%).

Variables	Number of patients (n)	Percentage (%)
Age group (years)		
30-39	22	14.7%
40-49	40	26.7%
50-59	48	32.0%
60-70	40	26.7%
Gender		
Male	96	64.0%
Female	54	36.0%

[Table/Fig-1]: Age and gender distribution of study participants (N=150).

Variables	Number of patients	Percentage
Established hypertensives	118	78.66%
Newly diagnosed hypertensives	32	21.33%
History of smoking and/or alcohol consumption	63	42%
History of cardiovascular disease in the family	37	24.66%

[Table/Fig-2]: Data regarding hypertension, smoking and cardiovascular history.

Treatment	Number of patients	Percentage
Established hypertensives on treatment	102	68%
Patients on calcium channel blockers	58	38.66%
Patients on ACE inhibitors/ARB's	20	13.33%
Patients on beta blockers	24	16%

[Table/Fig-3]: Treatment history.
ACE: Angiotensin converting enzyme; ARB: Angiotensin receptor blocker

[Table/Fig-4] demonstrates the overall prevalence of microalbuminuria, which was found in 67 (44.6%) out of 150 hypertensive patients. A significant association was observed between the duration of hypertension and microalbuminuria, with higher prevalence among those hypertensives for over five years (p=0.003) [Table/Fig-5]. [Table/Fig-6] demonstrates the relationship between blood pressure control and microalbuminuria, showing a significantly higher frequency in patients with uncontrolled hypertension (p=0.001). The relationship between lipid abnormalities and microalbuminuria demonstrated higher occurrence of microalbuminuria in dyslipidemic patients (p=0.037) [Table/Fig-7].

Microalbuminuria status	Number of patients (n)	Percentage (%)
Present	67	44.6%
Absent	83	55.3%

[Table/Fig-4]: Prevalence of microalbuminuria (N=150).

Duration of hypertension	Microalbuminuria present (n)	Microalbuminuria absent (n)	p-value
<5 years	15 (22.38%)	40 (48.19%)	0.003
5-10 years	25 (37.31%)	27 (32.5%)	
>10 years	27 (40.29%)	16 (19.27%)	

[Table/Fig-5]: Association between duration of hypertension and microalbuminuria.

BP control status	Microalbuminuria present (n)	Microalbuminuria absent (n)	p-value
Controlled	24 (38.09%)	56 (67.46%)	0.001
Uncontrolled	43 (68.25%)	27 (32.53%)	

[Table/Fig-6]: Microalbuminuria vs Blood Pressure (BP) control.

The ECG changes in the study population are demonstrated in [Table/Fig-8]. LVH was the most common cardiac abnormality seen as

Lipid status	Microalbuminuria present (n)	Microalbuminuria absent (n)	p-value
Abnormal	44 (65.67%)	29 (34.93%)	0.037
Normal	23 (34.32%)	54 (65.06%)	

[Table/Fig-7]: Lipid profile abnormalities and microalbuminuria.

ECG findings	Frequency (n)	Percent (%)
Left Ventricular Hypertrophy (LVH)	32	21.3
Normal	52	34.6
Q Waves	23	15.3
ST depression	16	10.6
T inversions	27	18.0
Total	150	100.0

[Table/Fig-8]: ECG findings.

per the ECG finding in 32 (21.3%) patients. The ischaemic changes on ECG were more frequent among patients with microalbuminuria (p<0.001) [Table/Fig-9].

ECG changes	Microalbuminuria present	Microalbuminuria absent	p-value
Normal	13 (19.40%)	39 (46.98%)	
Ischaemic changes	34 (50.74%)	32 (38.55%)	<0.001
LVH	20 (29.85%)	12 (14.45%)	0.014

[Table/Fig-9]: ECG Abnormalities and microalbuminuria.

[Table/Fig-10] demonstrates a significant association between echocardiographic evidence of CAD and presence of microalbuminuria. Patients with positive TMT or angiographic evidence of CAD had a significantly higher prevalence of microalbuminuria (p<0.001) [Table/Fig-11].

2D Echo finding	Microalbuminuria present (n)	Microalbuminuria absent (n)	p-value
Normal	31 (46.26%)	68 (81.92%)	<0.001
CAD indicative	36 (53.73%)	15 (18.07%)	

[Table/Fig-10]: 2D Echo findings and microalbuminuria.

CAD status	Microalbuminuria present (n)	Microalbuminuria absent (n)	p-value
Positive for CAD	35 (52.23%)	11 (13.25%)	<0.001
Negative for CAD	32 (47.76%)	72 (86.74%)	

[Table/Fig-11]: CAD confirmation (TMT/Angiography) and microalbuminuria.

[Table/Fig-12] presents the findings of a logistic regression analysis that was performed to establish predictors of cardiovascular abnormality among patients with microalbuminuria. The analysis revealed microalbuminuria, systolic blood pressure and diastolic blood pressure as predictors.

Predictor variable	B	SE	Wald	Sig. (p)	Exp (B) (Odds ratio)	95% CI (Lower-Upper)
Microalbuminuria (Yes)	1.324	0.482	7.554	0.006	3.759	1.471-9.604
Systolic BP (mmHg)	0.028	0.013	4.781	0.029	1.028	1.003-1.054
Diastolic BP (mmHg)	0.045	0.021	4.567	0.033	1.046	1.003-1.091
Constant	5.472	1.834	8.916	0.002	0.004	-

[Table/Fig-12]: Logistic regression analysis for prediction of cardiovascular abnormality in patients with microalbuminuria.
B: Regression coefficient, SE: Standard error

Microalbuminuria was a robust independent predictor of cardiovascular abnormality, with an Odds Ratio (OR) of 3.759 (95% CI: 1.471-9.604, p=0.006). It indicates that patients with microalbuminuria are almost 3.8 times more likely to have cardiovascular abnormalities than those with no microalbuminuria.

DISCUSSION

This cross-sectional study was conducted to evaluate the prevalence of microalbuminuria among patients with essential hypertension and to explore its association with CAD and other cardiovascular risk factors. Out of the 150 hypertensive patients enrolled, microalbuminuria was present in 44.6% of the individuals, highlighting a substantial burden of early renal involvement and endothelial dysfunction in this population. These findings were consistent with previous literature suggesting microalbuminuria as a reliable early marker for systemic vascular damage in hypertension [19].

The age distribution indicated a concentration of cases in the 50-59 years age group, with a clear male predominance. These demographics aligned with the epidemiological pattern seen in hypertensive populations globally, where middle-aged and older males exhibit higher vulnerability to hypertension related complications [20]. Importantly, a significant association was observed between the duration of hypertension and the presence of microalbuminuria. Patients with a longer duration of illness, especially more than 10 years, showed increased prevalence, indicating the cumulative vascular impact of chronic blood pressure elevation [21].

Another notable observation was the statistically significant association between microalbuminuria and blood pressure control status. Those with uncontrolled hypertension had a higher likelihood of microalbuminuria than those with well-controlled BP. This emphasises the need for tight control of blood pressure in avoiding microvascular injury [22].

Microalbuminuria was also seen to be associated more frequently with dyslipidaemia, as postulated in the hypothesis that metabolic abnormalities additionally exacerbate vascular risk in patients with hypertension [23]. Cardiac evaluations further strengthened the usefulness of microalbuminuria as an early indicator of cardiovascular risk. A greater number of patients with microalbuminuria evidenced ischaemic changes on ECG and structural changes indicative of CAD on echocardiography. Notably, evidence of microalbuminuria was most strongly associated with positive coronary angiography results, linking the condition firmly with overt CAD [24].

These results collectively underscore the importance of microalbuminuria as a sensitive, non-invasive indicator of early systemic and coronary vascular engagement in patients with hypertension. Its detection signified generalised endothelial dysfunction, which not only indicated renal impairment but also foretells increased cardiovascular morbidity. Early detection through screening may permit early intervention to prevent progression to overt CAD and other complications. The strength of this study is in its holistic strategy, integrating biochemical, clinical, and imaging information to define the cardiovascular importance of microalbuminuria.

Limitation(s)

One limitation of this study is that it being a single-center study with cross-sectional design, causal associations could not be determined. Larger cohorts with follow-up studies would be helpful to confirm such associations and measure prognostic value of microalbuminuria with time.

CONCLUSION(S)

The findings of this research reinforce the importance of microalbuminuria, which was found in 44.6% of the hypertensive patients, as an important biomarker for hypertensive complications. Significant association was observed between microalbuminuria and CAD OR of 3.759 in hypertensive patients. Because it has predictive value for renal as well as cardiac disease, microalbuminuria needs to

be included as a component of risk stratification among hypertensive patients. The high prevalence of uncontrolled hypertension and the high rate of untreated cases underline the need for intensified early screening, intensive therapeutic management, and comprehensive management strategies. Microalbuminuria can and must be used as a screening device for early identification of at-risk hypertensive patients. Through the management of microalbuminuria at an early stage of time with a combination of pharmacologic therapy, lifestyle modification, healthcare providers may be able to efficiently reduce the burden of cardiovascular and renal disease among hypertensive individuals. Additional research is needed to study long-term outcomes, simplify treatment algorithms, and refine screening recommendations to more effectively treat patients and reduce hypertension morbidity and mortality.

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