Original Article

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Study of Microalbuminuria in Hypertension

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Abstract

Background: Hypertension is the single most important risk factor in both coronary heart disease and cerebrovascular accidents. The onset of microalbuminuria correlates with duration and severity of hypertension, and its occurrence also heralds the onset of microvascular damage in other organs as kidney, retina, and heart. Microalbuminuria has recently emerged as an early marker of hypertension induced target organ damage.

Objectives: The objective was to study incidence and severity of microalbuminuria among hypertensive population.

Materials and Methods: This study was performed in Medical College, Jabalpur. 50 patients of mild, moderate, and severe hypertension were studied. After complete medical history and physical examination, routine biochemical analysis of blood and urine were obtained from every patient. Hypertension was defined according to Joint National Committee 6 criteria as an average blood pressure (BP) > 140-90 mmHg on at least three different occasions. Albumin excretion rate was determined by immunoturbidimetric test (Micral test).

Results: The incidence of microalbuminuria was 28% (14 out of 50) and was more prevalent in males. Maximum incidence of microalbuminuria was seen in higher age group (60-79 years). Microalbuminuria positive cases had significantly higher systolic BP (SBP) (171.86 ± 7.70 vs. 163.72 ± 7.35) and pulse pressure (75.86 ± 8.75 vs. 68.28 ± 10.04). Chances of microalbuminuria are higher in smokers. Microalbuminuria positive hypertensives had significantly higher level of serum creatinine (1.37 ± 0.46 vs. 1.09 ± 0.33). Microalbuminuria positive hypertensives had significantly lower creatinine clearance and a higher uric acid and cholesterol. Coronary artery disease and retinopathy were more prevalent in microalbuminuria positive patients. Electrocardiography (ECG) and echocardiography (Echo) changes of hypertension were more in microalbuminuria positive patients.

Conclusions: Microalbuminuria was significantly associated with higher SBP and pulse pressure higher creatinine, uric acid, cholesterol. ECG and Echo changes of hypertension were more in microalbuminuria positive patients. A risk coronary artery disease and retinopathy were more prevalent in microalbuminuria positive patients.

Key words: Blood pressure, Hypertension, Microalbuminuria

INTRODUCTION

Hypertension is the single most important risk factor in both coronary heart disease and cerebrovascular accidents.[1] It is common, asymptomatic, readily detectable, and easily treatable, and is the leading cause of morbidity and mortality if left untreated. It may lead to congestive cardiac failure (hypertensive heart disease), renal failure, ocular damage, and aortic dissection.

Hypertension is an iceberg disease. In a developing country like India, only a small proportion of actual hypertensive's are aware of their condition and very few among them are taking regular medications for its control. When defined as systolic blood pressure (SBP) > 140 mmHg and diastolic BP (DBP) > 90 mmHg, prevalence of hypertension is approximately.

i. 59.9/1000 population in males, 69.9/1000 population in females
ii. 19-25% in rest of world according to various studies.

About 90% of hypertension is primary or essential, remainder is secondary mostly related to renal disease,

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endocrine abnormalities, vascular malformations, neurogenic, and psychogenic disorders.

Hypertension affects principally small muscular arteries and arterioles.[2] Hypertension accelerates atherogenesis and causes two types of arteriosclerosis:

i. Hyaline arteriosclerosis.
ii. Hyperplastic arteriosclerosis or necrotizing arteritis.

Both of which are characterized by diffuse arteriolar wall thickening and luminal narrowing resulting in ischemia, necrosis, and fibrosis of tissues.

Hypertension principally affects organs with rich microvascular circulation as kidneys, brain, retina, and heart. One of the earliest biochemical markers of hypertensive microvascular angiopathy is filtration of small amount of albumin from glomerular capillaries due to intraglomerular hypertension. The onset of microalbuminuria correlates with duration and severity of hypertension, and its occurrence also heralds the onset of microvascular damage in other organs as kidney, retina, and heart.[3] It is considered to be present when urinary albumin excretion is more than 20 μg/min, but less than 200 μg/min. This corresponds to approximately 30-300 mg/24 h.

Since this disease is associated with multisystem damage, very high morbidity and mortality, there was a long felt need of a marker that could predict multisystem changes at very early stage. Microalbuminuria has recently emerged as an early marker of hypertension induced target organ damage. A large number of studies all over the world have found a strong correlation between onset of microalbuminuria and biochemical markers of atherosclerosis (high and low-density lipoprotein [HDL and LDL] triglycerides, very LDL, cholesterol, apolipoprotein B, reduced HDL, and smoking) and have found a strong association between microalbuminuria and severity and duration of hypertension; microvascular changes in kidneys, retina, and heart.

The present study was conducted to find whether there exists any correlation between microalbuminuria, biochemical changes, and target organ damage in hypertension.

AIMS AND OBJECTIVES

1. To detect incidence of microalbuminuria among the hypertensive population.
2. To correlate incidence and severity of microalbuminuria with.
    a. Detailed physical examination to detect any physical finding significantly correlating with microalbuminuria.
    b. Various hematologic and biochemical parameters.
    c. Microvascular changes in the fundus detected through detailed fundus examination.
    d. Electrocardiography (ECG) findings of changes in coronary circulation, rhythm, and size of cardiac chambers.
    e. Any radiologically evident change in chest X-rays.
    f. Echo changes of systolic and diastolic dysfunction, ischemic heart disease (IHD).

MATERIALS AND METHODS

This study was performed in Medical College, Jabalpur. Permission from Ethical Committee was taken. 50 patients of mild, moderate, and severe hypertension were studied. Informed consent was obtained from each patient. The statistical analysis was carried out with SAS data analysis system. For statistical significance, the $P < 0.05$ was considered.

Inclusion criteria: Patients of mild, moderate, and severe hypertension.

Exclusion criteria:

1. Age <18 or >85 years.
2. Presence of neoplastic, hepatic or renal disease.
3. Diabetes mellitus (fasting plasma glucose > 140 mg/dl).
4. History of urinary tract infection, positive qualitative urine analysis of proteins.
5. Females consuming oral contraceptives.

The attending physician made a diagnosis of essential hypertension. After complete medical history and physical examination, routine biochemical analysis of blood and urine were obtained from every patient. Hypertension was defined according to Joint National Committee 6 criteria as an average BP > 140-90 mmHg on at least three different occasions.

BP measurements: SBP and DBP were read to the nearest 2 mmHg. The lowest of the three consecutive readings was recorded. Pulse pressure (SBP − DBP) and mean BP (DBP + 1/3 pulse pressure) were recorded.

Body mass index (BMI) was calculated.

24 h urinary collections were obtained from each patient starting from second morning sample of the previous day to first morning sample of the test day.

Smoking was graded with a five point scale: Non-smoker, ex-smoker, smoking 1-14 g/day, smoking 15-25 g/day smoking > 25 g/day (1 cigarette = 1 g).

Retinopathy: The presence, type, and extent of hypertensive retinopathy were investigated.

ECG: It was used to detect signs of cardiac involvement, left ventricular hypertrophy, left atrial enlargement, left axis deviation, ventricular extrasystoles, atrial fibrillation, and myocardial infarction. Sokolow Lyon voltage criteria were used for detection of left ventricular hypertrophy as recommended by WHO. A criterion for IHD was based on the presence of Q-waves.

Chest X-rays: PA view of the chest was taken to note cardiothoracic ratio, pulmonary venous congestion, and prominence or calcification of aortic knuckle. Cardiothoracic ratio > 0.5 was considered as evidence of cardiomegaly.

Echo: In this study, M mode and 2D Echo were done on BPL US9101 machine.

Urine: Albumin**,** sugar, and ketone bodies were detected.

Blood: Fasting and postprandial blood sugar, urea, serum uric acid, and serum cholesterol were estimated.

Serum and urinary creatinine estimation were done with measurement of creatinine clearance.

Albuminuria: Albumin excretion rate was determined in the first morning urine sample by immunoturbidimetric test (Micral test).

Microalbuminuria: In this study, we estimated albumin excretion rate by immunoturbidimetric test.

OBSERVATIONS

Of these 50 hypertension subjects, 28% ([*n* = 14], 10 males (71.4%), and 4 females [28.6%]) were taken as study group being microalbuminuria positive and remaining 72% ([*n* = 36], 15 males [41.7%] and 21 females [58.3%]) were taken as control groups being normoalbuminuric. Microalbuminuria positive cases were subdivided on the basis of microalbuminuria range into three groups for comparative study of microalbuminuria with some clinical and biochemical parameters. Findings of current study are as follows:

1. The incidence of microalbuminuria is 28% (14 out of 50). The distribution of cases according to Albumin excretion rate is shown in Figure 1.
2. The peak incidence of microalbuminuria was found in the age group 60-79 years being 64% (9 out of 14 cases). The next maximum microalbuminuria cases were found in 40-59 years age range being 35% (5 out of 14 cases) (Table 1).
3. Male sex is associated with higher incidence of microalbuminuria (71.4% [*n* = 10] were males and 28.6% [*n* = 4] were females).
4. Microalbuminuria is significantly associated with higher SBP. Mean SBP (171 ± 7.70 mmHg) of microalbuminuria positive patients was significantly higher than mean SBP (163.72 ± 7.35 mmHg) of microalbuminuria negative patients (Table 2).
5. DBP was comparable in microalbuminuria positive (96 ± 10.32 mmHg) and microalbuminuria negative patients (95.75 ± 9.64 mmHg) and no significant association could be drawn.
6. Mean BP (120.21 ± 8.16 mmHg) of microalbuminuria positive patients was not significantly higher than mean BP (118.75 ± 7.35 mmHg) of microalbuminuria negative patients.
7. Mean pulse pressure (75.86 ± 8.75 mmHg) in microalbuminuria positive cases was significantly higher than mean pulse pressure (68.28 ± 10.04 mmHg) in microalbuminuria negative cases.
8. Prevalence of smoking was 20% (50) in the study. Among the smokers, 60% were microalbuminuria positive and 40% (*n* = 4) were microalbuminuria negative.
9. Increased BMI (BMI > 30 for males and > 28 for females) was observed in 24% cases (*n* = 12) in the study. No significant association was found with microalbuminuria.

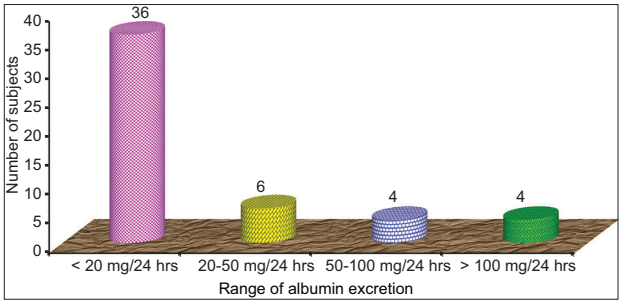

Figure 1: Distribution of cases according to albumin excretion rate

Table 1: Age and sex distribution of cases in the study

Age groups (years)	Microalbuminuria				Total
	Positive (%)		Negative		
	Male	Female	Male	Female	
<19	-	-	1	-	1
20-39	-	-	1	4	5
40-59	5 (35.71)	-	5	12	22
60-79	5 (35.71)	4 (28.57)	7	4	20
80 years and above	-	-	1	1	2
Total	10	4	15	21	50
Mean age±SD	59.79±10.00	61.75±2.05	52.30±14.28	49.13±13.20	

Statistically significant test value. Results: $Z_{m+,-}$ = 2.09; *P*<0.05, $Z_{f+,-}$=4.13*; *P*<0.001. Maximum incidence of microalbuminuria was seen in the higher age group (60-79 years). SD: Standard deviation

10. The mean hematocrit (40.95 ± 30.30 [male]; 34.53 ± 1.83 [female]; 39.11 ± 4.50 [total]) was very close to the mean hematocrit (40.54 ± 3.02 [male]; 33.6 ± 3.43 [female]; 36.49 ± 4.73 [total]) in microalbuminuria negative cases. No significant difference was observed.
11. The mean serum urea levels for the three different (20-50, 50-100 and > 100 mg/24 h) ranges of microalbuminuria were 29.28 ± 11.69; 28.5 ± 17.21; 30.75 ± 12.12 mg/dl, respectively. No significant association was found on correlating mean serum urea (29.47 ± 12.62 mg/dl) of total microalbuminuria positive cases (n = 14) and mean serum urea (22.68 ± 8.44 mg/dl) of total microalbuminuria negative cases (n = 36).
12. Mean serum creatinine levels among the three grades (20-50, 50-100 and > 100 mg/24 h) of microalbuminuria were 1.37 ± 0.46, 1.375 ± 0.56, and 1. 375 ± 0.49 mg/dl, respectively. The mean value of serum creatinine (1.37 ± 0.46 mg/dl) of total microalbuminuria positive cases was significantly higher than the mean serum creatinine (1.09 ± 0.33 mg/dl) of microalbuminuria negative subjects (Table 3).
13. The mean urinary creatinine (19 ± 2.98 mg/dl) in microalbuminuria positive males was lower than the mean urinary creatinine (20.73 ± 2.02 mg/dl) in microalbuminuria negative males. It was statistically not significant.
14. The mean creatinine clearance (97.14 ± 6.75 ml/min) of total microalbuminuria positive cases was significantly lower than mean creatinine clearance (111.64 ± 13.98 ml/min) of total microalbuminuria negative cases.
15. The mean serum uric acid (8.58 ± 1.52 mg/dl) in total microalbuminuria positive cases was significantly higher than the mean serum uric acid (6.81 ± 1.14 mg/dl) of total microalbuminuria negative cases.
16. The mean serum cholesterol in total microalbuminuria positive cases (245.14 ± 35.40 mg/dl) was significantly higher than the mean serum cholesterol of total microalbuminuria negative cases (220.75 ± 27.08 mg/dl).
17. IHD was detected in 12% (n = 6) cases on the basis of ECG and Echo criteria, while 88% (n = 4) were normal (Figure 2). Among the IHD cases, 50% (n = 3) cases were microalbuminuria positive. In all microalbuminuria positive cases 21.4% (n = 3) had IHD whereas in all microalbuminuria negative cases (n = 36), only 8.3% (n = 3) had IHD. The correlation between microalbuminuria and coronary artery disease was insignificant, but a higher prevalence of coronary artery disease was seen in microalbuminuria positive cases (Table 4).

Table 2: Correlation between microalbuminuria and BP

BP	Microalbuminuria		Test statistic value
	Positive (n=14)	Negative (n=36)	
Mean SBP	171.86±7.70	163.72±7.35	Z=3.40* P<0.05
Mean DBP	96.00±10.32	95.75±9.64	Z=0.08 P>0.05
Arithmetic mean of mean BP	120.21±8.16	118.75±7.35	Z=0.58 P>0.05
Mean pulse pressure	75.86±8.75	68.28±10.04	Z=2.63* P<0.05

*Significant test statistic value. Microalbuminuria positive cases had significantly higher SBP and pulse pressure. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BP: Blood pressure

Table 3: Correlation between microalbuminuria and serum creatinine

Microalbuminuria	Positive (n=14)	Negative (n=36)	Test statistic value
Mean serum creatinine (mg/dl)		1.09±0.33	
Range			
20-50 mg/24 h (n=6)	1.37±46		Z=2.08*
50-100 mg/24 h (n=4)	1.375±0.56		
>100 mg/24 h (n=4)	1.375±0.49		
Total (n=14)	1.37±0.46		

Statistically Significant test value. Results: Z=2.08; P<0.05. Microalbuminuria positive hypertensive's had significantly higher level of serum creatinine

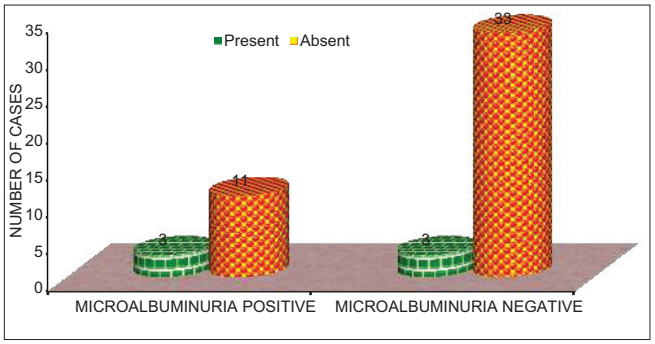

Figure 2: Correlation between microalbuminuria and coronary artery disease

18. The prevalence of hypertensive retinopathy was 58% in the study. Among microalbuminuria positive cases 85.7% (n = 12) cases had retinopathy, whereas only 47.2% (n = 17) cases had retinopathy in microalbuminuria negative cases.
19. Changes in X-rays were seen in 22% cases (n = 11) in the study, among microalbuminuria positive cases (n = 14) changes were seen in 28% whereas in microalbuminuria negative cases (n = 36) changes were seen in 19% cases.
20. ECG changes were seen in 40% cases in the study 85.7% of microalbuminuria positive cases had ECG

changes of hypertension whereas only 22.2% of microalbuminuria negative cases had changes in ECG. A significant correlation was seen between microalbuminuria and ECG changes (Table 5).

21. Echocardiographic features of systolic or diastolic dysfunction were seen in 60% or thirty cases (Figure 3). 85.7% of microalbuminuria positive cases had Echo changes of systolic or diastolic dysfunction whereas only 50% of microalbuminuria negative cases had Echo features of hypertension. Chi-square test shows significant correlation (Table 6).

DISCUSSION

Prevalence of Microalbuminuria

Of 50 hypertension patients in this study, 28% (n = 14) were found to be microalbuminuria positive. Of these 20% (n = 10) were males and 8% (n = 4) were females.

Similar prevalence rate was also found in the studies of Wu *et al.*, 1998[4] (28%); Spangler *et al.,* 1997 (25%).[5]

Correlation between Microalbuminuria and Age

The age of the patients ranged from 18 to 80 years in the study. Of the total 14 microalbuminuria positive cases in the study, 35.71% (n = 5) male microalbuminuria positive cases were found in 40-59 years age range. 35.71% (n = 5) males and 28.57% (n = 4) females were in 60-79 years.

The mean age (59.79 ± 10.00 years) of microalbuminuria positive males was significantly higher than the mean age (52.30 ± 14.28 years) of microalbuminuria negative males (Z = 2.09*; P < 0.05). The mean age (61.75 ± 2.05 years) of microalbuminuria positive females was significantly higher than the mean age (49.13 ± 13.20 years) of microalbuminuria negative females (Z = 4.13*; P < 0.001).

The above findings correlate with the studies of Luft, 1997;[6] Bonet *et al.*, 2000.[7]

Correlation between Microalbuminuria and Sex

A male predominance was seen in microalbuminuria positive cases.

These findings correlate with studies of Hillege *et al.*, 2000;[8] Gould *et al.*, 1993; Bonet *et al.* 2000.

Correlation of Microalbuminuria and SBP

The mean SBP (171.86 ± 7.70 mmHg) of microalbuminuria positive cases was significantly higher than mean SBP (163.72 ± 7.35 mmHg) of microalbuminuria negative cases (Z = 3.40*, P < 0.05). The study results were very close to the findings of Mimran *et al.* 1994; Bonet *et al.*, 2000. These studies have emphasized that microalbuminuria was very much associated with higher SBP.

Table 4: Correlation between microalbuminuria and coronary artery disease

Coronary artery disease	Microalbuminuria (%)		Total (%)
	Positive	Negative	
Present	3 (50) (21.4)	3 (50) (8.33)	6 (12)
Absent	11 (25) (78.5)	33 (75) (91.6)	44 (88)
Total	14	36	50

*Statistically significant test value. χ^2=1.64; P>0.05 at 1 df. Coronary artery disease was more prevalent in microalbuminuria positive patients

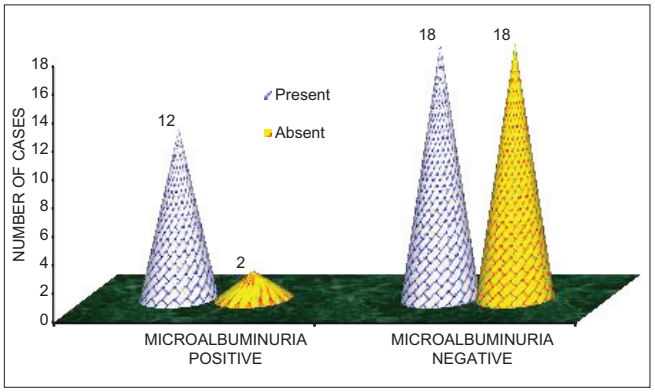

Figure 3: Correlation between microalbuminuria and echocardiographic changes

Table 5: Correlation between microalbuminuria and ECG changes

Changes in ECG	Microalbuminuria (%)		Total (%)
	Positive	Negative	
Present	12 (60) (85.7)	8 (40) (22.2)	20 (40)
Absent	2 (6.6) (14.3)	28 (93.3) (77.8)	30 (60)
Total	14	36	50

Statistically significant test value. Results χ^2=16.93; P<0.001 (Significant at 1 df). Higher incidence of ECG changes of hypertension were seen in microalbuminuria positive patients. ECG: Electrocardiography

Table 6: Correlation between microalbuminuria and echocardiographic changes

Echocardiographic changes	Microalbuminuria (%)		Total (%)
	Positive	Negative	
Present	12 (40) (85.7)	18 (60) (50)	30 (60)
Absent	2 (10) (14.3)	18 (90) (50)	20 (40)
Total	14	36	50

Statistically significant test value. Results χ^2=5.36; P<0.005 (Significant at 1 df). Higher incidence of echocardiographic changes was seen in microalbuminuria positive patients

Correlation between DBP and Microalbuminuria

The findings of mean DBP correlate with the studies of Pedrinelli *et al.*, 1999[9] who did not find any correlation between DBP and microalbuminuria. Only SBP was associated with microalbuminuria in their studies.

The results of this study do not match with study results of Redon *et al.*, 1996[10] who found microalbuminuria to be more closely associated with DBP.

Correlation between Microalbuminuria and Mean BP

In the study, the mean BP did not correlate with microalbuminuria.

The opinion of Mimran *et al.*, 1999[11] and Wu *et al.*, 1998 was different from our findings who found the mean BP to be significantly higher in microalbuminuria positive cases.

Correlation between Microalbuminuria and Pulse Pressure

The mean pulse pressure (75.86 ± 8.75 mmHg) of microalbuminuria positive cases was significantly higher than the mean pulse pressure (68.28 ± 10.04 mmHg) of microalbuminuria negative cases ($Z = 2.63$*, $P < 0.05$).

The above relationship have been confirmed by the studies of Pedrinelli *et al.*, 2000 and Bonet *et al.*, 2000 who found a significant correlation between microalbuminuria and widened pulse pressure.

Correlation between Microalbuminuria and Smoking

Our findings closely match with studies of Mimran *et al.* who in their study found the prevalence of microalbuminuria to be two fold higher in hypertensive smokers. The similar findings studied by Spangler *et al.*, 1997; Luft 1997 and Hillege *et al.*, 2001 advocate that smoking was significantly associated with more microalbuminuria positivity in hypertension.

Correlation between Microalbuminuria and BMI

No significant association could be drawn from the results of chi square test $\chi^2_{f+,-} = 0.20$, $P > 0.05$; $\chi^2_{m+,-} = 0.09$; $P > 0.05$.

The above findings were different from the studies of Mimran *et al.*, 1994; Bonet *et al.*, 2001. These showed a strong correlation between higher BMI and microalbuminuria.

Correlation between Microalbuminuria and Hematocrit

No statistically significant difference was found in the mean hematocrit and serum urea was found in this study.

Correlation between Microalbuminuria and Serum Creatinine

The level of serum creatinine ranged from 0.9 to 2.2 mg/dl in microalbuminuria positive subjects and 0.5-2.25 mg/dl in microalbuminuria negative subjects.

The above findings were statistically significant and similar to those of Agrawal *et al.*, 1996;[12] Ruilope, 2001;[13] and Bonet *et al.*, 2000.

Correlation between Microalbuminuria and Creatinine Clearance

The levels of creatinine clearance in the study ranged from 76 to 118 ml/min among microalbuminuria positive subjects and 96-136 ml/min among microalbuminuria negative subjects.

These observations are in agreement with those of Ruilope *et al.*, 2001.

Correlation between Microalbuminuria and Serum Uric Acid

Serum uric acid was found to be elevated in 36% ($n = 18$) cases in the study group. Of these 18 patients, 72% ($n = 13$) were microalbuminuria positive and 28% ($n = 5$) were microalbuminuria negative. The levels of serum uric acid ranged from 3.6 to 11.2 mg/dl in the study population.

The mean serum uric acid (8.58 ± 1.52 mg/dl) in total microalbuminuria positive cases was significantly higher than mean serum uric acid (6.81 ± 1.14 mg/dl) of total microalbuminuria negative cases ($Z = 3.95$*; $P < 0.05$).

These findings corroborate with the works of Mattel *et al.*, 1997[14] ($r = 0.43$, $P < 0.005$*); Bigazzi *et al.*, 1998;[15] and Bianchi *et al.*, 1999.

Correlation between Microalbuminuria and Serum Cholesterol

The mean serum cholesterol (240.5 ± 34.63 mg/dl) in microalbuminuria positive males is significantly higher than the mean serum cholesterol (212.8 ± 23.55 mg/dl) in microalbuminuria negative males ($Z = 2.21$*, $P < 0.05$).

The above findings closely match with studies of Bigazzi, Bianchi *et al.*, 1999; Mimran *et al.,* 1994; Bonet *et al.*, 2001; Mettal ($P < 0.005$*), Agrawal *et al.*, 1996. Their studies showed a very strong correlation between microalbuminuria and elevated serum cholesterol, elevated LDL, reduced HDL, high LDL: HDL ratio, elevated triglycerides, elevated serum levels of apolipoprotein A and B, thus increasing the atherogenic risk profile.

Correlation between Microalbuminuria and Coronary Artery Disease

Of the total 50 hypertension cases of study group, 12% ($n = 6$) were found to suffer from IHD whereas 88% ($n = 44$) had no Echo/ECG evidence of IHD.

Though the results of Chi-square test as stated above did not show significant correlation between microalbuminuria and coronary artery disease, yet the prevalence of coronary artery disease was higher (21%) in microalbuminuria

positive cases than (8%) in microalbuminuria negative cases in the present study.

Bianchi *et al.*, 1997, found a very strong correlation ($P < 0.0002$*) between microalbuminuria and IHD. Olinic *et al.*, 1994[16] ($P < 0.001$*), Redon *et al.*, 1991; Wu *et al.*, 1998; Agrawal *et al.*, 1996 ($P < 0.05$); Biesenbach[17] found the prevalence of coronary artery disease to be 11% in normoalbuminuric hypertensives and 29% in microalbuminuric hypertensives and the results of present study were very near to the above study.

Correlation between Microalbuminuria and Retinopathy

Out of the total 50 hypertension patients in the study, 58% ($n = 29$) cases had evidence of hypertensive retinopathy, whereas in 42% ($n = 21$) cases fundus was normal.

The findings of the present study were strongly supported by the similar results found in the studies conducted by Pontremolli *et al.*, 1997.

Correlation between Microalbuminuria and ECG Changes

The results show a highly significant correlation between microalbuminuria and ECG changes in hypertension.

The above findings match with study of Pontremolli *et al.*, 1998.[18]

Correlation between Microalbuminuria and Echo Changes

There is a significant correlation between microalbuminuria and presence of Echo findings in hypertension.

These results are powered by similar finding in studies of Pontremolli *et al.*, 1997;[19] Cerasola *et al.* 1996;[20] Agewall *et al.*, 1993.

CONCLUSION

1. The incidence of microalbuminuria in hypertension was 28% with a peak incidence of in 60-79 years age group.
2. Male sex was associated with higher incidence of microalbuminuria.
3. Microalbuminuria was significantly associated with higher SBP and mean pulse pressure.
4. Microalbuminuria was strongly associated with smoking.
5. Microalbuminuria positive patients have significantly elevated levels of serum creatinine and significantly lower levels of urinary creatinine. Creatinine clearance was significantly reduced in microalbuminuria positive hypertensive patients.
6. Microalbuminuria positive hypertensives have significantly elevated uric acid and serum cholesterol.
7. Microalbuminuria was significantly associated with retinopathy, ECG and Echo changes.

LIMITATIONS OF STUDY

Analysis of 100 hospitalized patients may not reflect the pattern of disease in the community and requires a large population study. Cases were selected from a tertiary care center, so reference bias may be present.

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