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To Study Endothelial Dysfunction by Brachial Artery Flow-mediated Dilatation and Its Relationship with Microalbuminuria in Hypertensive Individuals

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ABSTRACT

Introduction: Hypertension remains a central pathophysiologic contributor to cardiovascular morbidity and mortality. In its earliest stage, the principal endothelial alteration is merely functional and addressed as "endothelial dysfunction". Flow-mediated dilatation (FMD) of the brachial artery has been widely used as a noninvasive marker to vascular reactivity. Both microalbuminuria and endothelial dysfunction are expressions of an endothelial pathology; however, it is still uncertain whether they are interrelated, or if the two phenomena are caused in parallel by the cardiovascular risk burden. **Aim:** To study the relationship of brachial artery flow-mediated dilatation (BAFMD) with microalbuminuria in hypertensive subjects. **Method:** Total 120 subjects were included in the study comprising 80 hypertension cases and 40 controls. All subjects were subjected to anthropometric measurements and routine biochemical tests – hemogram, urea, serum creatinine, liver function test, lipid profile, BAFMD and urinary albumin to urinary creatinine ratio (30-300 mg/g Cr). **Conclusion:** Mean % FMD was lower in patients with abnormal microalbuminuria compared to normal and this was statistically verified, with p = 0.016, thereby verifying the central hypothesis of this study.

Keywords: Hypertension, microalbuminuria, brachial artery flow-mediated dilatation

Hypertension remains a central pathophysiologic contributor to cardiovascular morbidity and mortality. Although the precise cascade of events from the development of hypertension to adverse cardiovascular events remains to be elucidated, cardiovascular risk factors, including hypertension, are clearly associated with the development of vascular endothelial dysfunction. Endothelial dysfunction is a phenotypical alteration of the endovascular lining of blood vessels that is characterized by a prothrombotic, proinflammatory and proconstrictive phenotype. Endothelial function is readily measurable through multiple modalities and is an established barometer of cardiovascular risk. Further, interventions aimed at reducing cardiovascular risk, including antihypertensive therapy, are more effective if they concomitantly improve endothelial function. These data support the provocative hypothesis that reductions in cardiovascular risk secondary to antihypertensive therapy may relate independently to a particular intervention's beneficial effects on endothelial function as well as to its absolute effect on blood pressure.[1]

Recent studies have established microalbuminuria as an important cardiovascular risk factor. Data reported thus far clearly underpin the importance of measuring urinary albumin in patients with hypertension.

More importantly, patients with hypertension may benefit from prevention of the onset or progression of albuminuria, and to this end, further characterization of albuminuria in hypertensive patients or of possible risk factors affecting urinary excretion of albumin, could provide useful information.

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In disease conditions, including cardiovascular risk factors, the vascular endothelium undergoes functional and structural alterations. In its earliest stage, the principal endothelial alteration is merely functional and addressed as "endothelial dysfunction". The fundamental feature of this condition is impaired nitric oxide (NO) bioavailability. This can be evaluated in humans by measuring the downstream effects, namely vasodilatation through vascular reactivity tests. In the last decade, flow-mediated dilatation (FMD) of the brachial artery has been widely used as a noninvasive marker for this purpose.[2]

Both microalbuminuria and endothelial dysfunction are expressions of an endothelial pathology; however, it is still uncertain whether they are interrelated, or if the two phenomena are caused in parallel by the cardiovascular risk burden. Although endothelial dysfunction is constantly present in advanced renal disease, its association in mild renal dysfunction is still uncertain.[3]

AIMS AND OBJECTIVES

- To assess endothelial dysfunction by brachial artery flow-mediated dilatation (BAFMD) in hypertensive individuals and normotensive controls.
- To study microalbuminuria in the study population.
- To study the relationship of BAFMD with microalbuminuria.

MATERIAL AND METHODS

The present study was conducted in the Dept. of General Medicine, Cardiology and Radiology, Gajra Raja Medical College, Gwalior (Madhya Pradesh) in between January 2016 and September 2017.

Target sample size of 120 was divided into the following groups according to their age:

- Cases: Eighty individuals (40 male and 40 female) between age 30 and 50 with hypertension.
- Controls: Forty individuals (20 male and 20 female) between age 30 and 50 without hypertension.

Hypertension among the subjects was defined as per the seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC VII) (systolic BP [SBP] >140 mmHg and diastolic BP [DBP] >90 mmHg).

All subjects were subjected to anthropometric measurements and routine biochemical tests – hemogram, urea, serum creatinine, liver function test and lipid profile.

Patients were subjected to BAFMD study in the Dept. of Radiology. The procedure involved placing a pneumatic sphygmomanometer cuff on the forearm distal to the brachial artery and inflating it to suprasystolic levels and subsequently releasing it 5 minutes later. FMD was assessed by Doppler ultrasound with high resolution. FMD_{max} value was used in the present study.

Patient's urine sample was collected for detection of microalbuminuria. A single-void, urine sample was used to measure urinary excretion of albumin. Urinary albumin concentrations were measured by turbidimetric immunoassay and were as ratio of concentrations of urinary albumin to urinary creatinine (UACR). Microalbuminuria was defined according to recommendations of the American Diabetes Association and National Kidney Foundation (300 > UACR >30 mg/g Cr).

Inclusion Criteria

- **Cases**: Individuals having age between 30 and 50 years suffering from hypertension.
- **Controls:** Individuals having age between 30 and 50 years with no history of hypertension.

Exclusion Criteria

- Age below 30 and above 50 years.
- Documented or detected cases of type 1 or type 2 diabetes mellitus, chronic kidney disease, chronic inflammatory conditions, coronary artery disease, heart failure, acute febrile illnesses and on angiotensin-converting enzyme (ACE) inhibitors.
- Subjects who did not provide consent for the study.

Statistical Methods

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented as mean ± SD (Min-Max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Student *t*-test has been used to find the significance of study parameters between the two groups of patients. Chi-square/Fisher exact test has been used to find the significance of study parameters on categorical scale between the two groups. Pearson's correlation test was used for exploring correlation.

OBSERVATIONS

In cases and controls, most of the subjects belonged to age groups of 46-50 years (34 [42.5%]) and 36-40 years (13 [32.5%]), respectively (Table 1). Age of the study

Table 1. Distribution of Subjects According to Age and Gender

Age group	Cases		Controls	
	Male	Female	Male	Female
30-35	4 (5)	2 (2.5)	5 (12.5)	4 (10)
36-40	11 (13.8)	9 (11.2)	9 (22.5)	4 (10)
41-45	8 (10)	12 (15)	4 (10)	7 (17.5)
46-50	17 (21.2)	17 (21.2)	2 (5)	5 (12.5)

population was restricted to 30-50 years to avoid the confounding influence of age-related atherogenic changes on the measurement of BAFMD. Equal number of males and females were selected within the cases and controls for comparability.

Amongst the cases, 57.5% of the subjects belonged to the Stage 1 hypertension (HTN) group as per the JNC VII criteria (Table 2). More number of females than males was present in Stage 2 HTN group while the inverse was true for Stage 1 HTN. Subjects were distributed equally among the normal and prehypertensive categories in the control group with no female preponderance. Figure 1 depicts the distribution of study participants according to stage of hypertension.

Mean baseline lumen diameter (mm) in male and female cases and controls was 3.65 ± 0.86 vs. 3.75 ± 0.71 and 3.67 ± 0.66 vs. 3.70 ± 0.66, respectively. After occlusion cuff release, among male and female cases and controls, the diameter was 3.97 ± 0.92 vs. 4.15 ± 0.74 and 4.05 ± 0.71 vs. 4.10 ± 0.79, respectively. Mean BAFMD (%) in male and female cases and controls was 6.85 ± 2.86 vs. 10.75 ± 2.38 and 7.2 ± 3.12 vs. 10.35 ± 2.76, respectively (Table 3 and Figs. 2-4). Although the baseline diameter showed no significant difference among the hypertensive and normotensive groups, the mean post occlusion diameter was much lower in the hypertensive subjects, which was thereby reflected in a much lower mean % FMD amongst them. The lowest baseline diameter, post occlusion diameter and % BAFMD were recorded in the male hypertensives while the highest of these parameters were recorded amongst the male control group.

All cases of microalbuminuria were present in the hypertensive group. Among them, more males were observed to have abnormal levels than females (Table 4 and Fig. 5).

Mean values of body mass index (BMI), total cholesterol (TC), triglycerides (TGs), low-density lipoprotein

Table 2. Distribution of Subjects According to Blood Pressure

Blood pressure (mmHg)	Cases		Controls	
	Male	Female	Male	Female
Normal				
SBP <120 mmHg	0 (0)	0 (0)	10 (25)	10 (25)
DBP <80 mmHg				
Prehypertension				
SBP 120-139 mmHg	0 (0)	0 (0)	10 (25)	10 (25)
DBP 80-89 mmHg				
Stage 1 HTN				
SBP 140-159 mmHg	24 (30)	22 (27.5)	0 (0)	0 (0)
DBP 90-90 mmHg				
Stage 2 HTN				
SBP ≥160 mmHg	16 (20)	18 (22.5)	0 (0)	0 (0)
DBP ≥100 mmHg				

SBP = Systolic blood pressure; DBP = Diastolic blood pressure; HTN = Hypertension.

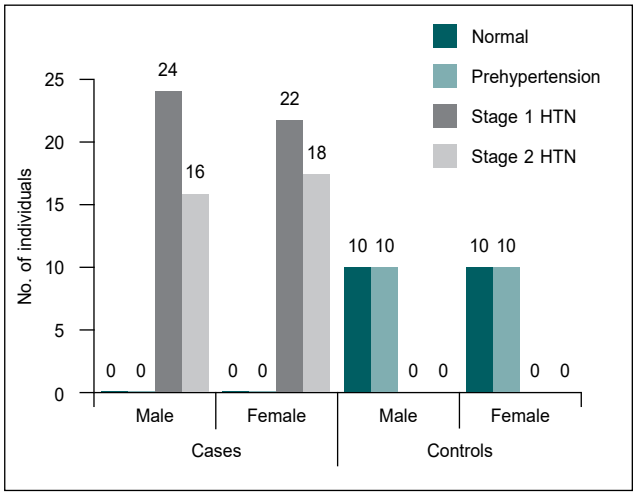

Figure 1. Distribution according to stage of hypertension.

cholesterol (LDL-C) and microalbuminuria (UACR) were higher in the case group when compared to the controls. Additionally, % BAFMD was lower in hypertensives when compared to the normotensive subjects (Table 5). On applying Students *t*-test, this difference in mean values between the cases and controls was statistically significant with each of them having a p value of <0.05.

Mean FMD (%) was significantly different across the age groups (p = 0.001), with FMD (%) showing a declining trend as age increases, whereas distribution of microalbuminuria was comparable across the age groups (p = 0.52) (Table 6; Figs. 6 and 7).

Table 3. Comparison of Assessment of FMD Between Cases and Controls

Variable	Cases		Controls	
	Male (mean ± SD)	Female (mean ± SD)	Male (mean ± SD)	Female (mean ± SD)
Baseline lumen diameter (mm)	3.65 ± 0.86	3.67 ± 0.66	3.75 ± 0.71	3.70 ± 0.66
Diameter after occlusion release (mm)	3.97 ± 0.92	4.05 ± 0.71	4.15 ± 0.74	4.10 ± 0.79
BAFMD (%)	6.85 ± 2.86	7.2 ± 3.12	10.75 ± 2.38	10.35 ± 2.76

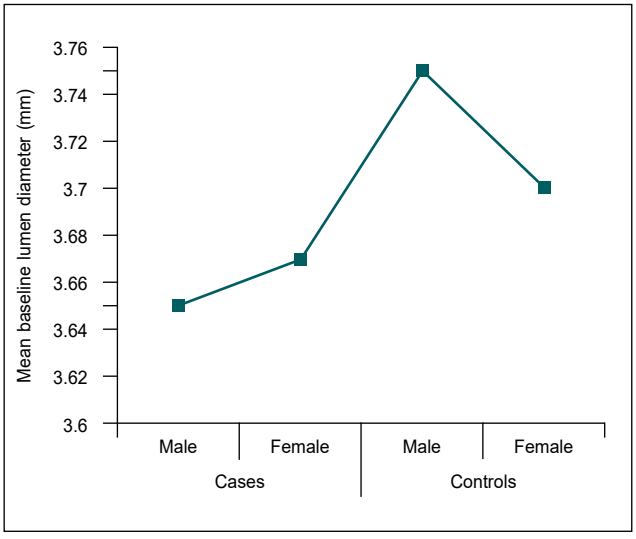

Figure 2. Mean baseline lumen diameter in study population.

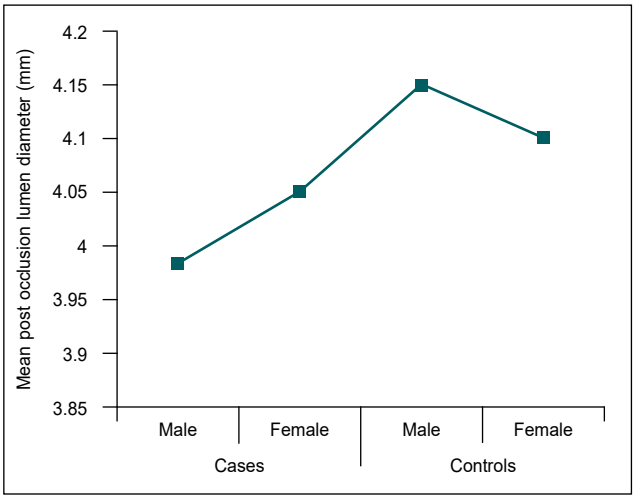

Figure 3. Mean post occlusion lumen diameter in study population.

Mean FMD was insignificantly higher among males (7.05 ± 2.55) compared to females (7 ± 3.38) (p = 0.87), whereas microalbuminuria was significantly higher among females (20 [25%]) compared to males (11 [13.8%]) (p = 0.039) in relation to smoking (Table 7).

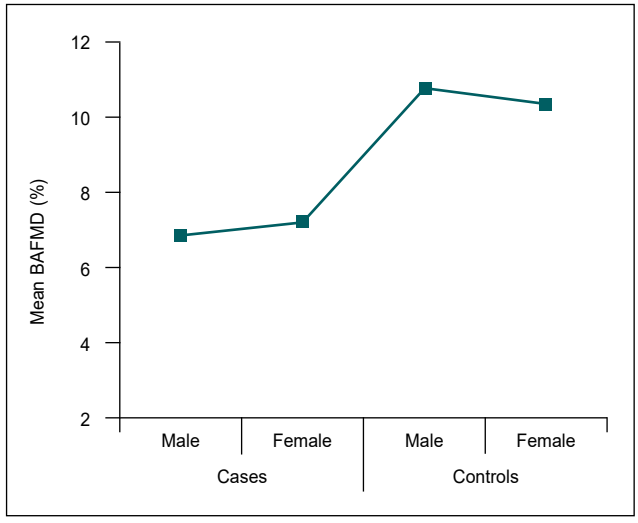

Figure 4. Mean BAFMD (%) in study population.

Table 4. Distribution of Subjects According to Microalbuminuria Levels

Microalbuminuria	Cases		Controls	
	Male	Female	Male	Female
Normal (<30)	20 (25)	29 (36.2)	20 (50)	20 (50)
Abnormal (>30)	20 (25)	11 (13.8)	0 (0)	0 (0)

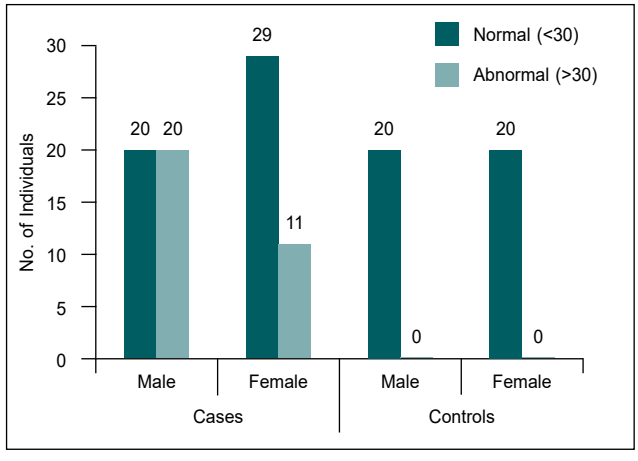

Figure 5. Distribution according to microalbuminuria.

Table 5. Comparison Between Cases and Controls

Variable	N	Mean	SD	P value
BMI				
Case	80	26.08	2.79	0.031*
Control	40	22.68	2.25	
TC				
Case	80	173.76	29.03	<0.001*
Control	40	162.77	6.19	
HDL-C				
Case	80	44.95	5.88	0.056
Control	40	44.08	28.83	
TG level				
Case	80	119.25	32.06	<0.001*
Control	40	97.58	23.50	
LDL-C				
Case	80	104.95	24.73	<0.001*
Control	40	97.57	16.25	
Microalbuminuria (ACR)				
Case	80	27.44	38.86	<0.001*
Control	40	3.73	0.68	
FMD %				
Case	80	7.04	2.173	<0.001*
Control	40	10.61	1.19	

*Significant

BMI = Body mass index; TC = Total cholesterol; HDL-C = High-density lipoprotein cholesterol; TG = Triglyceride; LDL-C = Low-density lipoprotein cholesterol; ACR = Albumin-to-creatinine ratio; FMD = Flow-mediated dilatation; N = Number; SD = Standard deviation.

Table 6. Relation of BAFMD and Microalbuminuria with Age in Cases

Age	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
30-35	9.2	3.09	6 (7.5)	0
36-40	9.27	3.54	12 (15)	8 (10)
41-45	8.03	2.7	10 (12.5)	10 (12.5)
46-50	7.1	3.27	21 (26.2)	13 (16.2)
P value	0.001*		0.52	

The FMD % showed a secular and significant decrease in mean value in the progressively higher JNC VII stages of hypertension with computed p value of 0.038 (Table 8 and Fig. 8). The prevalence of microalbuminuria

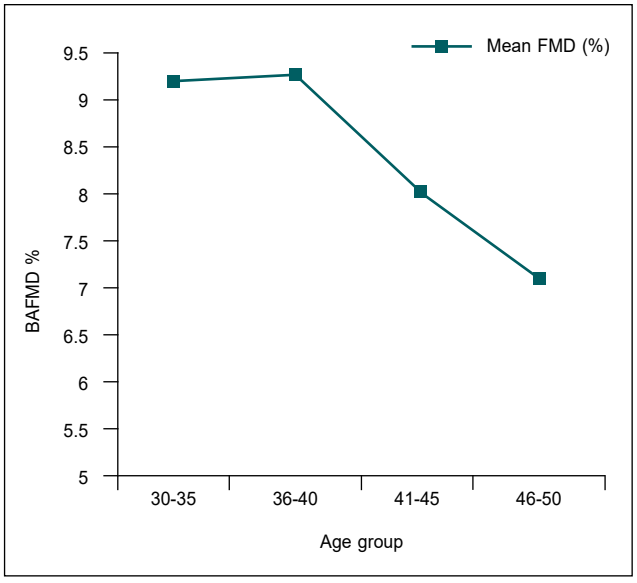

Figure 6. Age and BAFMD %.

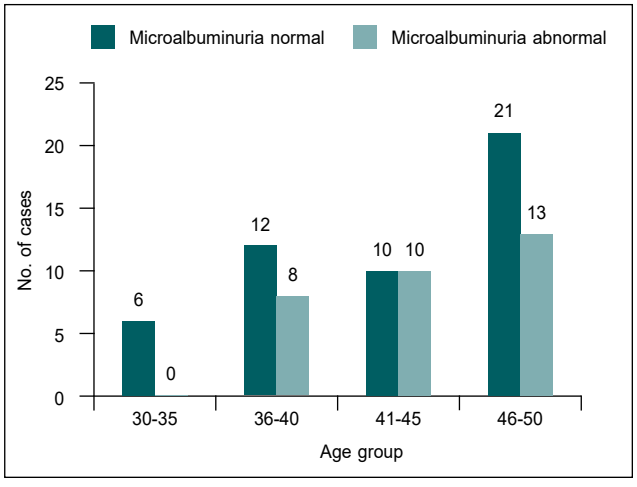

Figure 7. Age and microalbuminuria.

Table 7. Relation of BAFMD and Microalbuminuria with Smoking Habit in Cases

Smoking habit	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
Male	7.05	2.55	20 (25)	20 (25)
Female	7	3.38	29 (36.2)	11 (13.8)
P value	0.87		0.039*	

was higher in Stage 2 HTN than Stage 1 HTN, with a significant p value of 0.009 (Table 8).

Mean FMD was significantly lower in patients with abnormal SBP (>140 mmHg) compared to normal SBP (Table 9 and Fig. 9). Microalbuminuria was significantly

Table 8. Relation of BAFMD and Microalbuminuria with Stage of Hypertension in Cases

Blood pressure (mmHg)	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
Normal	10.61	3.72	0 (0)	0 (0)
Prehypertension	8.73	3.55	0 (0)	0 (0)
Stage 1 HTN	7.53	2.81	34 (42.5)	12 (15)
Stage 2 HTN	6.58	2.91	20 (25)	14 (17.5)
P value	0.038*		0.009*	

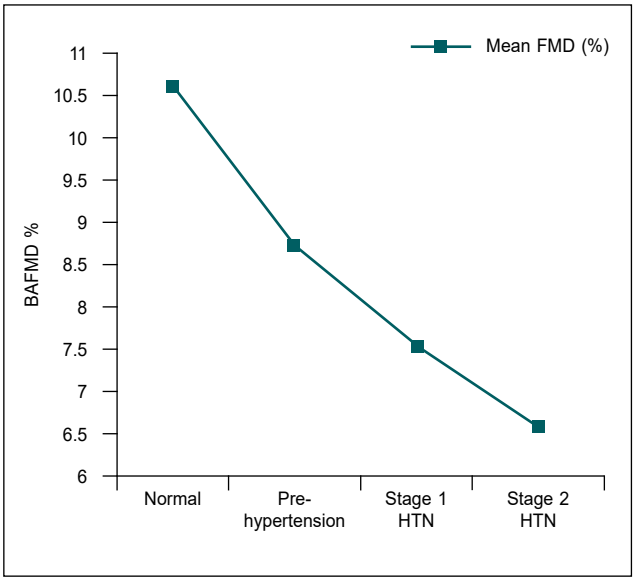

Figure 8. Stage of hypertension and BAFMD %.

Table 9. Relation of BAFMD and Microalbuminuria with SBP in Cases

SBP	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
Normal (<140)	8	2.91	12 (15)	1 (1.2)
Abnormal (>140)	6.84	2.97	37 (46.2)	30 (37.5)
P value	0.002*		0.001*	

higher in patients with abnormal SBP (p = 0.001) (Table 9).

Mean FMD was significantly lower in patients with abnormal DBP (>90 mmHg) compared to normal DBP (p = 0.027) (Table 10 and Fig. 10). Also, microalbuminuria was significantly higher in patients with abnormal DBP (p = 0.005) (Table 10).

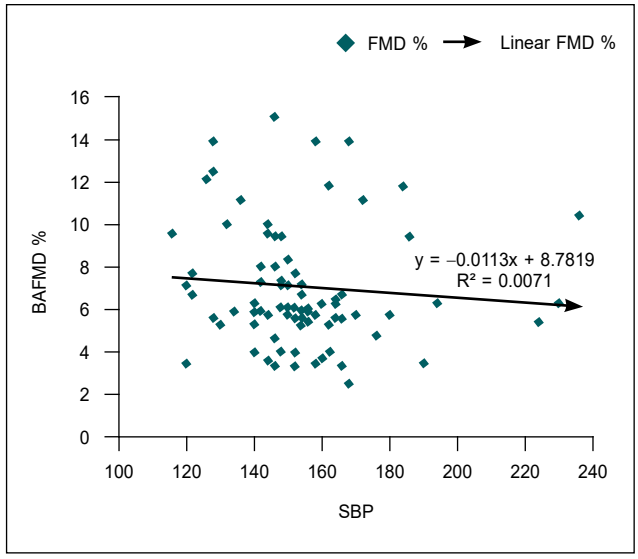

Figure 9. Systolic blood pressure and BAFMD %.

Table 10. Relation of BAFMD and Microalbuminuria with DBP in Cases

DBP	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
Normal (<90)	7.27	2.99	36 (45)	13 (16.2)
Abnormal (>90)	6.65	2.96	13 (16.2)	18 (22.5)
P value	0.027*		0.005*	

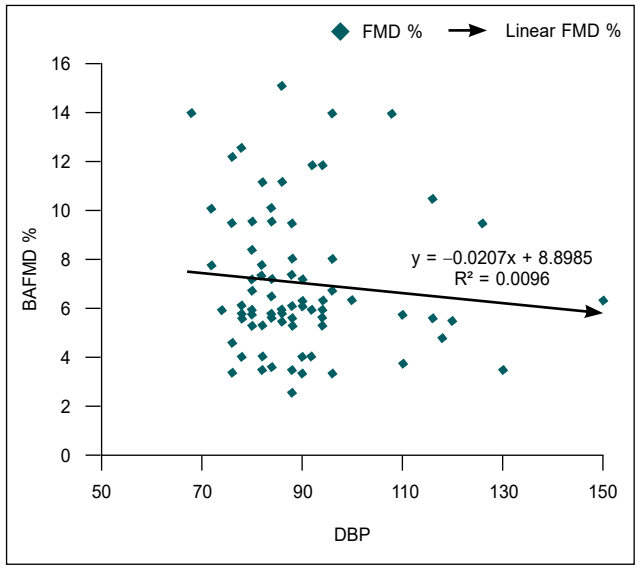

Figure 10. Diastolic blood pressure and FMD %.

Mean % FMD was significantly lower in patients with longer history of hypertension compared to patients with no history of hypertension (p = 0.022) (Table 11 and Fig. 11). The most precipitous dip in mean %

Table 11. Relation of BAFMD and Microalbuminuria with Duration of Hypertension

Duration of hypertension	FMD (%)		Microalbuminuria	
	Mean	SD	Normal	Abnormal
No history of hypertension (control group)	10.55	2.55	40 (100)	0
1 year	6.89	2.91	33 (41.25)	10 (12.5)
1-3 years	7.8	3.51	10 (12.5)	5 (6.25)
3-5 years	7.36	2.76	5 (6.25)	9 (11.25)
5-7 years	4.5	1.29	0 (0)	4 (5)
>7 years	3.91	1.01	1 (1.25)	3 (3.75)
P value	0.022*		0.036*	

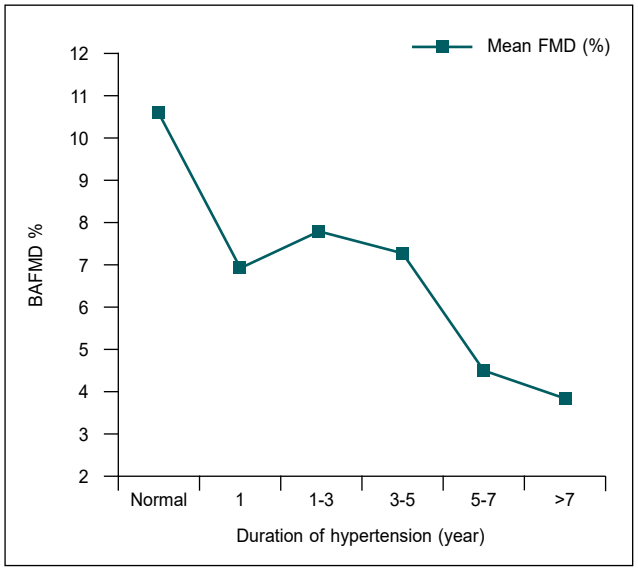

Figure 11. Duration of hypertension and FMD %.

BAFMD value in hypertensives occurred when the duration of hypertension exceeded 5 years. Similarly, the tendency for abnormal levels of microalbuminuria was significantly higher in patients with longer hypertensive history (p = 0.036) (Table 11).

When multiple cardiovascular risk factors (hypertension, dyslipidemia, smoking and obesity) were combined, it was noted that the cases tended to have a progressively lower mean % FMD and a higher mean level of microalbuminuria as the number of risk factors increased (Table 12; Figs. 12 and 13). In the case of % FMD, the decreasing trend was more or less secular in nature, with the most precipitous fall in % FMD value occurring when smoking was added as a risk factor. When the

Table 12. Impact of Various Risk Factors on BAFMD and Microalbuminuria

Risk factors	N	Mean FMD (%)	Mean level of microalbuminuria
Hypertension	80	7.03 ± 2.98	27.12 ± 38.58
Dyslipidemia	45	7.13 ± 2.96	67.49± 72.61
Smoking	23	7.06 ± 2.99	85.01 ± 71.23
Obesity	46	7.09 ± 2.89	56.23 ± 69.83
HTN + Obesity	46	7.09 ± 2.89	62.95 ± 69.83
HTN + Dyslipidemia	45	7.01 ± 2.97	73.82 ± 68.59
HTN + Smoking	23	7.06 ± 2.99	94.76 ± 71.23
HTN + Dyslipidemia + Obesity	25	7.05 ± 2.08	83.51 ± 70.12
HTN + Obesity + Smoking	13	5.78 ± 2.13	106.47 ± 75.88
HTN + Smoking + Dyslipidemia	10	5.69 ± 2.14	105.428 ± 69.87
HTN + Dyslipidemia + Obesity + Smoking	5	4.85 ± 1.89	103.74 ± 88.52

trend of mean levels of microalbuminuria was plotted, the trend showed general increase in the mean levels of microalbuminuria, and peaked at the points where smoking was added as risk factor.

Mean % FMD was lower in patients with microalbuminuria compared to those with normal values and this was statistically verified (Table 13 and Fig. 14), with p = 0.016, thereby verifying the central hypothesis of this study.

DISCUSSION

Our core question was whether hypertension related endothelial dysfunction detected in peripheral circulation by high frequency ultrasound measurement of BAFMD independently favors the progressive loss of albumin through urine, which shall be an indicator of early hypertensive renal disease. Moreover, we have also outlined the various cardiovascular determinants of BAFMD and microalbuminuria.

The present study limited the age of the participants within 30-50 years, with a deliberate intent of avoiding the confounding influence that age has been demonstrated to have on endothelial function. In spite of this, BAFMD showed a significant decline moving

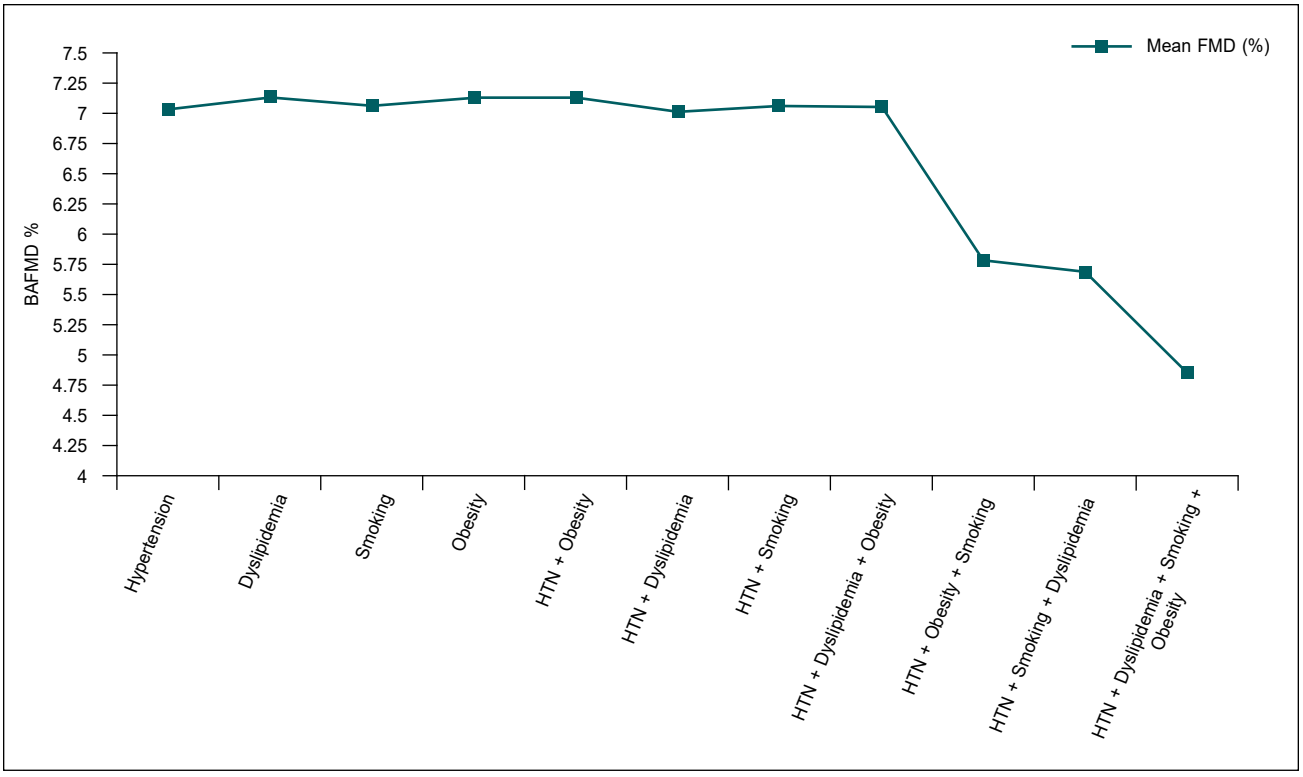

Figure 12. Combination of cardiovascular risk factors and BAFMD %.

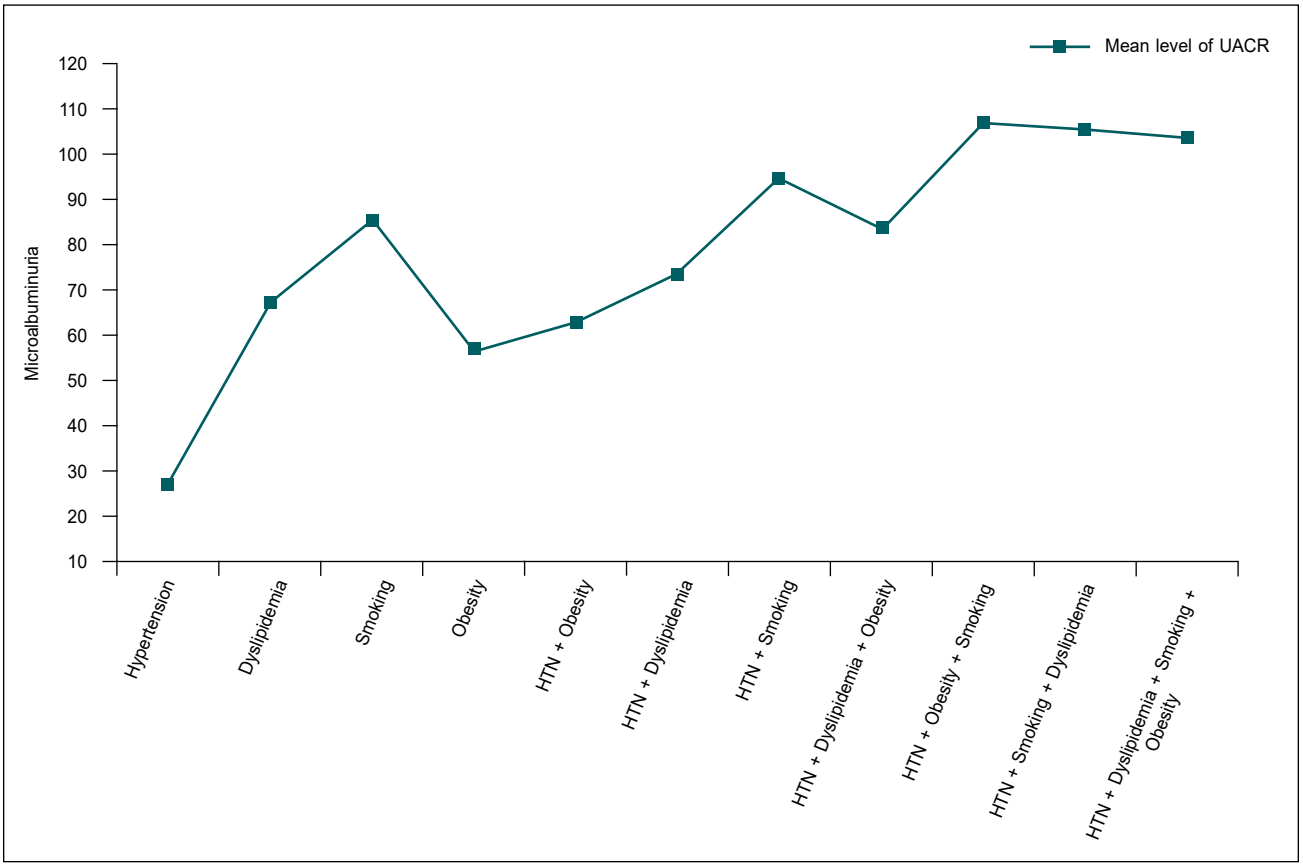

Figure 13. Combination of cardiovascular risk factors and microalbuminuria.

Table 13. Relationship of BAFMD and Microalbuminuria in Cases

Microalbuminuria	FMD %	
	Mean	SD
Normal	7.69	3.001
Abnormal	5.97	2.664
P value	0.016*	

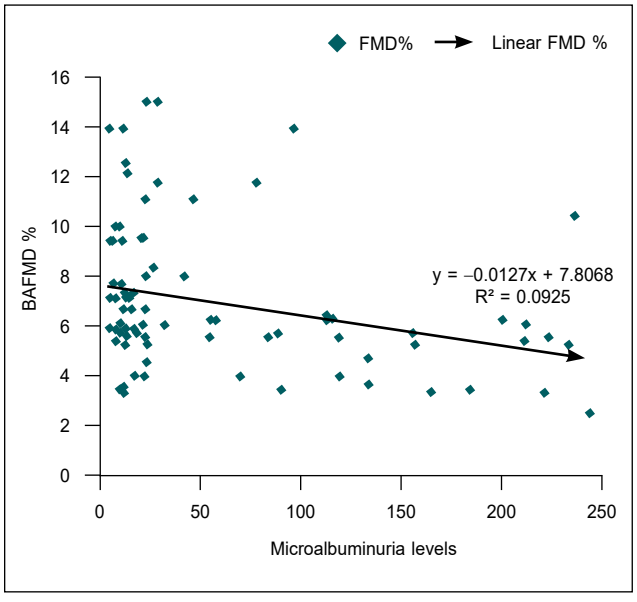

Figure 14. Microalbuminuria and BAFMD %.

towards the higher age groups, with a precipitous decline occurring at the 45 age cut-off. This trend across the age groups was statistically verified with a 'p' value = 0.001.

The number of males and females were equally distributed within the case and control group for comparability purposes. The prevalence of microalbuminuria reported by Sabharwal et al in males and females was found to be 34% and 30.7%, respectively.[4] In the present study, microalbuminuria was significantly higher among females (25%) compared to males (13.8%) (p = 0.039). Although various pathophysiological mechanisms have been propounded for this observation, it has to be pointed out that this may also reflect a certain fallacy arising in the nature of measurement of microalbuminuria, i.e., UACR. Urinary creatinine is a reflection of the overall body muscle mass and its metabolism, i.e., individuals with more muscle bulk tend to excrete higher levels of creatinine. In the measurement of UACR, as creatinine is placed in the denomination, and with middle-aged Indian females tending to have a decreased muscle bulk than their male counterparts, a higher UACR may be observed in females due to this inherent flaw.

Yang et al[5] studied the relationship of several cardiovascular risk factors (CVRF) to BAFMD in Chinese subjects and reported that according to multivariate analysis, negative FMD correlated with age ($\beta = -0.29$, $p < 0.001$), gender ($\beta = -0.12$, $p < 0.001$), BMI ($\beta = -0.12$, $p = 0.001$), waist circumference (WC) ($\beta = -0.10$, $p = 0.011$), SBP ($\beta = -0.12$, $p < 0.001$), fasting glucose ($\beta = -0.04$, $p = 0.009$), TC ($\beta = -0.04$, $p = 0.014$), smoking ($\beta = -0.05$, $p = 0.003$) and baseline brachial artery diameter ($\beta = -0.35$, $p < 0.001$). FMD decreased with increasing age in both genders. In women, FMD was higher than men and age-related decline in FMD was steepest after age 40; FMD was similar in men above 55 years old. In the present study, FMD was significantly different across the age groups (p = 0.001), lower among smokers (5.73 ± 2.69), higher among male (7.05 ± 2.55) compared to female (7 ± 3.38) (p = 0.87), lower in obese Grade I patients (7.16 ± 2.73) compared to obese Grade II (7.38 ± 2.72) and overweight (8.35 ± 3.37) (p = 0.007), lower in patients with Stage 2 HTN (6.58 ± 2.91) compared to Stage 1 HTN (7.53 ± 2.81) and prehypertension (8.73 ± 3.35) (p = 0.038), lower in patients with abnormal TC (>200 mg/dL), significantly lower in patients with abnormal TG (>150 mg/dL) compared to normal TC (p = 0.047) and significantly lower in patients with abnormal baseline diameter (>5) compared to normal baseline diameter ($p < 0.001$).

Multivariate analyses resulted in different conclusions. Schnabel et al noted that FMD was associated with age, sex, BMI, SBP, DBP, TC, HDL-C, TG, C-reactive protein, hypertension, hypertension treatment and dyslipidemia, whereas Philpott et al. argued FMD was only associated with SBP.[6,7] Although Mizia-Stec et al agreed FMD was associated with CVRF, he insisted that such correlations were limited among populations at high risk of cardiovascular disease.[8]

As observed in the current study, FMD was correlated with the traditional CVRFs including BP, blood lipid, obesity and smoking, in particular the baseline brachial artery diameter; however, it was not correlated with serum creatinine and uric acid. In our study, we further listed dyslipidemia, hypertension and smoking as the major risk factors. Grouping based on the number of risk factors showed that the FMD value declined along with the increase of the number of risk factors which means lower FMD was recorded in patients with multiple risk factors.

In the study by Yang et al, women had higher FMD values than men, which was consistent with a previous study,[9] suggesting the endothelial function is better in women than in men.[5,10] Contrary to these, in the present study, FMD was comparable between males (7.05 ± 2.55) and females (7 ± 3.38) (p = 0.87).

Gupta et al assessed the various factors affecting endothelial function in essential hypertensives and reported that endothelial dysfunction was significantly more quantified in Stage 2 HTN as compared with Stage 1 HTN (p < 0.01).[11] Similar to that, in our study, mean FMD was lower in patients with Stage 2 HTN (6.58 ± 2.91) compared to Stage 1 HTN (7.53 ± 2.81) and prehypertension (8.73 ± 3.35) (p = 0.038). Shimbo et al examined the cross-sectional and longitudinal relationships between endothelial dependent BAFMD and hypertension prevalence and incidence in 3,500 participants from the Multi-Ethnic Study of Atherosclerosis (MESA) and reported that reduced FMD was not an independent predictor of hypertension incidence, suggesting that impaired endothelial function does not play a major role in the development of hypertension.[12] Contrary to Shimbo et al, in the present study, FMD significantly decreased as we progressed to the higher stages of hypertension.

Mean FMD was significantly lower in patients with Stage 2 HTN (6.85 ± 2.91) compared to Stage 1 HTN (7.53 ± 2.81), prehypertension (8.73 ± 3.35) (p = 0.038) and the normotensive controls (10.61 ± 3.72). Whereas microalbuminuria was significantly distributed across the hypertensive ranges (p = 0.009). Mean FMD was significantly lower in patients with abnormal SBP (>140 mmHg) compared to normal BP, whereas microalbuminuria was significantly higher in patients with abnormal SBP (p = 0.001). Mean FMD was significantly lower in patients with abnormal DBP (>90 mmHg) compared to normal BP (p = 0.027), whereas abnormal microalbuminuria was significantly higher in patients with abnormal DBP (p = 0.005). Stehouwer et al concluded that both in nondiabetic and diabetic subjects, microalbuminuria is associated with an increased cardiovascular risk, independent of known risk determinants. As such, microalbuminuria is potentially useful for improved cardiovascular risk stratification.[13] Dinneen and Gerstein,[14] in a systematic review, showed microalbuminuria among individuals with type 2 diabetes to be associated with a 2.4-fold (95% confidence interval [CI] 1.8-3.1) increased risk for cardiovascular death as compared with normoalbuminuria. In addition, similar associations exist in hypertensive individuals (without diabetes) and in the general population.[15]

In the present study, mean FMD was lower in patients with abnormal microalbuminuria compared to normal (p = 0.016). Yokoyama et[16] measured FMD, carotid intima-media thickness (IMT) and pulse-wave velocity (PWV) in 158 subjects with type 2 diabetes (normo- 49, micro- 64, macroalbuminuria 45), explored the determinants of FMD and analyzed the relationship of FMD with traditional cardiovascular risk factors according to IMT and PWV levels.

They reported that microalbuminuria was significantly associated with lower FMD, higher IMT and higher PWV compared to normoalbuminuria (p < 0.001 for all). FMD was significantly correlated with IMT and PWV, and also with traditional risk factors, urinary albumin excretion (UAE), glomerular filtration rate, diabetic retinopathy and neuropathy. Multivariate regression analysis revealed that UAE remained a significant determinant of FMD independent of traditional risk factors, metabolic control and renal function. The relationship of FMD with IMT and PWV was less pronounced in subjects with increased IMT and PWV.[16] A report of Foster et al showed that microalbuminuria was associated with decreased hyperemic mean flow (47.2 ± 1.4 vs. 51.4 ± 0.5 mg/g, p = 0.005), but the association was not significant after multivariable adjustment (p = 0.09).[2] In agreement to this, in the present study, mean FMD was lower in patients with microalbuminuria compared to those with normal values (p = 0.016).

CONCLUSION

Traditional cardiovascular risk factors were significantly associated with both BAFMD and microalbuminuria. BAFMD had a significant inverse relationship with age (0.001), smoking (0.009), BMI (0.007), higher JNC VII stage of hypertension (0.038), duration of hypertension (0.002), SBP (0.027), DBP (0.022), abnormal TG levels (0.047) and a positive relationship with baseline diameter (<0.001).

Microalbuminuria was positively associated with female gender (0.039), smoking (0.001), stage of hypertension (0.009), duration of dypertension (0.001), SBP (0.005), DBP (0.036), abnormal TG levels (0.037), abnormal LDL-C levels (0.001).

Combination of more than one cardiovascular risk factor produced lower mean levels of BAFMD and higher levels of UAE.

BAFMD and microalbuminuria were significantly associated and the relationship was inverse in nature.

Based on the observations of the study, we can infer that:

- Both BAFMD as well as microalbuminuria can be used as surrogate markers in assessing increasing cardiovascular risk.
- BAFMD can be used as an effective tool to detect early hypertensive target organ damage, especially to the kidney.
- Hypertensive patients should be advised to maintain a within normal limit BMI.
- Effective therapeutic control of hypertension to prevent progress to higher stages of hypertension can prevent target organ damage.
- Hypertensive patients should be advised to cease smoking.
- Aggressive pursuit of target organ damage should be done in hypertensives, especially if the duration of hypertension exceeds 5 years.

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Every citizen of India should have the right to accessible, affordable, quality and safe heart care irrespective of his/her economical background

HEART CARE FOUNDATION OF INDIA
A Not-For-Profit Organisation

Sameer Malik Heart Care Foundation Fund

An Initiative of Heart Care Foundation of India

E-219, Greater Kailash, Part I, New Delhi - 110048 E-mail: heartcarefoundationfund@gmail.com Helpline Number: +91 - 9958771177

"No one should die of heart disease just because he/she cannot afford it"

About Sameer Malik Heart Care Foundation Fund

"Sameer Malik Heart Care Foundation Fund" it is an initiative of the Heart Care Foundation of India created with an objective to cater to the heart care needs of people.

Objectives

- Assist heart patients belonging to economically weaker sections of the society in getting affordable and quality treatment.
- Raise awareness about the fundamental right of individuals to medical treatment irrespective of their religion or economical background.
- Sensitize the central and state government about the need for a National Cardiovascular Disease Control Program.
- Encourage and involve key stakeholders such as other NGOs, private institutions and individual to help reduce the number of deaths due to heart disease in the country.
- To promote heart care research in India.
- To promote and train hands-only CPR.

Activities of the Fund

Financial Assistance

Financial assistance is given to eligible non emergent heart patients. Apart from its own resources, the fund raises money through donations, aid from individuals, organizations, professional bodies, associations and other philanthropic organizations, etc.

After the sanction of grant, the fund members facilitate the patient in getting his/her heart intervention done at state of art heart hospitals in Delhi NCR like Medanta – The Medicity, National Heart Institute, All India Institute of Medical Sciences (AIIMS), RML Hospital, GB Pant Hospital, Jaipur Golden Hospital, etc. The money is transferred directly to the concerned hospital where surgery is to be done.

Drug Subsidy

The HCFI Fund has tied up with Helpline Pharmacy in Delhi to facilitate patients with medicines at highly discounted rates (up to 50%) post surgery.

The HCFI Fund has also tied up for providing up to 50% discount on imaging (CT, MR, CT angiography, etc.)

Who is Eligible?

All heart patients who need pacemakers, valve replacement, bypass surgery, surgery for congenital heart diseases, etc. are eligible to apply for assistance from the Fund. The Application form can be downloaded from the website of the Fund. http://heartcarefoundationfund.heartcarefoundation.org and submitted in the HCFI Fund office.

Important Notes

- The patient must be a citizen of India with valid Voter ID Card/ Aadhaar Card/Driving License.
- The patient must be needy and underprivileged, to be assessed by Fund Committee.
- The HCFI Fund reserves the right to accept/reject any application for financial assistance without assigning any reasons thereof.
- The review of applications may take 4-6 weeks.
- All applications are judged on merit by a Medical Advisory Board who meet every Tuesday and decide on the acceptance/rejection of applications.
- The HCFI Fund is not responsible for failure of treatment/death of patient during or after the treatment has been rendered to the patient at designated hospitals.
- The HCFI Fund reserves the right to advise/direct the beneficiary to the designated hospital for the treatment.
- The financial assistance granted will be given directly to the treating hospital/medical center.
- The HCFI Fund has the right to print/publish/webcast/web post details of the patient including photos, and other details. (Under taking needs to be given to the HCFI Fund to publish the medical details so that more people can be benefitted).
- The HCFI Fund does not provide assistance for any emergent heart interventions.

Check List of Documents to be Submitted with Application Form

- Passport size photo of the patient and the family
- A copy of medical records
- Identity proof with proof of residence
- Income proof (preferably given by SDM)
- BPL Card (If Card holder)
- Details of financial assistance taken/applied from other sources (Prime Minister's Relief Fund, National Illness Assistance Fund Ministry of Health Govt of India, Rotary Relief Fund, Delhi Arogya Kosh, Delhi Arogya Nidhi), etc., if anyone.

Free Diagnostic Facility

The Fund has installed the latest State-of-the-Art 3 D Color Doppler EPIQ 7C Philips at E – 219, Greater Kailash, Part 1, New Delhi.
This machine is used to screen children and adult patients for any heart disease.

Free Education and Employment Facility

HCFI has tied up with a leading educational institution and an export house in Delhi NCR to adopt and to provide free education and employment opportunities to needy heart patients post surgery. Girls and women will be preferred.

Laboratory Subsidy

HCFI has also tied up with leading laboratories in Delhi to give up to 50% discounts on all pathological lab tests.

Help Us to Save Lives

The Foundation seeks support, donations and contributions from individuals, organizations and establishments both private and governmental in its endeavor to reduce the number of deaths due to heart disease in the country. All donations made towards the Heart Care Foundation Fund are exempted from tax under Section 80 G of the IT Act (1961) within India. The Fund is also eligible for overseas donations under FCRA Registration (Reg. No 231650979). The objectives and activities of the trust are charitable within the meaning of 2 (15) of the IT Act 1961.

Donate Now...

About Heart Care Foundation of India

Heart Care Foundation of India was founded in 1986 as a National Charitable Trust with the basic objective of creating awareness about all aspects of health for people from all walks of life incorporating all pathies using low-cost infotainment modules under one roof.

HCFI is the only NGO in the country on whose community-based health awareness events, the Government of India has released two commemorative national stamps (Rs 1 in 1991 on Run For The Heart and Rs 6.50 in 1993 on Heart Care Festival- First Perfect Health Mela). In February 2012, Government of Rajasthan also released one Cancellation stamp for organizing the first mega health camp at Ajmer.

Objectives

- Preventive Health Care Education
- Perfect Health Mela
- Providing Financial Support for Heart Care Interventions
- Reversal of Sudden Cardiac Death Through CPR-10 Training Workshops
- Research in Heart Care

Heart Care Foundation Blood Donation Camps

The Heart Care Foundation organizes regular blood donation camps. The blood collected is used for patients undergoing heart surgeries in various institutions across Delhi.

Committee Members

Chief Patron

Raghu Kataria

Entrepreneur

President

Dr KK Aggarwal

Padma Shri, Dr BC Roy National & DST National Science Communication Awardee

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Vishnu Sureka
Rishab Soni

This Fund is dedicated to the memory of **Sameer Malik** who was an unfortunate victim of sudden cardiac death at a young age.

- HCFI has associated with Shree Cement Ltd. for newspaper and outdoor publicity campaign
- HCFI also provides Free ambulance services for adopted heart patients
- HCFI has also tied up with Manav Ashray to provide free/highly subsidized accommodation to heart patients & their families visiting Delhi for treatment.

http://heartcarefoundationfund.heartcarefoundation.org