Section: Radiodiagnosis

Original Research Article

TO ASSESS THE ASSOCIATION OF CAROTID INTIMA MEDIA THICKNESS TO ESTIMATED GLOMERULAR FILTRATION AS A RISK MARKER FOR CARDIOVASCULAR DISEASE IN CHRONIC KIDNEY DISEASE PATIENTS

Tarun Narang[1], Laxman Yadav[2], Vikram Kala[3], Shweta[4]

[1]Associate Professor, Department of Radiodiagnosis, BPS GMC Khanpur Kalan Sonipat, India.
[2]Laxman Yadav, SR Department of medicine BPS GMC Khanpur Kalan Sonipat, India.
[3]Professor Department of medicine BPS GMC Khanpur Kalan Sonipat, India.
[4]Professor Department of physiology NC MCH Israna, India.

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Corresponding Author:
Dr. Tarun Narang,
Email: tarunnarang24@gmail.com

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Abstract

Background: Patients with chronic kidney disease (CKD) have increased risk of cardiovascular events. However, the association of glomerular filtration rate (GFR) and carotid intima-media thickness (CIMT) in non-diabetic CKD patients is under-investigated. Aim: To assess the association of carotid intima media thickness to estimated glomerular filtration as a risk marker for cardiovascular disease in chronic kidney disease patients. **Material and Methods:** Adults males and female and patients diagnosed by NKF KDOQI were included in the study. Anthropometry, Complete blood count and Lipid profile, Blood sugar and Carotid Intima Media Thickness GFR were calculated. **Results:** It was observed that age of the patient (positive correlation, r=0.422, p value < 0.01) and eGFR (inverse correlation, r=-0.613, p value < 0.01) had a significant correlation with mean CIMT. Other variables like BMI, HbA1c, LDL and serum cholesterol were not significantly correlated with mean CIMT. **Conclusion:** we conclude that Mean CIMT had a significant positive correlation with age of the patients. Mean CIMT had a significant inverse correlation with eGFR. Mean CIMT did not have a significant correlation with BMI, HbA1c, LDL and serum cholesterol.

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality among patients with CKD. Even after adjustment for known CAD risk factors, including diabetes and hypertension, mortality risk progressively increases with worsening CKD.[1] As glomerular filtration rate (GFR) declines below 60 to 75 ml/min/1.73 m2, the probability of developing CAD increases linearly, and patients with CKD stages G3a to G4 (15-60 ml/min/1.73 m2) have approximately double and triple the CVD mortality risk, respectively, relative to patients without CKD. As GFR declines, the prevalence of clinical manifestations of CAD increases, in parallel with the prevalence of large-vessel coronary disease, arteriosclerosis, microvascular disease, LVH, and myocardial fibrosis.[2] Cardiovascular abnormalities in CKD are associated with traditional (e.g., diabetes and hypertension) and nontraditional CKD-related CVD risk factors (e.g., mineral and bone disease abnormalities, anemia, inflammation, and oxidative stress), as well as dialysis-related factors (type and frequency of dialysis and dialysate composition). Vascular calcification also increases as GFR declines and is associated with mortality in ESKD; calcification of the subintima and media of large vessels are both associated with all-cause and cardiovascular mortality. There have been different views regarding the mechanism of calcium deposition in atherosclerotic plaques. Some initial theories suggest that calcification results from passive adsorption of Gla-containing proteins with a high affinity for calcium phosphate and hydroxyapatite, whose only known function is to bind calcium.[3] This seems unlikely in light of the fact that calcification occurs in only those vessels with atherosclerosis and is absent in normal arteries. Other evidence suggests that coronary calcification is an actively regulated process rather than passive adsorption and precipitation. In fact, several intriguing similarities have been noted between coronary calcification and bone formation.[4]

Carotid intima-media thickness (CIMT) is a simple and inexpensive tool to assess the cumulative effect of atherosclerotic risk factors and is an independent predictor of future cardiovascular (CV) risk.[5] CIMT is a measure of the thickness of the intima and media

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layer of the carotid artery most commonly assessed by B-mode ultrasound. CIMT is commonly used as a surrogate end point in research trials as a marker of atherosclerosis.[6] More important from a clinical perspective, CIMT has been shown to correlate with cardiac risk factors,6 to improve with therapy of known benefit in preventing atherosclerotic events,[7] and to be an independent predictor of future myocardial infarction and stroke risk. As the renowned physician William Osler noted, "We are as old as our arteries."[8] This statement rings especially true today, with CV disease being the leading cause of mortality in the developed world. Tests for subclinical atherosclerosis, such as CIMT, will help clinicians to more effectively identify the vulnerable patient who would benefit from aggressive prevention intervention.

Measuring common carotid arteries, IMT, as opposed to a more detailed carotid Doppler study, is a reliable method to detect the severity of atherosclerosis.[9] It is also related to systemic generalized atherosclerosis.[10] Carotid Doppler studies are used to assess intimal- medial thickness, plaque presence, degree of stenosis, and calcification. It can be used to determine the efficacy of interventions which are aimed to reduce the risk of development of cardiovascular events.

MATERIALS AND METHODS

This is an observational cross-sectional study conducted in the Department of General Medicine of Bhagat Phool Singh Government Medical College for Women, Khanpur Kalan, Sonipat, Haryana with a duration of 18 months (June 2019 till May 2020). Adults (aged more than 18 years) males and female and patients diagnosed by NKF KDOQI (National Kidney Foundation Kidney Disease Outcomes Quality Initiative) were included in the study. Patients with Ischemic Heart Disease (as per history and ECG findings), patients with history of Cerebrovascular event (CVA), patients with transient ischemic attack (TIA) and patients on Lipid lowering drugs were excluded from this study. The study protocol conforms to the Declaration of Helsinki and was approved by the Institutional Ethics Committee before commencement. Written informed consent was taken from all patients. No harm is intended for the subjects. A prick pain was experienced during the withdrawal of the blood sample. The same was explained to the participants before consenting. The participants were not subjected to any extra cost because of the study.

Methodology

Data were collected using a pre-designed semi-structured study proforma. Detailed demographic, clinical, past medical history, comorbidities, personal history and medication history was noted for all patients. The findings of general and systemic physical examination were noted as well. Blood pressure was measured with a standard mercury sphygmomanometer after the subject had been seated for at least 5 min. Hypertension was defined as a systolic blood pressure >140 mmHg, a diastolic blood pressure >90 mmHg, and/or the use of antihypertensive medication in accordance with JNC VII criteria. The following investigations were sent for the patients:

Anthropometry, Complete blood count and Lipid profile, Blood sugar and Carotid Intima Media Thickness GFR was calculated.[11-14]

Statistical Analysis:

The analysis included profiling of patients on different demographic, laboratory and clinical parameters. Patients were divided according to increased CIMT and those with normal CIMT. Cross tables were generated and chi square test was used for testing of associations. Student t test was used for comparison of quantitative parameters. P-value < 0.05 is considered statistically significant. All analysis was done using SPSS software, version 24.0.

RESULTS

In the present study, 110 patients were included. Mean CIMT in the right and left was found to be 0.86 ± 0.15 mm and 0.85 ± 0.14 mm. Mean CIMT was 0.85 ± 0.14 mm.

We observed that mean CIMT was increased in 57.3% of the patients.

It was observed that patients with increased CIMT were significantly older as compared to those with normal CIMT. Mean age of patients with increased CIMT was 56.6 ± 13.06 years, which was significantly higher as compared to those with normal CIMT (47.51± 14.3 years), p value < 0.05.

It was observed that 57.3% of the patients were males. We observed that increase in CIMT was not significantly associated with gender of the patient (p value = 0.65). In our study population, 26.4% had hypertension and 25.4% had diabetes mellitus. Increased CIMT was not significantly associated with either diabetes mellitus or hypertension. We observed that 14.5% had a history of smoking and 14.5% had a history of alcohol consumption. Neither smoking nor alcohol consumption were found to be significantly associated with increase in CIMT. Family history of hyperlipidemia was not significantly associated with increased CIMT in our study population (p value = 0.18).

We observed mean systolic and diastolic blood pressures were similar between patients with and without increased CIMT. In patients with increased CIMT, mean systolic blood pressure was 124.7 ± 20.09 mm Hg and mean diastolic blood pressure was 81.21 ± 15.9 mm Hg. In patients with normal CIMT, mean systolic blood pressure was 126.02± 19.09 mm Hg and mean diastolic blood pressure was 81.51 ± 15.09 mm Hg. Thus, systolic as well as diastolic blood pressures were not significantly associated with increased CIMT. It was observed that mean BMI of patients with and without increased CIMT was

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23.2 ± 2.65 and 23.17 ± 2.5 kg/m2, with no significant difference between them (p value = 0.94). We observed that patients with increased mean CIMT, BUN (69.18 ± 34.78 vs 46.64± 22.24 mg/dl, p value < 0.01) and serum creatinine (3.50 ± 2.38 vs 1.89 ± 1.04 mg/dl, p value < 0.01) were significantly higher as compared to those with normal CIMT. Serum uric acid, serum calcium and phosphorous levels were not significantly different between the two groups of patients. It was observed that mean HbA1c and fasting blood sugar were not associated with increased mean CIMT. Mean HbA1c was 5.91 ± 2.13% and 5.69 ± 1.96% in patients with increased and normal CIMT respectively (p value = 0.57). Similarly, mean fasting blood sugar was also found to be 113.33.7 mg/dl and 111.72 ± 35.09 mg/dl in patients with increased and normal CIMT respectively (p value = 0.84). Mean serum albumin levels were 3.4 ± 0.49 in both the groups of patients. Thus, serum albumin was not found to be significantly associated with increased CIMT (p value = 0.95). It was observed that serum cholesterol (150.89 ± 68.17 vs 155.89 ± 56.39 mg/dl), serum LDL (83.81 ± 57.02 vs 84.67 ± 46.07 mg/dl), VLDL (33.51 ± 14.60 vs 38.59 ± 18.60 mg/dl) and triglyceride levels (168.11 ± 73.14 vs 190.71 ± 93.12 mg/dl) were higher among patients with increased mean CIMT. However, none of the difference was statistically different between the two patient groups. Thus, lipid profile parameters were not significantly associated with increased mean CIMT.

We observed that among patients with increased mean CIMT, 33.3% were in CKD stage 5, 38.1% were in CKD stage 4 and 22.2% in CKD stage 3B. However, among patients with normal mean CIMT, 27.7% were in CKD stage 2, 23.4% in stage 3A, 19.1% in stage 3B and 23.4% in stage 4. In addition, mean eGFR was significantly lower in patients with increased mean CIMT as compared to those with normal CIMT (22.91 ± 8.99 vs 45.41 ± 12.62 ml/min/1.73m2, p value < 0.01). Thus, increase in mean CIMT was significantly associated with higher stage of CKD and lower eGFR.

It was observed that age of the patient (positive correlation, r=0.422, p value < 0.01) and eGFR (inverse correlation, r=-0.613, p value < 0.01) had a significant correlation with mean CIMT. Other variables like BMI, HbA1c, LDL and serum cholesterol were not significantly correlated with mean CIMT.

Table 1: Description of mean CIMT in our study population

	Mean CIMT	Std. Deviation	Minimum	Maximum
Right (mm)	0.86	0.15	0.5	1.1
Left (mm)	0.85	0.14	0.5	1.1
Mean (mm)	0.85	0.14	0.5	1.08

Table 2: Distribution of patients according to increased CIMT

Increased mean CIMT	Frequency	Percent
Yes	63	57.3
No	47	42.7
Total	110	100

Table 3: Basic profile of patients

		Increased mean CIMT		Total	p value
Age groups (years)		**No**	**Yes**		
Up to 40	N	19	10	29	
	%	40.40%	15.90%	26.40%	
41 to 60	N	17	29	46	
	%	36.20%	46.00%	41.80%	
61 to 80	N	11	21	32	
	%	23.40%	33.30%	29.10%	
More than 80	N	0	3	3	
	%	0.00%	4.80%	2.70%	
Total	N	47	63	110	
	%	100.00%	100.00%	100.00%	
Mean age		47.51 ± 14.3	56.63 ± 13.06		
Gender					0.65
Female	N	19	28	47	
	%	40.40%	44.40%	42.70%	
Male	N	28	35	63	
	%	59.60%	55.60%	57.30%	
Total	N	47	63	110	
	%	100.00%	100.00%	100.00%	
Past history					
Angina/ MI/ Stroke	N	0	0	0	NA
	%	0.00%	0.00%	0.00%	
Diabetes mellitus	N	12	16	28	0.44
	%	25.50%	25.40%	25.40%	
Hypertension	N	13	16	29	0.79
	%	27.70%	25.40%	26.40%	
Total	N	47	63	110	

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	%	100.00%	100.00%	100.00%	
Addiction history					
Smoking	N	6	10	16	0.64
	%	12.80%	15.90%	14.50%	
Alcohol	N	5	11	16	0.31
	%	10.60%	17.50%	14.50%	
Total	N	47	63	110	
	%	100.00%	100.00%	100.00%	
Family history					
Cardiovascular disease	N	0	0	0	NA
	%	0.00%	0.00%	0.00%	
Hyperlipidemia	N	3	1	4	0.18
	%	6.40%	1.60%	3.60%	
Total	N	47	63	110	
	%	100.00%	100.00%	100.00%	

Table 4: Association of increased CIMT with systolic and diastolic blood pressure of the patients and association with Body Mass Index

		Increased mean CIMT		**Total**	**p value**
Systolic blood pressure (mm Hg)		**No**	**Yes**		
< 120	N	22	25	47	0.59*
	%	46.80%	39.70%	42.70%	
120 to 129	N	8	17	25	
	%	17.00%	27.00%	22.70%	
130 to 139	N	5	8	13	
	%	10.60%	12.70%	11.80%	
≥ 140	N	12	13	25	
	%	25.50%	20.60%	22.70%	
Mean SB (mm Hg)		126.02± 19.09	124.78± 20.09		0.74**
Diastolic blood pressure (mm Hg)					
< 80	N	25	30	55	0.55*
	%	53.20%	47.60%	50.00%	
80 to 89	N	6	13	19	
	%	12.80%	20.60%	17.30%	
≥ 90	N	16	20	36	
	%	34.00%	31.70%	32.70%	
Mean DBP (mm Hg)		81.51 ± 15.09	81.21 ± 15.95		0.92**
Body Mass Index					
Underweight	N	1	3	4	0.71*
	%	2.10%	4.80%	3.60%	
Ideal	N	21	24	45	
	%	44.70%	38.10%	40.90%	
Overweight	N	23	31	54	
	%	48.90%	49.20%	49.10%	
Obese	N	2	5	7	
	%	4.30%	7.90%	6.40%	
Total	N	47	63	110	
	%	100.00%	100.00%	100.00%	
Mean BMI (kg/m2)		23.17 ± 2.5	23.20 ± 2.65		0.94**

Table 5: Association of increased CIMT with various lab tests of patients

	Increased mean CIMT				
Glycemic profile	**No**		**Yes**		**p value**
	Mean	**SD**	**Mean**	**SD**	
HbA1c (%)	5.69	1.96	5.91	2.13	0.57
Fasting blood sugar (mg/dl)	111.72	35.09	113.05	33.77	0.84
Protein					
Albumin (gm/dl)	3.40	0.49	3.40	0.49	0.95
Lipid profile					
Serum total cholesterol (mg/dl)	150.89	68.17	155.89	56.39	0.67
Low density lipoprotein (mg/dl)	83.81	57.02	84.67	46.07	0.93
High density lipoprotein (mg/dl)	33.55	10.48	33.24	9.75	0.87
Very low density lipoprotein (mg/dl)	33.51	14.60	38.59	18.60	0.12
Triglycerides (mg/dl)	168.11	73.14	190.71	93.12	0.17
Renal function					
Blood urea nitrogen (mg/dl)	46.64	22.24	69.18	34.78	< 0.01
Creatinine (mg/dl)	1.89	1.04	3.50	2.38	< 0.01
Serum uric acid (mg/dl)	5.97	2.16	7.56	5.61	0.06
Serum calcium (mg/dl)	8.69	0.98	8.46	1.22	0.29
Serum phosphorus (mg/dl)	4.25	1.35	4.60	1.81	0.26

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Table 6: Association of increased CIMT with CKD stages of the patients

	Increased mean CIMT			Total
Stages of CKD	**No**		**Yes**	
2	N	13	1	14
	%	27.70%	1.60%	12.70%
3A	N	11	3	14
	%	23.40%	4.80%	12.70%
3B	N	9	14	23
	%	19.10%	22.20%	20.90%
4	N	11	24	35
	%	23.40%	38.10%	31.80%
5	N	3	21	24
	%	6.40%	33.30%	21.80%
Total	N	47	63	110
	%	100.00%	100.00%	100.00%
Mean eGFR (ml/min/1.73m2)		45.41 ± 12.62	22.91 ± 8.99	

Table 7: Correlation of patient variables with mean CIMT of the patients

Variables	Correlation coefficient	p value*
Age	0.422	< 0.01
Body mass index	-0.047	0.628
HbA1c	0.128	0.184
eGFR	-0.613	< 0.01
Low density lipoprotein	-0.034	0.722
Serum cholesterol	-0.001	0.995

*analyzed using Pearson's correlation

DISCUSSION

This observational cross-sectional study was conducted in the Department of General Medicine of Bhagat Phool Singh Government Medical College for Women, Khanpur Kalan, Sonipat, Haryana. In this study, we included adult patients diagnosed with chronic kidney disease as per the National Kidney Foundation Kidney Disease Outcomes Quality Initiative definition. The study aimed to identify the association between estimated glomerular filtration rate with CIMT in chronic kidney disease patients. CIMT was measured using the B mode ultrasonographic scanning of the carotid arteries. Increased CIMT in the carotid artery was defined as a CIMT of > 0.9 mm.

Carotid intima-media thickness is a measure of atherosclerotic vascular disease, and it is considered a comprehensive picture of all alterations caused by multiple cardiovascular risk factors over time on the arterial walls. Carotid intima- media thickness is a noninvasive and reproducible method of identifying and quantifying subclinical CVD and for evaluating cardiovascular risk. Individuals with subclinical atherosclerosis are likely to experience future cardiovascular events, thus identifying such individuals and providing evidence-based medical intervention reduce cardiovascular risk, which likely decreases future morbidity and mortality from CVD.[15]

In the present study, mean CIMT in the right and left was found to be 0.86 ± 0.15 mm and 0.85 ± 0.14 mm. Mean CIMT was 0.85 ± 0.14 mm. In addition, we observed that mean CIMT was increased in 57.3% of the patients. Lyngdoh et al observed that mean CIMT level was 1.21 ± 0.53 mm.71. In the study by Lahoti et al Left CIMT in CKD group was 0.81 ± 0.31 mm and 0.63 ± 0.17 mm in control group (p=0.0001). [16] Right CIMT in CKD group was 0.78 ± 0.26 mm and 0.64 ± 0.16 mm in control group (p=0.0001).

We observed that mean age of patients with increased CIMT was 56.6 ± 13.06 years, which was significantly higher as compared to those with normal CIMT (47.51 ± 14.3 years), p value < 0.05. In addition, we observed that increase in CIMT was not significantly associated with gender of the patient (p value = 0.65). It was also observed that age of the patient had a positive correlation with mean CIMT, r=0.422, p value < 0.01.

In a similar study by Lyngdoh et al, out of 70 CKD patients, 39 (55.7%) were males, and 31 (44.3%) were females.[17] The mean age of study population was 58.37±12.193 years (34–90 years). The authors observed that mean CIMT is maximum in the age group more than 80 years and minimum in the age group of 61–80 years, with no statistical difference. Similarly, it is observed that there is statistically no significant relation of sex with respect to mean CIMT as the p value >0.05, at 5% level of significance. Mean CIMT was more in male than in female.

Roumeliotis et al observed that patients in the high CIMT group versus those in the low were significantly older (70 ± 9 vs. 67 ± 9 years old respectively, p = 0.04).[18] Multivariate analysis showed that both mean cIMT and cIMT max were positively correlated with age (r = 0.217, p = 0.01 and r = 0.210, p = 0.012, respectively).

In our study population, 26.4% had hypertension and 25.4% had diabetes mellitus. Increased CIMT was not significantly associated with either diabetes mellitus or hypertension.

Srikant assessed the association of hypertension with mean CIMT levels.[19] They observed that the mean CIMT in patients with 3-5 stages of CKD with and without hypertension in which (right CIMT) is 0.9

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mm in hypertensive individuals compared with non-hypertensive individuals it is 0.8 mm which is statistically insignificant (p value = 0.8). The mean Left CIMT in hypertensive individuals was 0.8 mm compared to non-hypertensive individuals it was 0.9 mm which was insignificant (p value = 0.2). Likewise, mean right CIMT in diabetes was 0.8 mm and non- diabetes was 0.9 mm which was statistically insignificant (p value=0.47). The mean left CIMT in diabetes was 0.9 mm and non-diabetes was 0.8 mm which was insignificant (P value 0.5). Lahoti and colleagues observed that the mean CIMT in Diabetic CKD patient was 1.09 ± 0.22 mm and that in Non-Diabetic CKD was 0.63 ± 0.16 mm.[16] Left CIMT in diabetic CKD group was 1.14 ± 0.23 mm and 0.62 ± 0.17 mm in non-diabetic CKD group (p=0.0001). Right CIMT in diabetic CKD group was 1.03 ± 0.22 mm and 0.64 ± 0.15 mm in non-diabetic CKD group (p=0.0001). There was statistically significant (p<0.0001) difference in CIMT between the two groups

We observed that 14.5% had a history of smoking and 14.5% had a history of alcohol consumption. Neither smoking nor alcohol consumption were found to be significantly associated with increase in CIMT.

In the study by Srikant et al, mean Right CIMT in smokers is 0.86 mm compared to non-smokers 0.85 mm which is statistically insignificant (P value 0.8).[19] The mean left CIMT in smokers is 0.85 mm compared to non- smokers 0.84 mm which is statistically insignificant (p value = 0.77). In addition, mean CIMT is 0.9 mm on right side in both alcoholics and non - alcoholics (p value = 0.6). The mean CIMT on left side 0.8 mm in alcoholics and 0.9 mm in non-alcoholics which is insignificant (p value = 0.4).

We observed mean systolic and diastolic blood pressures were similar between patients with and without increased CIMT. In patients with increased CIMT, mean systolic blood pressure was 124.7 ± 20.09 mm Hg and mean diastolic blood pressure was 81.21 ± 15.9 mm Hg. In patients with normal CIMT, mean systolic blood pressure was 126.02 ± 19.09 mm Hg and mean diastolic blood pressure was 81.51 ± 15.09 mm Hg. Thus, systolic as well as diastolic blood pressures were not significantly associated with increased CIMT.

In the study by Roumeliotis et al, mean systolic and diastolic blood pressure was not statistically significantly associated with increased CIMT.[18] In their study, mean SBP and DBP was 138 mmHg and 78 mm Hg in patients with increased CIMT and 137 mm Hg and 77 mmHg in patients with normal CIMT.

We observed that mean BMI of patients with and without increased CIMT was 23.2 ± 2.65 and 23.17 ± 2.5 kg/m2, with no significant difference between them (p value = 0.94).

Contrary to our findings, Lyngdoh et al observed that there was statistically significant relation of BMI with respect to mean CIMT as the p<0.05, at 5% level of significance, as mean CIMT was more in obese than in non-obese.[17] Likewise, Chhajed et al also found a significant correlation between CIMT and BMI (r = 0.377; p <0.001).65

We observed that mean HbA1c and fasting blood sugar were not associated with increased mean CIMT. Mean HbA1c was 5.91 ± 2.13% and 5.69 ± 1.96% in patients with increased and normal CIMT respectively (p value = 0.57). Similarly, mean fasting blood sugar was also found to be 113.33.7 mg/dl and 111.72 ± 35.09 mg/dl in patients with increased and normal CIMT respectively (p value = 0.84).

In the study by Roumeliotis et al, mean HbA1c was 7.4% in patients with increased mean CIMT as compare to 7.6% in patients with normal mean CIMT.[18] Similar to our findings, HbA1c was not significantly associated with increased CIMT.

In our study, mean serum albumin levels were 3.4 ± 0.49 in both the groups of patients. Thus, serum albumin was not found to be significantly associated with increased CIMT (p value = 0.95).

Albuminuria has been associated with carotid intima-media thickness (CIMT),78 which is a widely accepted marker of subclinical CVD. Similarly, the association of normal range urine albumin-to-creatinine ratio (UACR) values (i.e., <30mg/g) and CIMT should be studied separately, because the normal ranges of UACR has been reported to have predictive values for subsequent hypertension and mortality.[20] The potential pathophysiological mechanism linking low-grade albuminuria to atherosclerosis and CVD is not fully established. In fact, low-grade albuminuria is considered to relate to inflammation, hypertriglyceridemia, and hypertension, which are the risk factors for CVD.[21]

We observed that serum cholesterol (150.89 ± 68.17 vs 155.89 ± 56.39 mg/dl), serum LDL (83.81 ± 57.02 vs 84.67 ± 46.07 mg/dl), VLDL (33.51 ± 14.60 vs 38.59 ± 18.60 mg/dl) and triglyceride levels (168.11 ± 73.14 vs 190.71 ± 93.12 mg/dl) were higher among patients with increased mean CIMT. However, none of the difference was statistically different between the two patient groups. Thus, lipid profile parameters were not significantly associated with increased mean CIMT.

In another study by Lyngdoh et al, it was observed that there is statistically significant relation of total cholesterol with respect to mean CIMT as the P<0.001 at 1% level of significance, as mean CIMT was more in TC (≥200) than in TC (<200).[17] In addition, there was statistically significant relation of triglycerides with respect to mean CIMT as the P<0.001 at 1% level of significance, as mean CIMT was more in TG (≥150) than in TC (<150). Similar observations were made for HDL, LDL and VLDL as well.

Roumeliotis et al observed that mean CIMT was positively correlated with triglyceride levels (r = 0.176, p = 0 .037), while maximum CIMT was marginally not significantly associated (r = 0.164, p = 0.053).[18] Other parameters of lipid profile did not correlate significantly with CIMT.

We observed that patients with increased mean CIMT, BUN (69.18 ± 34.78 vs 46.64± 22.24 mg/dl,

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p value < 0.01) and serum creatinine (3.50 ± 2.38 vs 1.89 ± 1.04 mg/dl, p value < 0.01) were significantly higher as compared to those with normal CIMT. In addition, we observed that among patients with increased mean CIMT, 33.3% were in CKD stage 5, 38.1% were in CKD stage 4 and 22.2% in CKD stage 3B. However, among patients with normal mean CIMT, 27.7% were in CKD stage 2, 23.4% in stage 3A, 19.1% in stage 3B and 23.4% in stage 4. In addition, mean eGFR was significantly lower in patients with increased mean CIMT as compared to those with normal CIMT (22.91 ± 8.99 vs 45.41± 12.62 ml/min/1.73m2, p value < 0.01). Thus, increase in mean CIMT was significantly associated with higher stage of CKD and lower eGFR. Furthermore, we observed that eGFR had an inverse correlation with mean CIMT, r=-0.613, p value < 0.01. In the study by Lyngdoh et al, 14 (20.0%) of the patients were in the Stage 5, 11 (15.7%) were in Stage 4.71 About 64.3% of the patients were in early stage of kidney disease (Stages 1, 2, and 3A and 3B). The authors observed that there is no direct co- relation of the CIMT and eGFR (CC=−0.169 [P=0.163]). However, CIMT values are more in later stages of CKD (Stage 3B, 4, and 5) compared to early stages (Stages 1, 2, and 3A).

In another study, Margekar et al observed that out of 100 CKD patients, 67% of patients were in stage V CKD, 14% of patients were in stage IV CKD and 21% of patients were in stage III CKD.[22] Majority of the cases had CIMT between 0.9-1.0 mm (42%) followed by 0.7-0.8 mm (17%) as compared to 0.5-0.6 mm (42%) in control. However, no significant difference in mean CIMT was found between different stages of CKD (p=0.649).

Chhajed et al did not find a difference in eGFR between subjects with and without increased CIMT.[23] In the linear regression model, factors associated with CIMT were predominantly traditional atherosclerotic risk factors, whereas eGFR was not independently associated with CIMT, which indicates that increased CIMT in patients with CKD might be caused at least in part by traditional risk factors.

CONCLUSION

We conclude that Mean CIMT had a significant positive correlation with age of the patients. Mean CIMT had a significant inverse correlation with eGFR. Mean CIMT did not have a significant correlation with BMI, HbA1c, LDL and serum cholesterol. Our results show that CIMT is significantly associated age and CKD stage of the patient. Assessment of CIMT combines the unparalleled advantages of being a sensitive, non-invasive and a reproducible test for assessing atherosclerotic vascular diseases and risk of cardiovascular diseases.

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