Correlation between ankle brachial index, carotid intima media thickness and left ventricular hypertrophy in patients on maintenance hemodialysis

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Introduction: Left ventricular hypertrophy (LVH) is a major cardiovascular risk factor in patients on maintenance hemodialysis (HD). The aim of our study is to find correlation between ankle brachial index (ABI), carotid intima media thickness (IMT) and left ventricular hypertrophy in this population.

Patient and methods: Twenty consecutive patients on maintenance hemodialysis were studied, all clinical data were included and laboratory data recorded, three most recent pre-dialysis blood pressure measurements were recorded and averaged. Ankle brachial index, also carotid intima media thickness were measured for all patients echocardiography to asses left ventricular wall thickness mainly was done.

Results: There was positive correlation between IMT and LVH as well as a negative correlation between ABI and LVH in those patients on hemodialysis. Both parameters were correlated with BMI and serum albumin. When serum albumin level rise, ABI increase and IMT decrease indicating no atherosclerotic changes. Left ventricular mass index (LVMI) was also highly negatively correlated with serum albumin. Obesity was found to be associated with more atherosclerotic changes with rise of IMT and lowering of ABI in our work, but not correlated with LVMI. Systolic blood pressure (SBP) was also correlated with more atherosclerotic changes.
1. Introduction

Cardiovascular diseases are the most frequent cause of death among hemodialysis patients with sudden cardiac death accounting for between 10% and 30% of deaths from all causes. Left ventricular hypertrophy (LVH) is a potent predictor of cardiovascular morbidity and mortality in those patients.10

Being present in 40% of patients with chronic renal insufficiency and in 75% of patients starting dialysis, LVH represents a key prognostic factor and can predict development of heart failure and ischemic heart disease.11

In addition, a fall in left ventricular mass index or a rise in fractional shortening in the first year of dialysis therapy was associated with a lower probability of new onset cardiac failure.11

Peripheral vascular disease (PVD) is more common among patients with end-stage renal disease (ESRD) than in the general population. Prevalence rates cited in the literature range from 17% to 48%, depending on the ESRD population studied and the diagnostic methods used. The presence of PVD substantially increases the risk for both morbidity (chronic ischemic ulceration, gangrene, and amputation) and death among ESRD patients.12 They also demonstrated that LVH in maintenance hemodialysis patients was associated with peripheral vascular disease.

Prediction of major cardiovascular and cerebrovascular events using conventional risk factor models is limited. Both carotid intima-media thickness (IMT), and ankle-brachial pressure index (ABI) are noninvasive subclinical markers associated with coronary artery disease.3

They could improve risk prediction and provide more focused primary prevention strategies.3

The ABI was originally used to identify lower-limb atherosclerosis. However, it has subsequently been shown to be an accurate and reliable marker of generalized atherosclerosis.14

Previous cross-sectional studies have demonstrated significant associations between the ankle-brachial index (ABI) and carotid intimal media thickness (IMT) in diabetic subjects5 but up to our knowledge correlation between ankle brachial index, carotid intima media thickness, and left ventricular hypertrophy in ESRD were not studied.

2. Aim

Our aim was to assess ankle brachial index (ABI) and carotid intima-media thickness (IMT) and their correlation to left ventricular hypertrophy in hemodialysis patients.

3. Patients and method

Twenty patients on regular hemodialysis in our unit performing 3 sessions/week with bicarbonate dialysis were included in our study. All clinical data, including name, gender, age, smoking history (ever versus never), underlying disease, co-morbid conditions, duration of dialysis were obtained. Hemoglobin, serum albumin, C-reactive protein, calcium, phosphorus, total cholesterol, total triglycerides, low density lipoprotein, high density lipoprotein and pre and post-dialysis urea were recorded. Three most recent pre-dialysis blood pressure measurements were recorded and averaged.

\[ \text{Ku/V} \] was calculated by using the formula: \[ \text{Ku/V} = (0.026 \times \text{average urea reduction ratio}) - 0.46 \].

3.1. Ankle brachial index measurement

All participants were required to rest in supine position for 5 min before ABI measurement. A blood pressure cuff of appropriate size was wrapped over non fistula brachial artery and above each malleolus. Cuff is rapidly inflated to 20 mmHg above the audible systolic pressure in non fistula arm and deflated at a rate of 2 mm/s. The systolic pressure was recorded as the pressure at which the first sustained systolic pressure was audible. We used an ultrasound machine HDI5000 (ATL-Philips, Bothell, WA, USA) and 5 MHz Doppler probe.

Ankle brachial index is calculated by the ratio of the ankle systolic pressure divided by the arm systolic pressure. An ABI between 0.9 and 1.3 is defined normal, less than 0.9 is classified as peripheral arterial disease.

3.2. Echocardiography

Transthoracic echocardiography (2D and M mode) was done to all patients to assess left ventricular dimension and function, interventricular septum and posterior wall thickness.

LVM was calculated as: LVM/body surface area (m²).

\[ \text{LVM} \]
\[ (g) = 1.04((\text{LVDd} + \text{IVST} + \text{PWT})3 - (\text{LVDd})3 - 13.6) \]

LVH is defined as LVM $\geq$ 134 g/m² for male patients and LVM $\geq$ 110 g/m² for female.

3.3. Carotid intima media thickness

The degree of carotid atherosclerosis was evaluated ultrasonographically by an experienced sonographer using an 8–15 MHz scanner. The maximum intimal-medial thickness indicates the maximum wall thickness of the whole carotid arteries.

3.4. Statistical analysis

We used the Statistical Package for Social Sciences for Windows, version 10.0 soft ware package. Mean differences between the LVH group and the non LVH group was assessed with the student t-test for the normal data and Wilcoxon rank sum test for the non normal data. Pearson correlation coefficient was used to examine correlation between variables.
Multiple regression analysis was used to assess independent association between one dependent and two or more independent variables. All measurement data were expressed as mean ± SD. *P value < 0.05 was considered to indicate significance and **P value < 0.01 to indicate highly significant result.

4. Results

Twenty patients with age 45.45 ± 13.48 (25–70) on MHD of 32.7 ± 18.87 (7–67) month’s duration were studied. They were divided into two groups according to presence or absence of LVH (left ventricular hypertrophy). Eleven patients were in group of LVH and 9 patients had no ventricular hypertrophy. There is significant difference between the two groups as regard SBP, serum Alb level, serum TGs, HDL, ABI, IMT and echocardiographic data of IVSTd, LVPWTd and EF but no statistical difference with serum calcium, phosphorus, Ca × P product, BMI, duration of dialysis, dialysis adequacy between the two groups (Table 1).

Bivariate analysis showed that LVMI was negatively correlated with ABI, HDL and serum calcium (*r = −0.692, −0.539, P < 0.05) and with albumin (*r = −0.692, P < 0.01). LVMI was positively correlated with IMT, TGs DBP (*r = 0.486, 0.508, 0.446, P < 0.05) and with SBP (*r = 0.590, P < 0.01). No correlation with Kt/V, CRP, Ca × P, lipid profile, HR, Hb, duration of dialysis or smoking (Table 2). For ABI for hemodialysis patients Table 3 showed significant negative correlation with LVMI, SBP (*r = −0.510, −0.496, P < 0.05) and a highly significant reverse correlation with IMT and BMI (*r = −0.751, −0.608, P < 0.01). A highly significant positive correlation was found with serum albumin (r = 0.592, P < 0.01). No correlation with Kt/V, CRP, Ca × P, lipid profile, HR, Hb, duration of dialysis or smoking (Table 4).

Table 5 shows the results of multiple linear regression tests. There is significant predictive value of ABI (P = 0.022) and carotid IMT (P = 0.030) as well as SBP (P = 0.006) and DBP (P = 0.049) in predicting LVMI. Kt/V, serum hemoglobin level failed to show this relation.

5. Discussion

The risk of cardiovascular death is 10 times higher in patients with end stage renal disease (ESRD) than in the general population. This higher death rate may be attributable to pathophysiologic causes leading to advanced atherosclerotic changes of the arterial wall and left ventricular hypertrophy.9

<table>
<thead>
<tr>
<th>Variable</th>
<th>LVH group</th>
<th>Non LVH group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>11</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>50.73 ± 13.78</td>
<td>39 ± 10.44</td>
<td>0.050</td>
</tr>
<tr>
<td>Duration of dialysis (months)</td>
<td>38.09 ± 20.1</td>
<td>26.11 ± 15.86</td>
<td>0.163</td>
</tr>
<tr>
<td>BMI</td>
<td>24.8 ± 4.32</td>
<td>22.4 ± 1.67</td>
<td>0.135</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>141.36 ± 14.85</td>
<td>126.67 ± 10.0</td>
<td>0.021*</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>85.45 ± 11.93</td>
<td>80.56 ± 9.82</td>
<td>0.337</td>
</tr>
<tr>
<td>HR (b/min)</td>
<td>82.55 ± 8.44</td>
<td>77.33 ± 8.19</td>
<td>0.181</td>
</tr>
<tr>
<td>Hb (g/dl)</td>
<td>10.19 ± 1.42</td>
<td>10.8 ± 1.51</td>
<td>0.363</td>
</tr>
<tr>
<td>Alb (mg/dl)</td>
<td>3.64 ± 0.4</td>
<td>4.07 ± 0.25</td>
<td>0.013*</td>
</tr>
<tr>
<td>T. CHOL (mg/dl)</td>
<td>178.00 ± 32.2</td>
<td>158.44 ± 25.7</td>
<td>0.157</td>
</tr>
<tr>
<td>TGs (mg/dl)</td>
<td>169.64 ± 58.57</td>
<td>110.44 ± 36.04</td>
<td>0.017**</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>34.64 ± 6.83</td>
<td>42.78 ± 4.52</td>
<td>0.007**</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>107.27 ± 19.12</td>
<td>99.67 ± 16.37</td>
<td>0.358</td>
</tr>
<tr>
<td>Ca (mg/dl)</td>
<td>8.91 ± 1.05</td>
<td>9.72 ± 1.21</td>
<td>0.125</td>
</tr>
<tr>
<td>Ph (mg/dl)</td>
<td>6.01 ± 1.99</td>
<td>4.94 ± 1.54</td>
<td>0.204</td>
</tr>
<tr>
<td>Ca × P (mg²/dl²)</td>
<td>53.97 ± 19.35</td>
<td>47.98 ± 15.28</td>
<td>0.460</td>
</tr>
<tr>
<td>CRP (mg/dl)</td>
<td>13.14 ± 6.45</td>
<td>10.32 ± 4.86</td>
<td>0.293</td>
</tr>
<tr>
<td>ABI</td>
<td>0.704 ± 0.247</td>
<td>1.084 ± 0.123</td>
<td>0.002**</td>
</tr>
<tr>
<td>IMT</td>
<td>1.282 ± 0.197</td>
<td>0.932 ± 0.239</td>
<td>0.002**</td>
</tr>
<tr>
<td>EF%</td>
<td>56.34 ± 11.11</td>
<td>68.014 ± 5.087</td>
<td>0.01**</td>
</tr>
<tr>
<td>LVMI (g/m²)</td>
<td>164.57 ± 28.08</td>
<td>101.00 ± 7.5</td>
<td>0.000**</td>
</tr>
<tr>
<td>IVSTd</td>
<td>15.027 ± 1.7</td>
<td>11.21 ± 1.06</td>
<td>0.000**</td>
</tr>
<tr>
<td>LVMPWTd</td>
<td>12.809 ± 1.3</td>
<td>9.25 ± 3.25</td>
<td>0.004**</td>
</tr>
<tr>
<td>Kt/V</td>
<td>0.99 ± 0.27</td>
<td>1.09 ± 0.23</td>
<td>0.393</td>
</tr>
<tr>
<td>HTN (%)</td>
<td>72.72%</td>
<td>33.33%</td>
<td>0.086</td>
</tr>
<tr>
<td>DM (%)</td>
<td>54.54%</td>
<td>11.1%</td>
<td>0.048*</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>54.54%</td>
<td>22.22%</td>
<td>0.152</td>
</tr>
<tr>
<td>Male/female</td>
<td>7/4</td>
<td>5/4</td>
<td>0.721</td>
</tr>
</tbody>
</table>

* P < 0.05.

** P < 0.01. ABI, ankle brachial index; IMT, intima media thickness; BMI, body mass index; LVMI, left ventricular mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; EF, ejection fraction; Hb, hemoglobin; HR, heart rate; MHD, maintenance hemodialysis; IVSTd, interventricular septal diameter; LVMPWTd, left ventricular posterior wall diameter; Ca × P, calcium phosphorus product; CRP, C reactive protein.
In patients with chronic kidney disease, left ventricular mass (LVM) increases progressively as renal function deteriorates, and in a substantial number of cases this trend is not arrested. Partial regression of LVH occurs only after renal transplantation.

The major finding in the study of Paoletti et al. is that the worsening of pre-existing LVH, independent of the absolute LVMI values at inception, is the strongest predictor of the risk of sudden cardiac death (SCD) in dialysis patients. In this population, LVH has been found to be associated with lower actuarial survival rates probably because LVH is progressive and continues after the initiation of dialysis treatment. In hemodialysis patients, long-lasting arterial hypertension and pre-existing IHD were demonstrated to also be correlates of SCD. However, the worsening of LVH turned out to be the most significant predictor when all the putative factors were examined together by multivariate analysis. This result reflects a peculiar picture of dialysis patients, since the increase in LVMI is even a stronger predictor of SCD than IHD itself, which, on the contrary, is associated with SCD in ~80% of cases in the general population.

Peripheral arterial disease (PAD) patients are at high risk of cardiac death. Coincidental but silent coronary disease is obviously a major contributor but left ventricular hypertrophy (LVH) could be a second major contributor.

Interest is increasing in the use of non invasive markers that allow the identification of subclinical cardiac disease including the ankle brachial index (ABI) and carotid intima media thickness (IMT). A low ABI has now been shown to be an accurate and reliable marker of generalized atherosclerosis and a good predictor of subsequent cardiovascular morbidity and mortality.  

### Table 2 Correlation coefficients for LVMI and other variables in MHD patients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>R</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kt/V</td>
<td>0.02</td>
<td>0.932</td>
</tr>
<tr>
<td>IMT</td>
<td>0.486</td>
<td>0.030</td>
</tr>
<tr>
<td>ABI</td>
<td>-0.510</td>
<td>0.022</td>
</tr>
<tr>
<td>EF</td>
<td>-0.685</td>
<td>0.001</td>
</tr>
<tr>
<td>IVSTd</td>
<td>0.639</td>
<td>0.002</td>
</tr>
<tr>
<td>CRP</td>
<td>0.174</td>
<td>0.463</td>
</tr>
<tr>
<td>Ca × P</td>
<td>-0.025</td>
<td>0.916</td>
</tr>
<tr>
<td>P</td>
<td>0.155</td>
<td>0.514</td>
</tr>
<tr>
<td>Ca</td>
<td>-0.539</td>
<td>0.014</td>
</tr>
<tr>
<td>LDL</td>
<td>0.226</td>
<td>0.338</td>
</tr>
<tr>
<td>HDL</td>
<td>-0.495</td>
<td>0.026</td>
</tr>
<tr>
<td>TG</td>
<td>0.508</td>
<td>0.022</td>
</tr>
<tr>
<td>Hb</td>
<td>-0.442</td>
<td>0.051</td>
</tr>
<tr>
<td>DBP</td>
<td>0.446</td>
<td>0.049</td>
</tr>
<tr>
<td>SBP</td>
<td>0.590</td>
<td>0.006</td>
</tr>
<tr>
<td>HR</td>
<td>0.169</td>
<td>0.476</td>
</tr>
<tr>
<td>BMI</td>
<td>0.379</td>
<td>0.099</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.058</td>
<td>0.807</td>
</tr>
<tr>
<td>DD</td>
<td>0.106</td>
<td>0.658</td>
</tr>
<tr>
<td>CHOL</td>
<td>0.185</td>
<td>0.436</td>
</tr>
<tr>
<td>Alb</td>
<td>-0.692</td>
<td>0.001</td>
</tr>
</tbody>
</table>

### Table 3 Correlation coefficients for ABI and other variables in MHD patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVMI</td>
<td>-0.510</td>
<td>0.022</td>
</tr>
<tr>
<td>Kt/V</td>
<td>-0.022</td>
<td>0.925</td>
</tr>
<tr>
<td>IMT</td>
<td>-0.751</td>
<td>0.000</td>
</tr>
<tr>
<td>EF</td>
<td>0.643</td>
<td>0.002</td>
</tr>
<tr>
<td>IVSTd</td>
<td>-0.616</td>
<td>0.004</td>
</tr>
<tr>
<td>CRP</td>
<td>0.091</td>
<td>0.702</td>
</tr>
<tr>
<td>Ca × P</td>
<td>0.008</td>
<td>0.973</td>
</tr>
<tr>
<td>P</td>
<td>-0.057</td>
<td>0.811</td>
</tr>
<tr>
<td>Ca</td>
<td>0.119</td>
<td>0.617</td>
</tr>
<tr>
<td>CHOL</td>
<td>-0.064</td>
<td>0.789</td>
</tr>
<tr>
<td>LDL</td>
<td>0.023</td>
<td>0.922</td>
</tr>
<tr>
<td>HDL</td>
<td>0.318</td>
<td>0.172</td>
</tr>
<tr>
<td>TG</td>
<td>-0.210</td>
<td>0.374</td>
</tr>
<tr>
<td>Hb</td>
<td>0.347</td>
<td>0.134</td>
</tr>
<tr>
<td>HR</td>
<td>-0.372</td>
<td>0.106</td>
</tr>
<tr>
<td>DBP</td>
<td>-0.280</td>
<td>0.232</td>
</tr>
<tr>
<td>SBP</td>
<td>-0.496</td>
<td>0.026</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.608</td>
<td>0.004</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.030</td>
<td>0.900</td>
</tr>
<tr>
<td>DD</td>
<td>-0.176</td>
<td>0.458</td>
</tr>
<tr>
<td>Alb</td>
<td>0.592</td>
<td>0.006</td>
</tr>
</tbody>
</table>

### Table 4 Correlation coefficient for IMT and other variables in MHD patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVMI</td>
<td>0.486</td>
<td>0.030</td>
</tr>
<tr>
<td>Kt/V</td>
<td>-0.142</td>
<td>0.549</td>
</tr>
<tr>
<td>ABI</td>
<td>-0.751</td>
<td>0.000</td>
</tr>
<tr>
<td>EF</td>
<td>-0.460</td>
<td>0.041</td>
</tr>
<tr>
<td>IVSTd</td>
<td>0.092</td>
<td>0.001</td>
</tr>
<tr>
<td>CRP</td>
<td>0.070</td>
<td>0.768</td>
</tr>
<tr>
<td>Ca × P</td>
<td>0.015</td>
<td>0.951</td>
</tr>
<tr>
<td>P</td>
<td>0.080</td>
<td>0.738</td>
</tr>
<tr>
<td>Ca</td>
<td>-0.183</td>
<td>0.440</td>
</tr>
<tr>
<td>CHOL</td>
<td>0.2</td>
<td>0.397</td>
</tr>
<tr>
<td>LDL</td>
<td>0.122</td>
<td>0.609</td>
</tr>
<tr>
<td>HDL</td>
<td>-0.237</td>
<td>0.315</td>
</tr>
<tr>
<td>TG</td>
<td>0.410</td>
<td>0.072</td>
</tr>
<tr>
<td>SBP</td>
<td>0.486</td>
<td>0.030</td>
</tr>
<tr>
<td>DBP</td>
<td>0.197</td>
<td>0.405</td>
</tr>
<tr>
<td>HR</td>
<td>0.351</td>
<td>0.129</td>
</tr>
<tr>
<td>Hb</td>
<td>-0.409</td>
<td>0.073</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.205</td>
<td>0.385</td>
</tr>
<tr>
<td>DD</td>
<td>0.371</td>
<td>0.107</td>
</tr>
<tr>
<td>Alb</td>
<td>-0.471</td>
<td>0.036</td>
</tr>
<tr>
<td>BMI</td>
<td>0.551</td>
<td>0.012</td>
</tr>
</tbody>
</table>

### Table 5 The results of multiple linear regression analysis for predicting LVMI.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Standardised β</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMT</td>
<td>0.486</td>
<td>0.030</td>
</tr>
<tr>
<td>ABI</td>
<td>-0.510</td>
<td>0.022</td>
</tr>
<tr>
<td>Kt/V</td>
<td>0.020</td>
<td>0.932</td>
</tr>
<tr>
<td>SBP</td>
<td>0.590</td>
<td>0.006</td>
</tr>
<tr>
<td>DBP</td>
<td>0.446</td>
<td>0.049</td>
</tr>
<tr>
<td>Hb</td>
<td>-0.442</td>
<td>0.51</td>
</tr>
<tr>
<td>Alb</td>
<td>-0.692</td>
<td>0.090</td>
</tr>
</tbody>
</table>
Several studies also examined the relationship between carotid IMT and the incidence of cardiovascular events, finding an independent relationship between a raised IMT and an increased risk of events.\textsuperscript{14}

In our study we found that LVMI was positively correlated with intima media thickness (IMT), triglycerides level, systolic and diastolic blood pressure (SBP and DBP). It is negatively correlated with ankle brachial index (ABI), calcium level, HDL and serum albumin level. Wencheng et al.\textsuperscript{1} found also correlation with hypertension, and same negative correlation with ABI and albumin level, but with calcium it was positively correlated. They found no correlation between LVMI and lipid levels and they correlated LVMI also to CRP, hemoglobin, phosphorus and calcium phosphorus product. In our study there was negative correlation with hemoglobin level but was of no statistical difference, this may be related to the wide use of erythropoietin for anemia treatment. Although structural LV alterations occur early during the course of renal disease and result in large part from volume and pressure overloads, several studies demonstrated that renal anemia, inflammatory status, protein malnutrition and disorders of calcium phosphorus metabolism played a role in the development of LVH in MHD patients, this will be different according to the population studied in each time.

Although peripheral atherosclerosis and increased arterial wall stiffness are closely correlated with LVH, no study has compared the relationship between ABI and carotid IMT in relation to LVH in patients on maintenance hemodialysis. Ono et al.\textsuperscript{13} found that ABI was reversed correlated with all cause and cardiovascular mortality in hemodialysis patients.

Our work showed that ABI was correlated with serum albumin as well as negative correlation between serum albumin and IMT, same correlation is found in work of Wencheng et al.\textsuperscript{1} between albumin level and ABI.

It has been shown that hypoalbuminemia is pathogenically associated with vascular disease.

(Effect dissociated from protein malnutrition in patients with ESRD), but protein malnutrition and hypoalbuminemia are both predictive of mortality in patients on dialysis. The odds for atherosclerosis linearly decreased as albumin level increased and patients with low albumin on chronic hemodialysis had significantly greater coronary artery disease.\textsuperscript{9}

ABI was negatively correlated with LVMI and its value in the LVH group was significantly lower than that in the non LVH group, same negative correlation also between ABI and carotid IMT, SBP and BMI but not correlated with serum CRP, calcium metabolism status or serum lipid levels in MHD patients; this is contradictory to other studies which found negative correlation with serum calcium, phosphorus and calcium phosphorus product. These results are contradictory to results of Guerrero et al.\textsuperscript{10} who fund positive correlation between calcium, CA $\times$ P, HDL but no correlation with TGs nor phosphorus as we found. ABI is also correlated with septum thickness and posterior wall motion as we found.

Wencheng et al.\textsuperscript{1} did not find association between serum lipid levels and LVH nor with ABI although hypertriglyceridemia and hypercholesterolemia are associated with cardiovascular risk in general population. Cheung et al.\textsuperscript{17} observes no statistically significant association of cholesterol level with peripheral vascular disease.

Chronic renal failure and/or metabolic alterations secondary to renal failure have been suggested to promote atherosclerosis. Both low ABI $\leq 0.9$ and high IMT $\geq 0.9$ have been shown to be independently related to increased risk of cardiovascular events but it is currently unclear whether measurement of ABI or IMT or both is the best approach to predict cardiovascular events in ESRD.

Our study showed correlation between carotid IMT and LVMI as well as with SBP. These results agree with reports showing LVH as risk factor for carotid atherosclerosis or ischemic stroke in patients with ESRD.\textsuperscript{9} We did not find difference between IMT in diabetic and non diabetic group inste the diabetes is known to contributes to severity of atherosclerosis and arterial stiffness in ESRD, this may be to the small number of the studied patients

ABI was negatively correlated with ABI, thus, IMT gives a comprehensive picture of the alterations caused by multiple risk factors over time on arterial walls. Prospective primary and secondary prevention studies have also shown that increased carotid IMT is a powerful predictor of coronary and cerebrovascular complications (risk ratio from 2 to 6) with a higher predictive value when IMT is measured at multiple extracranial carotid sites than solely in the distal common carotid artery.\textsuperscript{15}

There was no correlation between CRP and carotid IMT neither with ABI in our work. This is contradictory to the results of Wencheng et al.\textsuperscript{1} who found highly significant negative correlation between CRP and ABI. Folsom et al.\textsuperscript{8} found a weak positive association of CRP with carotid intima-media thickness in both genders and with prevalent CHD in women but in men there was a weak inverse association between CRP and ankle/brachial blood pressure index, independent of other risk factors, but no such association in women. Our findings indicate that CRP is not strongly and independently associated with prevalent atherosclerosis in hemodialysis patients. Because CRP as been associated with clinical events, it could be that elevated CRP may be a stronger marker of thrombotic risk than of the degree of atherosclerosis.

Generally results could differ from one study to another because of patient characteristics such as age, sex, diabetes and study sample.

Multivariate regression analysis showed that both ABI and IMT are both independently correlated with LVMI and both can be used to predict the degree of LVM in patients on hemodialysis. Wencheng et al.\textsuperscript{1} concluded that ABI was the only independent factor associated with LVMI (IMT was not studied in their work) but albumin, hemoglobin and hypertension entered the regression equation.

6. Conclusion

Both ABI and carotid IMT are equally effective to predict cardiovascular risk as regard to LVH in hemodialysis population and ABI should be included as a bed side cheap and reliable way to assess cardiovascular risk in hemodialysis patients.

References

1. Fu Wencheng, Ye Chaoyang, Mei Changlin, Rong Shu, Wang Wenjing. Reverse correlation between ankle-brachial index and


