Subclinical Coronary and Aortic Atherosclerosis Detected by Magnetic Resonance Imaging in Type 1 Diabetes With and Without Diabetic Nephropathy

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Background—Patients with type 1 diabetes and nephropathy maintain an excess cardiovascular mortality compared with diabetic patients with normoalbuminuria. We sought to evaluate coronary and aortic atherosclerosis in a cohort of asymptomatic type 1 diabetic patients with and without diabetic nephropathy using cardiovascular magnetic resonance imaging.

Methods and Results—In a cross-sectional study, 136 subjects with long-standing type 1 diabetes without symptoms or history of cardiovascular disease, including 63 patients (46%) with nephropathy and 73 patients with normoalbuminuria, underwent cardiovascular magnetic resonance imaging. All subjects underwent cardiac exercise testing and noninvasive tests for peripheral artery disease and autonomic neuropathy. Coronary artery stenoses were identified in 10% of subjects with nephropathy (versus 0% with normoalbuminuria; \( P = 0.007 \)). Coronary plaque burden, expressed as right coronary artery mean wall thickness \((1.7 \pm 0.3 \text{ versus } 1.3 \pm 0.2 \text{ mm}; P < 0.001)\) and maximum right coronary artery wall thickness \((2.2 \pm 0.5 \text{ versus } 1.6 \pm 0.3 \text{ mm}; P < 0.001)\), was greater in subjects with nephropathy. The prevalence of thoracic (3% versus 0%; \( P = 0.28 \)) and abdominal aortic plaque (22% versus 16%; \( P = 0.7 \)) was similar in both groups. Subjects with and without abdominal aortic plaques had similar coronary plaque burden.

Conclusions—In asymptomatic type 1 diabetes, cardiovascular magnetic resonance imaging reveals greater coronary plaque burden in subjects with nephropathy compared with those with normoalbuminuria. (Circulation. 2007;115:228-235.)

Key Words: aorta ■ atherosclerosis ■ coronary disease ■ diabetes mellitus ■ magnetic resonance imaging

Atherosclerotic cardiovascular disease, in particular coronary heart disease (CHD), is a major cause of mortality and morbidity in both type 1 and type 2 diabetes.\(^1\) Risk assessment in asymptomatic patients with type 1 diabetes is less stringent than for type 2 diabetes. The US guidelines for the prevention of CHD consider diabetes a CHD risk equivalent, regardless of diabetes type, age, and kidney function.\(^2\) The European guidelines do not consider type 1 diabetes to be a high-risk state unless microalbuminuria is present.\(^3\) In a recent prospective follow-up study, we found that the increased cardiovascular mortality in type 1 diabetes was due predominantly to a poor prognosis in patients with diabetic nephropathy.\(^4\)

Cardiovascular magnetic resonance imaging (CMRI) allows noninvasive detection of coronary artery stenoses\(^5\) and imaging of atherothrombosis in the aorta\(^6–7\) and carotid\(^8\) and coronary arteries.\(^8–11\) We sought to evaluate the effect of diabetic nephropathy on atherosclerosis in type 1 diabetes using CMRI to evaluate subclinical coronary and aortic atherosclerosis in asymptomatic type 1 diabetic patients with and without nephropathy.

Methods

Patient Cohort and Clinical Measurements

The study cohort consisted of 136 subjects with long-standing type 1 diabetes without cardiovascular symptoms or disease who were randomly selected from a larger cohort of \( \sim 3000 \) patients seen in the Steno Diabetes Center between July 2003 and February 2005. There...
were 400 patients with diabetic nephropathy in this larger cohort, which included 46 subjects from a prior 10-year prognostic follow-up study (31 with nephropathy, 15 with albuminuria).4 Of the 136 subjects in the study cohort, 63 (43%) had diabetic nephropathy, defined as previously persistent albuminuria (urinary albumin excretion rate >300 mg/24 h in 2 of 3 consecutive 24-hour urine collections), presence of retinopathy, and no evidence of other renal or urinary tract disease.12

Blood samples were obtained after 10 minutes of rest. Serum creatinine concentration was assessed by a kinetic Jaffé method. Urinary albumin excretion rate was measured in two 24-hour urine collections by an enzyme immunoassay.13 The most recent measurement of glomerular filtration rate in the patient file was noted because all patients with diabetic nephropathy have their glomerular filtration rate measured every year by a 51Cr-EDTA-clearance technique.14 The 24-hour ambulatory blood pressure was measured with a Takeda (Osaka, Japan) TM 2421 device. Values were averaged for each hour before the average 24-hour blood pressure was calculated. Ankle-brachial pressure index and systolic blood pressures in the big toe were measured by strain-gauge technique.15 Tests for autonomic neuropathy, heart rate variability, and orthostatic blood pressure were performed. In addition, somatic nerve function (vibratory perception threshold) was evaluated by biothesiometry. Bicycle exercise ECG was carried out in accordance with consensus guidelines.16 Test results were analyzed by a masked cardiologist (P.R.H.) and classified as either pathological or normal. If the subject failed to reach 85% of the estimated maximum heart rate, the test was classified as inconclusive. The present study was approved by the local ethics committee, and all patients gave written informed consent.

CMRI Studies
All subjects underwent CMRI examination with a Philips Intera 1.5 T MR whole-body scanner (Philips Medical Systems, Best, The Netherlands) equipped with a 5-element cardiac phased-array coil and a cardiac software package (R9.1.1). All coronary CMRI angiograms were acquired according to a previously validated protocol.5,17,18

Right coronary artery (RCA) vessel wall scanning was done in a subset of subjects when total scan time did not exceed 1.5 hours (24 with nephropathy, 37 patients without nephropathy) with 3-dimensional black-blood imaging according to a previously validated protocol.11,19

To evaluate aortic atherosclerosis, subjects underwent thoracoabdominal aortic CMRI with acquisition of 24 transverse slices spanning the aortic arch to the aortoiliac bifurcation using a ECG-gated, T2-weighted, and fat-suppressed black-blood turbo spin-echo sequence.7

Coronary Arteries: Stenosis and Plaque Burden
The 3-dimensional coronary data sets were reformatted along the entire visualized course of the coronary arteries and analyzed by an experienced reviewer (W.Y.K.) blinded to all clinical data. Aortic vessel wall and plaque data were classified as thoracic or abdominal, according to their location above or below the diaphragm, respectively. Atherosclerotic plaque was defined as characteristic luminal protrusions of ≥1 mm in radial thickness.7 The cross-sectional vessel wall area in each slice was computed. The total thoracic and abdominal aortic vessel wall volumes were then calculated as the sum of each slice area multiplied by the slice gap. To quantify the magnitude of aortic atherosclerosis in each subject, 2 estimates of plaque burden, slice plaque burden and area plaque burden, were determined.7

Statistical Analysis
Variables were compared between groups by a 2-sample Student t test or Wilcoxon rank-sum test. Frequencies were compared by use of a χ2 test or Fisher exact test.

Multiple linear regression analysis was performed to investigate the associations between CPB and the clinical variables (including tests for peripheral artery disease and autonomic neuropathy) listed in Tables 1 and 2. Each of the clinical variables was included in the analysis separately with and without diabetic nephropathy. The analysis was performed twice with and without the assumption that the association is different for subjects with and without nephropathy. This was done by including an interaction term for clinical variables and nephropathy for the model assuming different slopes. The multiple linear regression analysis also allowed us to compare CPB between subjects with and without nephropathy adjusted for the clinical variables. Two-tailed values of P<0.05 were considered significant. All calculations were made with SPSS version 13.0 (SPSS, Chicago, Ill) and STATA version 9.2 (College Station, Tex).

The authors had full access to the data and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results
Subject Characteristics and Nonimaging tests
The clinical characteristics of the study cohort are summarized in Table 1. Subjects with nephropathy were on average

Figure 1. Three-dimensional reformatted black-blood vessel wall imaging of the proximal RCA showing focal coronary vessel wall thickening (dotted line represents maximum wall thickness of 1–2.6 mm). Average vessel wall thickness (1–1.8 mm) is calculated as the mean of the anterior and posterior wall thicknesses along the proximal RCA as indicated by the black lines.
4 years younger than normoalbuminuric patients. Glycemic control was poorer in subjects with nephropathy ($P<0.001$), and the data suggest a higher systolic blood pressure ($P<0.065$). Total cholesterol, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol levels were similar, whereas triglycerides ($P<0.03$) and very low-density lipoprotein cholesterol ($P<0.007$) were higher in subjects with nephropathy. The renoprotective and cardioprotective pharmacological treatments in the 2 groups were different (Table 1). None of the subjects (0%) with normoalbuminuria had ischemia on exercise testing, whereas 2 subjects (3%) with nephropathy had inducible ischemia ($P=0.05$). Subjects with nephropathy more often had inconclusive exercise tests (47% versus 14%; $P<0.001$). The 2 groups had markedly different autonomic and somatic nerve function (Table 2). Subjects with nephropathy also had reduced ankle-brachial

### TABLE 1. Clinical Characteristics in 136 Type 1 Diabetic Patients With and Without Diabetic Nephropathy

<table>
<thead>
<tr>
<th>Clinical variables</th>
<th>Patients With Normoalbuminuria (N=73)</th>
<th>Patients With Diabetic Nephropathy (N=63)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex male, n (%)</td>
<td>43 (59)</td>
<td>36 (57)</td>
<td>0.84</td>
</tr>
<tr>
<td>Age, y</td>
<td>52±9</td>
<td>48±9</td>
<td>0.01</td>
</tr>
<tr>
<td>Duration of diabetes, y</td>
<td>31±7</td>
<td>34±9</td>
<td>0.02</td>
</tr>
<tr>
<td>Duration of nephropathy, y</td>
<td>...</td>
<td>15±7</td>
<td>...</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>24.7±2.7</td>
<td>24.4±2.9</td>
<td>0.62</td>
</tr>
<tr>
<td>HbA1c, %</td>
<td>8.0±0.9</td>
<td>8.8±1.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Glomerular filtration rate, mL · min⁻² · 1.73 m⁻²</td>
<td>...</td>
<td>66±34</td>
<td>...</td>
</tr>
<tr>
<td>Urinary albumin excretion rate, mg/24 h</td>
<td>8 (2–29)</td>
<td>209 (3–6375)*</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>S-creatinine, μmol/L</td>
<td>89 (61–116)</td>
<td>119 (68–825)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Systolic blood pressure, mm Hg</td>
<td>129±15</td>
<td>135±18</td>
<td>0.065</td>
</tr>
<tr>
<td>Diastolic blood pressure, mm Hg</td>
<td>71±6</td>
<td>71±10</td>
<td>0.58</td>
</tr>
<tr>
<td>Total cholesterol, mmol/L</td>
<td>4.8±0.8</td>
<td>4.7±0.8</td>
<td>0.94</td>
</tr>
<tr>
<td>HDL cholesterol, mmol/L</td>
<td>1.9±0.5</td>
<td>1.8±0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>LDL cholesterol, mmol/L</td>
<td>2.4±0.6</td>
<td>2.3±0.8</td>
<td>0.46</td>
</tr>
<tr>
<td>VLDL cholesterol, mmol/L</td>
<td>0.4±0.2</td>
<td>0.6±0.3</td>
<td>0.007</td>
</tr>
<tr>
<td>Triglycerides, mmol/L</td>
<td>0.8 (0.3–2.6)</td>
<td>1.1 (0.5–4.8)</td>
<td>0.002</td>
</tr>
<tr>
<td>Hemoglobin, mmol/L</td>
<td>8.5±0.7</td>
<td>7.9±0.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Current smoker, n (%)</td>
<td>17 (23)</td>
<td>15 (24)</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Renoprotective and cardioprotective treatment

| Statins, n (%)                        | 20 (27)                               | 36 (57)                                  | <0.001|
| Aspirin, n (%)                        | 19 (26)                               | 45 (71)                                  | <0.001|
| Patients receiving AHT, n (%)         | 33 (45)                               | 59 (93)                                  | <0.001|
| Average AHT drugs per patient, n      | 0.8±1.2                               | 2.3±1.2                                  | <0.001|

BMI indicates body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VLDL, very-low-density lipoprotein; and AHT, antihypertensive treatment. Data are mean±SD or median (range) as appropriate.

*Some patients with previously persistent albuminuria had a urinary albumin excretion rate <300 mg/24 h after receiving AHT.

### TABLE 2. Tests for Autonomic Neuropathy and Peripheral Arterial Disease

<table>
<thead>
<tr>
<th>Subjects With Normoalbuminuria (N=68)</th>
<th>Subjects With Diabetic Nephropathy (N=63)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibratory perception threshold, mV</td>
<td>22±10</td>
<td>30±14</td>
</tr>
<tr>
<td>Heart rate at rest, bpm</td>
<td>69±15</td>
<td>77±10</td>
</tr>
<tr>
<td>Heart rate variation during deep breathing, bpm</td>
<td>15±9</td>
<td>7±6</td>
</tr>
<tr>
<td>Postural blood pressure decrease, mm Hg</td>
<td>2.2±10</td>
<td>5.4±16</td>
</tr>
<tr>
<td>Ankle-brachial index</td>
<td>1.1±0.1</td>
<td>1.0±0.1</td>
</tr>
<tr>
<td>Blood pressure, big toe, mm Hg</td>
<td>113±27</td>
<td>96±37</td>
</tr>
</tbody>
</table>

Postural blood pressure decrease shows a reduction in systolic blood pressure after 7 minutes in the upright position vs lying down.
pressure index \((P<0.03)\) and big toe blood pressure \((P<0.001;\) Table 2).

**CMRI Measurements**

Coronary MRI was completed in 131 of the 136 subjects (96%). Ten percent of patients with nephropathy versus 0% of those with normoalbuminuria had CMRI evidence of coronary stenoses (1 vessel, 8%; 2 vessel, 2%) \((P<0.007\) versus normoalbuminuric).

Both subjects with ischemia on exercise testing showed evidence of coronary stenosis by CMRI. The CPB (mean and maximum RCA vessel wall thicknesses) was increased in patients with nephropathy compared with patients with normoalbuminuria (Table 3 and Figure 2). The prevalence of visually identifiable coronary plaque also was higher in subjects with nephropathy (76% versus 15%; \(P<0.001;\) Table 3). In patients with normoalbuminuria, all clinical characteristics were similar between the subset of subjects who had CPB assessment and those who did not. In subjects with nephropathy, systolic \((127\pm18\) versus \(139\pm17\) mm Hg; \(P=0.01)\) and diastolic \((67\pm8\) versus \(74\pm10\) mm Hg; \(P=0.01)\) blood pressures were lower in those subjects who underwent CPB scanning \((n=21)\) compared with those who did not \((n=42)\). Heart rate \((73\pm11\) versus \(97\pm8\) bpm; \(P=0.02)\) and statin use (33% versus 69%; \(P=0.007)\) also were lower in subjects who underwent CPB assessment.

CMRI of aortic atherosclerosis was completed in 128 of the subjects (94%). In 8 subjects, imaging was not completed or the image quality was inadequate for assessment. The prevalence of thoracic and abdominal plaques was similar in both patient groups \((P=NS;\) Table 4). Subjects with \((n=8)\) and without \((n=44)\) abdominal aortic plaques had similar CPB (mean vessel wall thickness, \(1.6\pm0.3\) versus \(1.5\pm0.3\) mm; \(P=0.15)\); maximum vessel wall thickness, \(2.0\pm0.4\) versus \(1.8\pm0.5\) mm; \(P=0.22)\).

The results of the multiple regression analysis of CPB for the clinical variables with at least 1 value of \(P<0.10)\) are summarized in Table 5. There was a significant association between CPB and the duration of diabetes (Figure 3) and total cholesterol level. In subjects with normoalbuminuria, CPB was significantly associated with systolic (significantly different from subjects with nephropathy; Figure 4) and diastolic blood pressure, whereas in patients with nephropathy, CPB showed an association with low-density lipoprotein cholesterol levels. After the effects of the clinical variables were accounted for, there was still a significant effect of nephropathy on CPB, with CPB being significantly higher for subjects with nephropathy compared with subjects with normoalbuminuria. Thus, for all clinical variables (independent variables), regression analysis showed significantly greater intercepts (ie, CPB) for subjects with nephropathy compared with subjects with normoalbuminuria (eg, Figure 3).

**Discussion**

To the best of our knowledge, the present study is the first to evaluate CPB and aortic plaque burden noninvasively in an asymptomatic cohort with long-standing type 1 diabetes.

In this cross-sectional study of 136 asymptomatic type 1 diabetic patients, CMRI revealed greater CPB and higher prevalence of coronary artery stenoses in patients with diabetic nephropathy compared with those with normoalbuminuria. None of our type 1 diabetic patients with normoalbuminuria had coronary artery stenoses or ischemia on
exercise testing, and the prevalence of subclinical coronary plaque was low (15%). These data suggest that asymptomatic patients with type 1 diabetes and normoalbuminuria are not necessarily at high risk of atherosclerotic cardiovascular disease, which is in accordance with the most recent prospective follow-up study and current European guidelines for the prevention of CHD.1

In comparison, the prevalence of asymptomatic coronary stenosis investigated with invasive coronary angiography was 47% among 110 pretransplant patients with type 1 diabetes21 and 34% in a cohort of 29 asymptomatic diabetics.22 These differences may be explained by clinical differences in the study groups and methodology and more recent intensified interventions toward reducing CHD risk factors.

Aortic plaque burden was similar between groups, and the prevalence of abdominal and thoracic plaques was comparable to a previously reported group of asymptomatic subjects from the Framingham Heart Study offspring cohort.7

Prior studies have shown an association between angiographically determined extent of coronary artery stenosis and atherosclerosis in the thoracic aorta in patients with CHD.23,24 In our population of asymptomatic type 1 diabetics, we found similar magnitudes of CPB in subjects with and without aortic atherosclerosis. Our data suggest that nephropathy is associated with a differential impact on aortic and coronary atherosclerosis and that coronary atherosclerosis is preferentially accelerated in subjects with nephropathy. A similar finding was reported from a prospective study, showing that peripheral artery disease and CHD in type 1 diabetes had different risk factors. Nephropathy was an independent risk factor for CHD but not for peripheral artery disease.25

Existing CHD risk prediction models have been developed with data from the general population or from patients with type 2 diabetes and therefore do not accurately predict cardiovascular events in type 1 diabetes.26 Furthermore, intensive contemporary cardioprotective and renoprotective medication has frequently been implemented, making risk stratification more challenging because the modifiable risk factors have already been favorably changed from baseline. Our data based on regression analysis showed that CPB was correlated to diabetes duration and present total cholesterol levels, whereas blood pressure showed a positive association with CPB only in patients with normoalbuminuria. The lack of correlation between blood pressure and CPB in patients with nephropathy most likely reflects the more intensive use of antihypertensive therapy. The cross-sectional design of our study precludes assessment of cardiovascular risk profile during the entire follow-up period; therefore, the long-term effect of modifiable risk factors on atherosclerosis could not be evaluated.

Cardiovascular autonomic neuropathy has been identified as an independent risk factor for cardiovascular morbidity and mortality in type 1 diabetic patients with nephropathy.29 Cardiovascular autonomic neuropathy results from damage to the autonomic nerve fibers that innervate the heart and blood vessels, resulting in abnormalities in heart rate control and vascular dynamics.30 The exact mechanism by which autonomic neuropathy increases cardiovascular risk in type 1 diabetes has not been fully elucidated; however, it is likely related to abnormalities in peripheral blood flow and autonomic control of cardiac function.

**TABLE 5. Factors Influencing CPB in Multiple Linear Regression Models**

| Variable                  | Subjects With Normoalbuminuria (N=68) | Subjects With Diabetic Nephropathy (N=60) |  
|---------------------------|---------------------------------------|------------------------------------------|---
| Thoracic plaque frequency, n (%) | 0 (0)                                  | 2 (3)                                    | 0.28  
| Thoracic VW volume, mm³    | 6718±1631                              | 7130±1594                                | 0.14  
| Thoracic APB, %            | 0±0                                    | 0.08±0.5                                 | 0.15  
| Thoracic SPB, %            | 0±0                                    | 0.4±2                                    | 0.12  
| Abdominal plaque frequency, n (%) | 11 (16)                                 | 13 (22)                                  | 0.7   
| Abdominal VW volume, mm³   | 5781±2725                              | 5330±2229                                | 0.31  
| Abdominal APB, %           | 0.68±1.9                               | 0.64±1.6                                 | 0.90  
| Abdominal SPB, %           | 0.76±2.1                               | 0.72±2.0                                 | 0.91  

VW indicates vessel wall; APB, area plaque burden; and SPB, slice plaque burden. Data are mean±SD when appropriate.

**LDL** indicates low-density lipoprotein; DN, diabetic nephropathy.

*P<0.05, significant regression; †P<0.05, significant difference in regression slope for +DN vs −DN.
diabetes is unknown. Our data did not show significant associations between CPB and cardiovascular autonomic neuropathy.

The development of atherothrombosis in the presence of nephropathy has been attributed to several mechanisms, including hypertension, dyslipidemia, and abnormalities of fibrinolysis and coagulation. Diabetic nephropathy is associated with an atherogenic lipoprotein profile, including elevated low-density lipoprotein, very low-density lipoprotein, and lipoprotein(a) and decreased high-density lipoprotein. Furthermore, a hypercoagulable state characterized by increased plasminogen activator inhibitor-I, factor VII, and plasma fibrinogen levels has been described. Reduced renal function can lead to the accumulation of advanced glycosylation end products in the circulation and tissue, which may accelerate atherosclerosis.

Noninvasive surrogate measures for cardiovascular disease events have the potential to increase the efficiency of clinical trials and to improve risk stratification. A leading candidate for such a surrogate is the carotid artery intima-media thickness. In the Epidemiology of Diabetes Interventions and Complications study, the carotid intima-media thickness of type 1 diabetics was related to conventional risk factors, including hypertension, dyslipidemia, and smoking, as well as urinary albumin excretion. Furthermore, intensive therapy presumably mediated through improved glycemic control resulted in decreased progression of intima-media thickness after 6 years. Whether the decrease in the progression of intima-media thickness translates into a reduction in cardiovascular events remains unknown.

The excess cardiovascular mortality in type 1 diabetes is present predominantly in patients with nephropathy. Despite favorable alteration in cardiovascular risk factors, 40% of type 1 diabetes patients with nephropathy (versus 10% with normoalbuminuria) develop cardiovascular events over a decade of follow-up.4

At baseline in 1993, the cohort of patients with diabetic nephropathy had elevated lipid levels and higher blood pressure compared with patients with normoalbuminuria. The high prevalence (76%) of coronary plaques compared with the relatively low prevalence (10%) of significant coronary stenosis in our patients with nephropathy confirms the concept of outward (positive or Glagov type) remodeling with preservation of lumen size despite the progression of atherosclerotic plaques. Outward arterial remodeling is more often associated with morphological predictors of plaque instability. Acute coronary syndromes frequently result from rupture of an atherosclerotic plaque in an area of only mild to moderate luminal narrowing. These data suggest that coronary atherothrombosis may play an important role in the overall high cardiovascular mortality in patients with nephropathy. Given the low number of ischemic exercise tests (3%) and coronary stenosis (10%) in subjects with nephropathy, screening this population with either cardiac exercise testing or noninvasive coronary angiography would not be appropriate for risk stratification. Furthermore, a large proportion (47%) of subjects with nephropathy were unable to achieve 80% of their maximum predicted heart rate with exercise, resulting in inconclusive test results. Current guidelines recommend stress testing in asymptomatic diabetic patients only if ≥2 risk factors are present or if the resting ECG suggests ischemia or infarction.

The assessment of coronary artery stenosis was based on visual inspection of the coronary angiograms using a previously validated approach with a sensitivity for detection of
significant coronary stenosis (compared with quantitative x-ray angiography) of 88% to 93%. Therefore, it is unlikely that the low prevalence of coronary stenoses in our study group was a false-negative finding. Furthermore, the reproducibility of CMRI for evaluating coronary and aortic atherosclerosis has been validated. Because of time constraints, only 54 subjects were able to have CPB assessments. Because CPB was not positively associated with blood pressures in subjects with nephropathy, it is unlikely that the lower blood pressures in those subjects with nephropathy who had CPB measured compared with those who did not have it measured would affect the observed difference in CPB between subjects with and without nephropathy. Other limitations include spatial resolution, analysis of CPB restricted to the RCA, and lack of plaque characterization.

Conclusions

A low prevalence of coronary stenoses was found in asymptomatic middle-aged patients with long-term type 1 diabetes on contemporary cardioprotective and renoprotective medication. However, CMRI identified a greater CPB in asymptomatic type 1 diabetic patients with nephropathy compared with those with normoalbuminuria. Given the well-known high risk of cardiovascular disease in patients with type 1 diabetes and nephropathy, the aortic plaque prevalence and plaque burden were unexpectedly low in this population. The prognostic value of CMRI awaits follow-up studies in subgroups of medium- to high-risk populations such as patients with type 1 diabetes.

Disclosures

Dr Parving is a current consultant to or has had a past relationship with the following companies: Merck & Co, Inc; Sanofi-Aventis; Novartis; Novo Nordisk A/S; and Pfizer, Inc. Dr Stuber was supported by a Biomedical Engineering Grant from the Whitaker Foundation (RG-02-0745) and a grant from the Donald W. Reynolds Foundation. Dr Stuber is compensated as a consultant by Philips Medical Systems NL, the manufacturer of equipment described in this presentation. The terms of this arrangement have been approved by the Johns Hopkins University in accordance with its conflict of interest policies. The other authors report no conflicts.

References

Patients with type 1 diabetes and nephropathy maintain an excess cardiovascular mortality compared with diabetic patients with normoalbuminuria. Risk assessment in asymptomatic patients with type 1 diabetes is less stringent than for type 2 diabetes, and the effect of diabetic nephropathy on atherosclerosis in type 1 diabetes is not well described. In this cross-sectional study of 136 asymptomatic type 1 diabetic patients with long-standing diabetes, cardiovascular magnetic resonance imaging revealed greater coronary plaque burden and higher prevalence of coronary artery stenoses in patients with diabetic nephropathy compared with those with normoalbuminuria. These data suggest that coronary atherothrombosis may play an important role in the overall high cardiovascular mortality in patients with type 1 diabetes and nephropathy.
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_Circulation_. 2007;115:228-235; originally published online December 26, 2006; doi: 10.1161/CIRCULATIONAHA.106.633339

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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