

Table 1. Clinical characteristics and lipid profile of patients

	Asymptomatic patients with NIDDM (n=136)	Patients with Coronary artery disease (n=37)
Age	59.8 ± 8.4	58.2 ± 7.4
Gender(female %)	57(43.5)	11(26.2)
WHR	0.97 ± 0.19	0.96 ± 0.05
BMI(Kg/m ²)	24.2 ± 3.1	24.5 ± 3.5
Fibrinogen(mg/dL)	384.4 ± 165.7	401.5 ± 137.6
Lp(a)(mg/dL)	32.4 ± 33.7	35.9 ± 27.4
Hypertension(%)	76(58.0)	16(38.1)
Smoking(%)	47(35.9)	27(64.3)
Family history of VD(%)	76(58.0)	19(45.5)
Total cholesterol(mg/dL)	204.0 ± 49.7	190.0 ± 105.1
Triglyceride(mg/dL)	193.0 ± 183.8	167.2 ± 105.1
HDL-cholesterol(mg/dL)	37.1 ± 9.2	38.9 ± 9.5
LDL-cholesterol(mg/dL)	123.8 ± 47.1	122.3 ± 45.0

WHR: waist-hip circumference ratio

BMI: body mass index

VD: cerebrovascular, cardiovascular, coronary vascular disease

Table 2. Clinical characteristics of 136 diabetic patients

Duration after diagnosis (years)	12.0 ± 8.4
Hemoglobin A1c(%)	9.7 ± 2.6
Fasting insulin(μU/ml)	10.6 ± 15.0
Fasting C-peptide(ng/ml)	2.0 ± 1.4
Body fat component(%)	21.9 ± 6.7
Current treatment of diabetes(%)	
Diet & Exercises only	31(23.7)
Oral agent	65(49.5)
Insulin	35(26.7)

가 , 가 , 가

CAC

(WHR) , (BMI)

CAC 1

Hitachi 736-40

, HDL dextran

sulfate MgCl₂

HbA1c HPLC , Lp(a)

(Immunozyeme LP(a), IMMUNO GHBH HEIDELBERG)

C-

(INCSTAR Corporation- Stillwater, Minnesota, USA)

2) (CAC)

EBT(IMATRON Ultrafast CT, USA)

(50 msec)

1) , 가 R-R

(Fig 1).

가 50%
 10).
 4) CAC 가
 ,
 .
 CAC
 가 Pearson's
 correlation student's unpaired
 t-test . CAC
 가
 CAC
 stepwise proce-
 dure 가
 CAC
 one-way ANOVA
 p 0.05

Fig 1. Scanning of coronary artery calcification by electron beam tomography

80% EKG gate ,
 3mm 40
 , CAC . CAC
 Agatston (pixel : 0.5mm²) EBT 136 CAC
 309.8 ± 718.6 , 91 (66.9%)
 CT number 130- 199HU (housefield unit) 1 ,
 200- 299HU 2 , 300- 399HU 3 , 400HU 4
 9).
 7
 EBT CAC .
 3)
 , CAC
 가
 가
 17
 , 가 CAC
 .

Fig 2. The distribution of coronary calcium score in asymptomatic diabetic patients and CAOD* patients
 *CAOD : coronary artery obstructive disease

Table 3. Age and sex distribution of coronary calcium score

Age(years)	CAC(mean ± SD)			
	Male	(N)	Female	(N)
40- 50	93.9 ± 172.6	(19)	3.6 ± 6.4	(3)
50- 60	370.0 ± 963.3	(43)	83.7 ± 183.0	(35)
60- 70	464.9 ± 724.8	(34)	111.7 ± 223.6	(23)
70-	681.2 ± 1419.9	(9)	549.3 ± 293.2	(7)
Total	377.5 ± 852.6	(105)	137.5 ± 293.6	(68)

CAC: coronary artery calcification score

가 (p<0.01)(Table 3).

2. CAC

, 가 CAC
가 가
, HDL

Fig. 3. The distribution of coronary calcium score according to hypertension duration of diabetes and smoking (Represents natural-log transformed value)

가 , (Fig. 3, 4).

(BMI),
(WHR),
C-

, HDL
가 CAC

(Table 4). CAC

, , HDL

Fig 4. Coronary calcium score distribution according to lipid profile (Represents natural-long transformed value)

, CAC
(Table 5).

CAC 200.5 ± 629.0
CAC
(p>0.05)(Fig 2).
가 CAC 가 (p<0.01),

, National Cholesterol Education Program (NCEP) Expert PanelII), , HDL
, 가
가 가

Table 4. Univariate analysis predicting natural log of coronary calcium score by simple linear regression and age & sex adjustment

		p- value	Age & Sex adjustment	
				p- value
Age	0.31	< 0.001		
Gender(male)	0.17	< 0.05		
HDL- cholesterol(mg/dL)	- 0.37	< 0.001	- 0.36	< 0.001*
Duration of diabetes	0.29	< 0.001	0.20	< 0.01*
Smoking amount(pack years)	0.23	< 0.05	0.17	0.14
Family or past history of VD	0.23	< 0.05	0.19	< 0.01*
Hypertension duration(years)	0.18	0.09	0.17	0.11
BMI(kg/m ²)	- 1.26	0.11	- 0.08	0.28
WHR	0.08	0.45	0.11	0.28
VSR	0.05	0.77	- 0.004	0.98
VTR	0.25	0.09	0.09	0.60
Fasting insulin(μ U/ml)	- 0.15	0.95	- 0.11	0.41
Fasting C- peptide(μ U/ml)	0.19	0.93	0.06	0.65
Body fat composition	0.09	0.50	0.10	0.54

BMI: body mass index, WHR: waist hip circumference ratio
 VSR: visceral fat versus subcutaneous fat area ratio
 VTR: visceral fat versus thigh muscle area ratio
 : regression coefficient

Table 5. Multiple linear regression predicting coronary artery calcification score

Risk factor	Standardized coefficients()	R square	p- value
Age	0.35	0.14	< 0.001
HDL cholesterol	0.34	0.27	< 0.001
Duration of DM	0.20	0.32	< 0.01
Gender(male)	0.18	0.35	< 0.01

* Represent natural-log transformation value; regression was computed using natural-log transformed calcium score as dependent variable

가 CAC 가
 가
 (Fig 5).

3.

, CAC
 가 17
 , 1

16

Fig. 5. The distribution of Coronary calcium score according to the sum of the numbers of atherosclerosis risk factors (Represents natural-long transformed value)

Table 6. Coronary angiography and CAC of asymptomatic NIDDM patients

No of vessel showing stenosis	N(%)	CAC	(range)
1 vessel disease	2(11.7)	18.5 ± 16.2	(7- 30)
2 vessel disease	6(35.3)	844.8 ± 1011.6	(54- 2832)
3 vessel disease	8(47.0)	1334.5 ± 1541.2	(511- 4857)
Normal coronary	1(5.9)	335	
Total	17	986.4 ± 1283.4	(7- 4857)

Table 7. Coronary artery calcification score and prevalence of detectable calcium in all arteries of 53 patients with coronary artery disease

	N	CAC	Detectable calcium(%)
1 vessel disease	17	90.5 ± 294.4	58.5
2 vessel disease	18	631.0 ± 1069.1	100
3 vessel disease	18	890.2 ± 1124.7	94.4
Total	53	521.7 ± 953.6	84.9

CAC: coronary artery calcification score

14 가 2 (Table 6). 2 4 ,

4. CAC 가 ,

CAC 가 ,

37 13, 14. 가

16 가

CAC 53 .

45 (84.9%) 가 ,

가 CAC가 (p<0.01).

17 7 (41.2%) (Table 7).

5, 6.

가 가 가 ,

12. 가 ,

가 ,

15, 16. 가

가 , (plaque in risk) 17-19). 가 , . Wong 25) 595 CAC 가 가 , CAC 가 500 2 23.3% 가 , CAC 가 (ectopic bone matrix proteins) 20). 가 21). CAC 가 22). EBT 가 CAC 가 26, 27). CAC 가가 , 가 28). , CAC 71% 91% 가 . Wong 703 23), Arad 1173 CAC 89% 77% 가 24). , CAC 가 29). CAC 가 50

가
CAC 가 32) CAC
40 8 (Natural log of CAC:2), 40
가 , 56 (Natural log of CAC:4) ,
(49.3%)가 136 67
CAC 가 , 1
, HDL 가 3
CAC
가
가
17 16
14 2
CAC 가 가 가
30).
가
CAC 가
, HDL 가
31). , HDL , CAC 가 가
가 LDL ,
small, dense LDL 가 ,
, CAC
LDL Fradiewald
가 , 가 가
CAC 가
, thalium 201
가
가
CAC 가
가

가 가 , CAC
 EBT
 CAC 가
 53 CAC
 가 가 CAC 가 가 , C-
 (42.2%) 17 7 CAC
 가 . CAC
 25% CAC 가 가
 33). CAC 가 0 가
 가
 , Helsinki study group
 가 가 36),
 (0.5mm2) CAC 가
 , CAC 가 가
 가 CAC
 가
 가 CAC EBT CAC
 가 가
 CAC 가 가
 (clustering)
 34). CAC
 가 가
 가 가
 가
 가
 35). CAC 가 , 가 가
 가 , 가

(42.4%)

: EBT CAC

(electron beam computed tomography, EBT)가

가
가

가

가

40

136

37

(CAC) EBT

3mm

CT number

Hemoglobin A1c

2

, C-

, Lp(a)

. CAC 가

17

CAC

가

($p < 0.01$),

($p > 0.05$).

, HDL

CAC

($p < 0.05$),

($p < 0.05$). CAC

, HDL

. CAC 가

17

, 16

53

CAC

17

7

= Abstract =

Coronary Artery Calcification Quantified by Electron Beam Tomography as a Screening for Coronary Artery Disease in Asymptomatic Non- Insulin- Dependent- Diabetes Mellitus

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Background : Patients with NIDDM are at increased risk for the development of coronary atherosclerosis and experience more silent myocardial infarction than non-diabetic subjects. The screening tools for early detection of coronary artery disease without significant narrowing has been requested in diabetic patients. Coronary artery calcification (CAC) score, quantified by electron beam computed tomography (EBT), have been reported to correlate with the amount of atherosclerotic plaque and vascular luminal narrowing.

We investigated the distribution of CAC score and associated risk factors in asymptomatic NIDDM patients and patients with ischemic heart disease to estimate the usefulness of CAC as a screening tool for ischemic heart disease in asymptomatic diabetes.

Method : 136 NIDDM patients without any symptom of coronary artery disease and 37 patients with significant coronary artery stenosis were included. CAC were measured by electron beam tomography (ultrafast CT). Forty contiguous 3-mm thickness transverse two-dimensional sections were obtained through root of aorta and heart. Coronary calcification were defined as the presence of at least two adjacent pixel within the border of visualized coronary artery with CT number of at least 130 HU. Body mass index, waist-hip ratio were measured and body fat components were counted by impedance method. Visceral fat versus subcutaneous fat ratio were calculated by abdominal computed tomography. Plasma lipid profile, fasting insulin, C-peptide level, HbA1c concentration were measured. Correlations between natural log of CAC score and clinical parameters were evaluated and multiple regression analysis with natural log of CAC score as a independent variable was performed. Coronary angiography were performed in 17 asymptomatic NIDDM patients..

Result : CAC score was significantly higher in male than female subjects and increased significantly with aging ($p < 0.01$). In patients with hypertension, previous history of cerebrovascular or peripheral vascular disease ($p < 0.05$), CAC score was significantly increased. The CAC score showed significant positive correlations with smoking amount, duration of diabetes and a negative correlation with HDL-cholesterol ($p < 0.05$). There were no association between CAC score and total cholesterol, LDL-cholesterol, waist to hip circumference ratio, or fasting insulin levels. After adjustment of compounding variables (age, sex), duration of diabetes, amount of smoking and previous history of atherosclerotic vascular disease were shown to be associated with CAC score. In multiple logistic regression analysis with natural log of CAC score as dependent variable, age, HDL-cholesterol, duration of diabetes, male gender were found to be significant independent variables. Seventeen diabetic patients with high CAC score, were taken coronary angiography and significant luminal narrowings (more than 50%) of coronary artery were documented in 16 patients. But, In 7 out of 17 patients with coronary one-vessel disease, coronary calcification were not detected by EBT.

Conclusion : coronary artery calcium score quantified by electron beam computed tomography may be useful for screening of preclinical or asymptomatic coronary

artery disease in asymptomatic NIDDM patients.

Key Words : Coronary artery calcification score, Diabetes Mellitus

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