

## 관상동맥경화증의 정도와 내장지방비만과의 관계

서정기<sup>1</sup> · 김동수<sup>2</sup> · 권혁문<sup>2</sup> · 장양수<sup>2</sup> · 김현승<sup>2</sup> · 조홍근<sup>3</sup> · 조은영<sup>4</sup> · 이종호<sup>4</sup>

## Severity of Coronary Artery Disease and Visceral Fat Obesity

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## ABSTRACT

**Background :** The visceral fat obesity is known to be associated with coronary artery disease. We investigated the relation between visceral fat obesity and the severity of coronary artery disease by angiography. **Methods :** The coronary artery disease (CAD) group included 54 angina patients (43 men and 11 women) with angiographically demonstrated coronary artery disease. The control group included angiographically normal 28 controls (15 men and 13 women). The subjects with hypertension, non-insulin dependent diabetes mellitus (NIDDM) and taking any medication known to affect the insulin sensitivity were excluded. We measured the visceral fat area, abdominal subcutaneous fat area, thigh muscle area and the thigh fat area with computed tomography (CT) in both groups. We measured the plasma lipid profile, fasting plasma insulin and glucose level in both groups. **Results :** There were no differences in the age, sex ratio and body mass index (BMI) between both groups. Total cholesterol and triglyceride increased in CAD group significantly ( $p < 0.05$ ,  $p < 0.001$ ). The HDL cholesterol decreased in CAD group. But there was no statistical significance ( $p = 0.056$ ). The fasting insulin increased in CAD group significantly ( $p < 0.001$ ). There were significant differences between CAD group and the control group in the visceral fat area ( $117.8 \pm 34.4 \text{ cm}^2$  vs.  $85.5 \pm 17.6 \text{ cm}^2$ ,  $p < 0.001$ ), thigh fat area ( $50.0 \pm 22.3 \text{ cm}^2$  vs.  $65.8 \pm 12.9 \text{ cm}^2$ ,  $p < 0.001$ ), visceral fat to abdominal subcutaneous fat area ratio (VS ratio :  $0.81 \pm 0.31$  vs.  $0.51 \pm 0.15$ ,  $p < 0.001$ ) and the visceral fat to thigh fat area ratio (VSFTF ratio :  $2.72 \pm 1.24$  vs.  $1.34 \pm 0.35$ ,  $p < 0.001$ ). In the male subgroup (CAD : 43, control : 15), triglyceride and fasting insulin increased in CAD group significantly ( $p < 0.001$ ). The visceral fat area, VS ratio, and VSFTF ratio increased in CAD group significantly ( $p < 0.001$ ). The thigh fat area decreased in CAD group significantly ( $P < 0.001$ ). In the female subgroup (CAD : 11, control : 13), fasting insulin and visceral fat area increased in CAD group significantly ( $p < 0.001$ ,  $p < 0.05$ ). Multiple logistic regression analysis revealed that VSFTF ratio, fasting insulin and the HDL cholesterol were independent associated factors of coronary artery disease. In comparison with normal control, one-vessel disease and multi-vessel disease (two vessel and three vessel), there were significant differences between groups in fasting insulin, triglyceride,

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visceral fat area, thigh fat area, VS ratio, VSFTF ratio. In Turkey's HSD Post Hoc test, however, there were no significant differences between one-vessel disease and multi-vessel disease. **Conclusion** : We observed significant increases in the visceral fat area, VS ratio and VSFTF ratio and decrease in thigh fat area in angiographically demonstrated CAD group compared with age, BMI matched angiographically normal control. But we did not observed any relation between the visceral fat area and the severity of coronary disease by angiography. (**Korean Circulation J 1998;28(7):1176-1184**)

**KEY WORDS** : Coronary artery disease · Thigh fat area · Visceral fat area · Visceral fat to abdominal subcutaneous fat area ratio · Visceral fat to thigh fat area ratio.

## 서 론

1-3) . . . . . (One vessel disease group ; 28 ; 21 , 7 ), (Multi - vessel disease group ; 26 ; 22 , 4 )

4) . . . . . 120 mg/dl

5)6) . . . . .

Periris (Computed Tomography ; CT) . . . . . 방 법

7) . . . . . 2 8 30 , HDL

8) . . . . . 가 (body mass index : BMI), (IBW)

9)10) . . . . . CT (GE 9800 Hilight Advantage , GE Co., USA) Hounsfield number가

대 상 . . . . . - 150 - 50 - 49 + 100 (visceral fat area), (sub - cutaneous fat area), (visceral fat to subcutaneous fat area ratio : VS ratio), (thigh fat area)

1997 5 1 9 30 . . . . . 40 67 (coro - . . . . .)

2) . . . . . (28 ; 15 , 13 )

50%

(visceral fat to thigh fat area ratio : VSFTF ratio)

IBM PC SPSSWIN 7.0

Student's t-test

Wilcoxon - rank sum test

(Analysis of Variance) test

Post Hoc test Turkey's HSD(honestly significant difference) test

Chi-square test

Multiple logistic regression

가 P 0.05

**결 과**

대조군과 환자군의 비교

54.2 ± 6.3  
 56.6 ± 6.6 가 BMI,  
 LDL , 가  
 192.4 ± 32.5 mg/dl, 155.6 ± 59.6 mg/dl, 10.3 ± 3.1 μIU/ml  
 176.5 ± 30.7 mg/dl, 116.0 ± 34.8 mg/dl, 5.0 ± 2.21 μIU/ml  
 HDL 36.2 ± 10.5 mg/dl  
 40.9 ± 9.7 mg/dl (p = 0.056, Table 1).

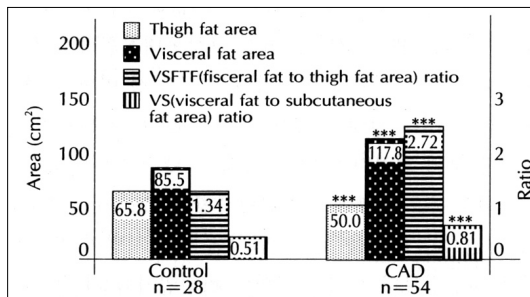
65.8 ± 12.9 cm<sup>2</sup>,  
 50.0 ± 22.3 cm<sup>2</sup>  
 (p < 0.001).

85.5 ± 17.6 cm<sup>2</sup>, 1.34 ± 0.35, 0.51 ± 0.15,  
 117.8 ± 34.4 cm<sup>2</sup>, 2.72 ± 1.24, 0.81 ± 0.31 가 (p < 0.001, Fig. 1).

**Table 1.** Clinical features of the control and the CAD group

	Control (n = 28)	CAD (n = 54)
Age (years)	54.2 ± 6.3	56.6 ± 6.6
BMI (kg/m <sup>2</sup> )	24.0 ± 2.1	24.9 ± 2.6
Total cholesterol (mg/dl)	176.5 ± 30.7	192.4 ± 32.5*
LDL cholesterol (mg/dl)	112.4 ± 32.0	124.4 ± 27.5
HDL cholesterol (mg/dl)	40.9 ± 9.7	36.2 ± 10.5 <sup>‡</sup>
Triglyceride(mg/dl)	116.0 ± 34.8	155.6 ± 59.6***
Fasting glucose(mg/dl)	93.8 ± 7.3	95.0 ± 11.2
Fasting insulin(μIU/ml)	5.0 ± 2.2	10.3 ± 3.1***

CAD : coronary artery disease BMI : body mass index  
 ‡ ; p = 0.056, \* ; p < 0.05, \*\*\* ; p < 0.001



**Fig. 1.** Thigh fat area, visceral fat area, VSFTF ratio and VS ratio of the control and the CAD group. \*\*\* ; p < 0.001 versus control

**Table 2.** Clinical features of the male control and the male CAD group

	Control (n = 15)	CAD (n = 43)
Age (years)	53.1 ± 5.9	55.9 ± 6.2
BMI (kg/m <sup>2</sup> )	24.5 ± 2.1	24.7 ± 2.4
Total cholesterol (mg/dl)	174.7 ± 29.2	193.9 ± 34.1
LDL cholesterol (mg/dl)	111.8 ± 30.0	126.6 ± 29.5
HDL cholesterol (mg/dl)	39.7 ± 7.7	34.8 ± 10.4
Triglyceride (mg/dl)	116.3 ± 34.9	162.6 ± 62.9***
Fasting glucose (mg/dl)	95.4 ± 7.5	94.6 ± 11.5
Fasting insulin (μIU/ml)	5.1 ± 1.9	10.1 ± 3.2***

CAD : coronary artery disease BMI : body mass index  
 \*\*\* ; p < 0.001

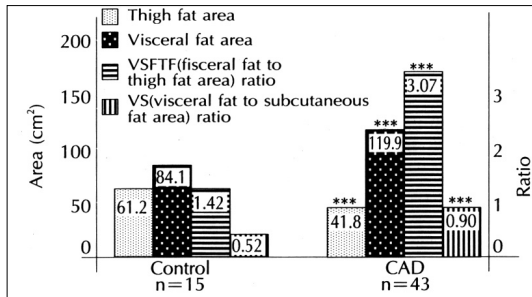
남녀에 따른 분류에 의한 분석

, BMI,  
 , LDL , HDL  
 (15 ) (43 ) 가  
 (162.6 ± 62.9 mg/dl vs. 116.3

$\pm 34.9$  mg/dl,  $10.1 \pm 3.2$   $\mu$ IU/ml vs.  $5.1 \pm 1.9$   $\mu$ IU/ml,  $p < 0.001$ , Table 2).

$61.2 \pm 13.1$  cm<sup>2</sup>,  $41.8 \pm 13.1$  cm<sup>2</sup> ( $p < 0.001$ ).

$84.1 \pm 17.9$  cm<sup>2</sup>,  $119.9 \pm 35.5$  cm<sup>2</sup>,  $1.42 \pm 0.34$ ,  $0.52 \pm 0.14$ ,  $3.07 \pm 1.15$ ,  $0.90 \pm 0.29$  가



**Fig. 2.** Thigh fat area, visceral fat area, VSFTF ratio and VS ratio of the male control and the CAD group. \*\*\* ;  $p < 0.001$  versus control

**Table 3.** Clinical features of the female normal and the female CAD group

	Control (n=13)	CAD (n=11)
Age (years)	$55.5 \pm 7.0$	$59.3 \pm 7.3$
BMI (kg/m <sup>2</sup> )	$23.6 \pm 2.0$	$25.6 \pm 3.4$
Total cholesterol (mg/dl)	$178.6 \pm 33.6$	$186.7 \pm 25.7$
LDL cholesterol (mg/dl)	$113.1 \pm 35.5$	$115.0 \pm 13.3$
HDL cholesterol (mg/dl)	$42.4 \pm 11.7$	$42.8 \pm 9.2$
Triglyceride (mg/dl)	$115.8 \pm 36.2$	$128.2 \pm 34.6$
Fasting glucose (mg/dl)	$91.8 \pm 6.9$	$96.6 \pm 10.2$
Fasting insulin ( $\mu$ IU/ml)	$4.8 \pm 2.6$	$11.0 \pm 2.7^{***}$

CAD : coronary artery disease BMI : body mass index \*\*\* ;  $p < 0.001$ ,

**Table 4.** Clinical features of the control group, one vessel disease group and the multi-vessel disease group

	Control (n=28)	One vessel disease (n=28)	Multi-vessel disease (n=26)	Significance of F
Age (years)	$54.2 \pm 6.3$	$55.9 \pm 6.5$	$57.4 \pm 6.8$	NS
BMI (kg/m <sup>2</sup> )	$24.0 \pm 2.1$	$24.7 \pm 3.2$	$25.1 \pm 1.9$	NS
Total cholesterol (mg/dl)	$176.5 \pm 30.8$	$191.7 \pm 34.6$	$193.2 \pm 32.6$	NS
LDL cholesterol (mg/dl)	$112.4 \pm 32.0$	$123.4 \pm 30.8$	$125.5 \pm 23.8$	NS
HDL cholesterol (mg/dl)	$40.9 \pm 9.7$	$37.4 \pm 8.8$	$35.1 \pm 12.3$	NS
Triglyceride (mg/dl)	$116.0 \pm 34.8$	$154.6 \pm 60.1^*$	$156.6 \pm 60.3^*$	0.008
Fasting glucose (mg/dl)	$93.8 \pm 7.3$	$95.1 \pm 11.0$	$94.9 \pm 11.6$	NS
Fasting insulin ( $\mu$ IU/ml)	$5.0 \pm 2.2$	$9.9 \pm 2.3^{***}$	$10.6 \pm 3.8^{***}$	<0.001

CAD : coronary artery disease BMI : body mass index \* ;  $p < 0.05$  versus control, \*\*\* ;  $p < 0.001$  versus control

( $p < 0.001$ , Fig. 2).

, BMI, , LDL , HDL , (11 ) (13 ) 가 .

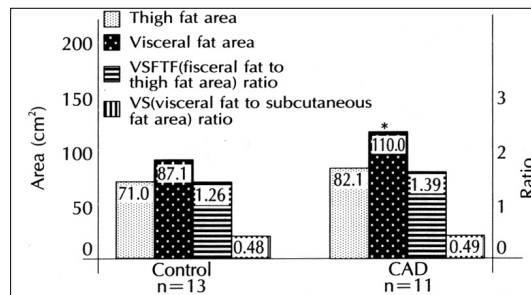
$11.0 \pm 2.7$   $\mu$ IU/ml vs.  $4.8 \pm 2.6$   $\mu$ IU/ml,  $p < 0.001$ , Table 3).

가 . 가 ( $110.0 \pm 29.9$  cm<sup>2</sup> vs.  $87.1 \pm 18.0$  cm<sup>2</sup>,  $p < 0.05$ , Fig. 3).

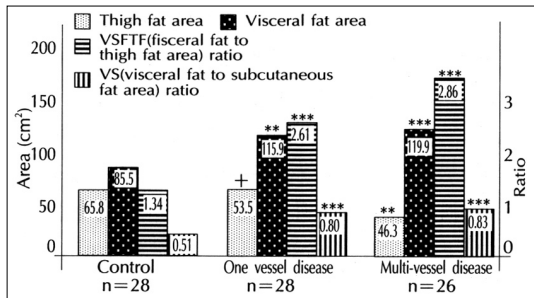
대조군과 단혈관 병변군 및 다혈관 병변군에 따른 분석 , BMI, , LDL , HDL 가 . 가

. Post Hoc test

가



**Fig. 3.** Thigh fat area, visceral fat area, VSFTF ratio and VS ratio of the female control and the female CAD group. \* ;  $p < 0.05$  versus control



**Fig. 4.** Thigh fat area, visceral fat area, VSFTF ratio and VS ratio of the control, one vessel disease and the multi-vessel disease.

**Table 5.** Odds ratio for coronary artery disease by the visceral fat area, VS ratio and the VSFTF ratio (n = 82)

	Odds ratio for coronary artery disease	Significance
Visceral fat area (110cm <sup>2</sup> )	8.0(2.1 31.5)	<0.001
VS ratio (0.4)	3.6(1.6 8.2)	<0.001
VSFTF ratio (1.90)	9.5(2.5 36.8)	<0.001

VS ratio ; visceral fat to abdominal subcutaneous fat area ratio, VSFTF ratio ; visceral fat to thigh fat area ratio

**Table 6.** Multiple logistic regression analyses with visceral fat area, VS ratio, VSFTF ratio and BMI as independent risk factors of coronary artery (n = 82)

	R	Significance	Exp (B)
VSFTF ratio (1.90) §	0.29	0.01	14.7
Visceral fat area (110 cm <sup>2</sup> ) †	0.13	0.05	5.5
VS ratio (0.4) ‡	-	-	-
BMI	-	-	-

VSFTF ratio ; visceral fat to thigh fat area ratio, BMI ; body mass index VS ratio ; visceral fat to abdominal subcutaneous fat area ratio, Dependent variable; 0, in the case of control, 1, in the case of coronary artery disease

§ ; 1 if VSFTF ratio is 1.90

† ; 1 if visceral fat area is 110 cm<sup>2</sup>

‡ ; 1 if VS ratio is 0.4

가 (Table 4).

가 (Significance of F<0.001, Fig. 4).

Post Hoc test

가

가 (Fig. 4).

**Table 7.** Multiple logistic regression analyses with visceral fat area, VSFTF ratio, fasting insulin, total cholesterol, triglyceride and HDL cholesterol as independent risk factors of coronary artery disease (n = 82)

	R	Significance	Exp (B)
VSFTF ratio (1.90) §	0.29	0.001	71.6
Visceral fat area (110 cm <sup>2</sup> ) †	-	-	-
Fasting insulin (μIU/ml)	0.33	0.0004	2.2
Total cholesterol(mg/dl)	-	-	-
Triglyceride(mg/dl)	-	-	-
HDL cholesterol(mg/dl)	0.17	0.026	0.9

VSFTF ratio ; visceral fat to thigh fat area ratio, Dependent variable; 0, in the case of control, 1, in the case of coronary artery disease

§ ; 1 if VSFTF ratio is 1.90

† ; 1 if visceral fat area is 110 cm<sup>2</sup>

관상동맥경화증의 위험인자

가

110 cm<sup>2</sup>

가 0.4

Odds ratio가 8.0, 3.6

75per -

centile 1.9

1.9

Odds ratios 9.5 (Table 5).

BMI

multiple logistic regression

(Table 6).

, , HDL  
multiple logistic regression

(R =

0.29),

(R = 0.33)

HDL

(R =

= - 0.17)

(Table 7).

고 안

. Vague

BMI

가 가

<sup>11)</sup> Kissebah

lipoprotein lipase hormone sens-  
itive lipase 가 가

<sup>5)</sup> 1980

<sup>22)23)</sup>

<sup>12)13)</sup> Tarui

(VS ratio)가 0.4 가 가

가 가

<sup>14)</sup> Williams 가 가

4 110 cm<sup>2</sup> lipop-  
40 cm<sup>2</sup>

<sup>15)</sup> Nakamura rotein lipase 가

, BMI가 ,

가 <sup>24)</sup> 가

<sup>16)</sup> 가 <sup>25)</sup>

가 가

가 가

가 가

<sup>17)18)</sup> 가 가

<sup>19)</sup> 가 가

<sup>20)</sup> 가 가

, BMI가 (score of severity)

<sup>26)</sup>

가

score <sup>27)</sup> Zamboni Reardon

Caprio

LDL

<sup>21)</sup> (scale)가 (arbitrary)

가  
luminogram  
가  
(Intravascular Ultrasound ;  
IVUS)

요 약

<sup>14)</sup> 연구배경 :  
1) 가 <sup>2)</sup>

가  
방 법 :  
가 54 28  
CT  
euglycemic insulin clamp  
결 과 :  
1) , HDL (p=0.056).  
<sup>28)</sup> San Antonio Heart Study  
2) , (p<0.001).  
가 <sup>29)</sup> Nakamura  
3) 가 (p<0.001).  
<sup>16)</sup> Kim , BMI, , LDL (15 )  
60 가 , HDL (43 ) 가  
가 <sup>30)</sup> Jung (p<0.001).  
가 4) (p<0.001).  
<sup>31)</sup> Kim Jung ,  
가 Kim 가 (p  
가 가 <0.001).  
5) (p<0.001).  
가 가 6)

7) , ,  
( $p < 0.05$ ).

8) (R = 0.29),  
(R = 0.33) HDL (R = - 0.17)

## 결론

, BMI가

가 가

중심 단어 :

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