

## CHAPTER IV

### RESULTS

#### 1. Subjects

I examined aerobic capacity in Thai patients with suspected CAD (N = 50, 34 men, 16 women). According to evaluation from EST; 32 subjects were categorized as “negative” and 18 as “positive”. After that 4 subjects of positive and 4 subjects from negative EST were confirmed CAD by echocardiography and coronary angiography performed by the physician. Therefore, 16% of patients with suspected CAD who were finally diagnosed CAD (3 men, 5 women, aged  $52.75 \pm 9.10$  years).

Their baseline characteristics are displayed in Table 4. Age was higher in subjects with positive vs. negative EST ( $58 \pm 7.47$  and  $53 \pm 8.33$  years;  $p < 0.001$  respectively).

There were no significant differences in anthropometry (height, weight, waist circumference and hip circumference) and body composition (fat mass and fat free mass) between subjects with negative and positive EST (Table 4).

Those risks include smoking ( $\geq 2$  packs of cigarette/week) ( $p = 0.001$ ), alcohol consumption ( $\geq 25$  g/day) ( $p = 0.004$ ), HT ( $p = 0.004$ ), DM ( $p < 0.001$ ), family history of CAD ( $p < 0.006$ ) and physical activity ( $\geq 3$  times/week) ( $p = 0.001$ ) (Table 5).

CAD patients had smoking ( $\geq 2$  packs of cigarette/week) (10%) HT (30%), DM (20%), and physical activity ( $\geq 3$  times/week) (40%). Furthermore, CAD patients had no history of alcohol consumption ( $\geq 25$  g/day) (Figure 5).

**Table 4** Baseline characteristics of subjects

<b>Variables</b>	<b>Negative EST (n=32)</b>	<b>Positive EST (n=18)</b>	<b>p value</b>
Age (yrs)	53±8.33	58±7.47	<0.001
Sex (M/F)	21/11	13/5	NS
Height (cm)	161±6.97	161±8.18	NS
Body mass (kg)	64±9.48	64±13.05	NS
BMI (kg/m <sup>2</sup> )	25±3.44	25±4.18	NS
%body fat	25±5.67	25±4.01	NS
FM (kg)	16±5.45	16±3.79	NS
FFM (kg)	46±11.19	48±10.87	NS
W/H ratio	0.90±0.56	0.90±0.06	NS

Values are expressed as means ± SD

NS, no significantly different; EST, exercise stress test; M, male; F, female; BMI, body mass index; %BF, percentage of body fat; FM, fat mass; FFM, fat free mass; W, waist; H, hip

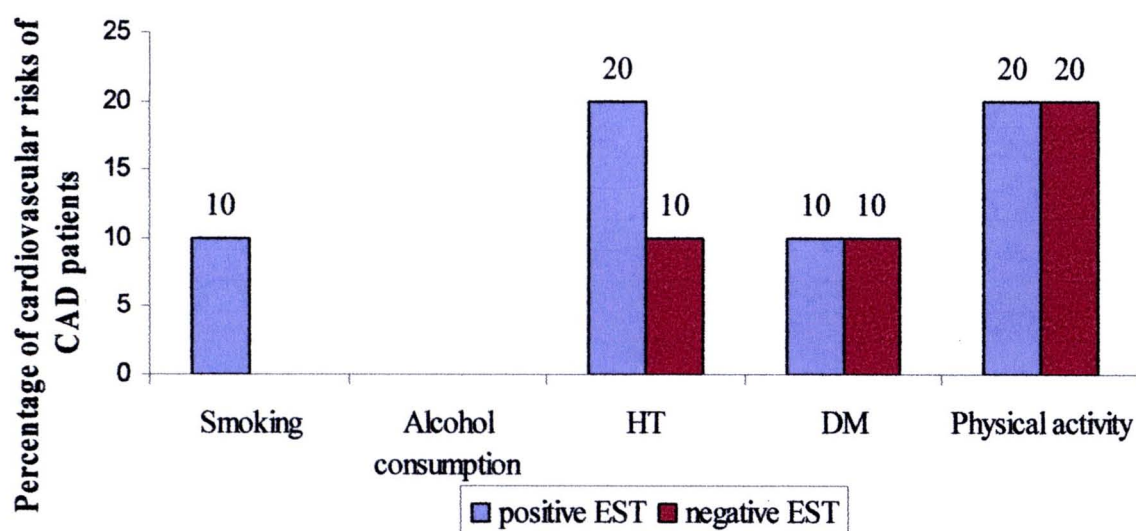
**Table 5** Cardiovascular risks in negative and positive EST groups

Cardiovascular risks	Negative EST (n=32)	Positive EST (n=18)	p value
Smoking ( $\geq 2$ packs of cigarette/week)	15.63% (5)	16.67% (3)	0.001
Alcohol consumption ( $\geq 25$ g/day)	25% (8)	22.22% (4)	0.004
DM	9% (3)	22.22% (4)	<0.001
HT	31% (10)	33.33% (6)	0.004
Family history of CAD	6% (2)	5.56% (1)	0.006
Physical activity ( $\geq 3$ times/week)	41% (13)	61.11% (11)	0.001

Values are expressed as percent (n).

NS, no significantly different; EST, exercise stress test; DM, diabetes mellitus;

HT, hypertension



**Figure 5** Percentage of cardiovascular risks of CAD patients with negative (n=4) and positive EST (n=4)

Values are expressed as percent

DM, diabetes mellitus; HT, hypertension; CAD, coronary artery disease

## 2. EST

During the EST, maximal HR ( $p=0.043$ ), 85% of maximal HR ( $p=0.048$ ), peak HR ( $p<0.001$ ), and energy expenditure ( $p=0.014$ ) were lower in subjects with positive than negative EST (Table 6). In contrast, there were no significant differences between groups in resting and peak values before the cessation of the EST of HR, mean arterial pressure (MAP), SBP and DBP. In addition, there was no significant difference between groups in duration of the EST.

HRR at 1 minute were higher in subjects with negative than positive EST ( $28.09\pm 12.39$  beats and  $16.39\pm 10.47$  beats,  $p=0.001$ , respectively). In addition, 33.3% of subjects with positive EST had abnormal HRR ( $<12$  beats) whereas no subject in negative EST had abnormal HRR.

Subjects with positive EST had lower HR reserve than those with negative EST ( $55.09\pm 18.82$  % and  $84.25\pm 22.42$  %;  $p<0.001$ ). There was significant difference in HR reserve between groups. Furthermore, 88.8 % of positive EST had HR reserve values below 80%. Conversely, only 50% of negative EST had HR reserve values below 80%.



**Table 6** Parameters during the EST in negative and positive EST groups

	<b>Negative EST (n =32)</b>	<b>Positive EST (n =18)</b>	<b>p value</b>
Resting SBP (mmHg)	129 $\pm$ 21.34	128 $\pm$ 18.12	NS
Resting DBP (mmHg)	77 $\pm$ 10.36	73 $\pm$ 12.81	NS
Resting HR (/min)	76 $\pm$ 10.25	75 $\pm$ 11.04	NS
Resting MAP (mmHg)	95 $\pm$ 11.91	91 $\pm$ 12.93	NS
Maximal HR (/min)	167 $\pm$ 8.33	162 $\pm$ 7.47	0.043
85% maximal HR (/min)	142 $\pm$ 7.05	138 $\pm$ 6.32	0.048
Peak HR (/min)	153 $\pm$ 20.19	123 $\pm$ 17.74	<0.001
Peak SBP (mmHg)	173 $\pm$ 25.72	160 $\pm$ 19.84	NS
Peak DBP (mmHg)	79 $\pm$ 16.20	81 $\pm$ 14.31	NS
Peak MAP (mmHg)	110 $\pm$ 15.30	107 $\pm$ 12.33	NS
Energy expenditure (METs)	9 $\pm$ 2.49	7 $\pm$ 2.60	0.014
HRR at 1 minute (beats)	28.09 $\pm$ 12.39	16.39 $\pm$ 10.47	0.001
Heart rate reserve (%)	84.25 $\pm$ 22.42	55.09 $\pm$ 18.82	<0.001
Duration of EST (min)	8.1 $\pm$ 2.73	7.0 $\pm$ 2.63	NS

Values are expressed as means  $\pm$  SD.

NS, significantly different; EST, exercise stress test; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial blood pressure; METs, metabolic equivalent; HRR, heart rate recovery

## 2.1 Causes of cessation of the EST

These data show causes of cessation of the EST. Almost all of the subjects with negative EST, stopped the EST because of reaching 85% of maximal HR (65.63%) whereas subjects with positive EST stopped the EST because of fatigue or tired (44.44%), reaching 85% of maximal HR (5.56%), dyspnea (11.11%), ST change (16.67%), chest pain (5.56%), leg pain (5.56%) and ST change and chest pain (11.11) (Table 7).

Causes of cessation of the EST in CAD patients with negative and positive EST who were finally diagnosed CAD was shown in Table 8.

CAD patients of positive results from the EST, stopped the EST because of fatigue or tired (75%), and ST change combine with chest pain (25%). However, 50% of CAD patients of negative EST stopped the EST because of dyspnea, reaching 85% of maximal HR (25%) and fatigue or tired (25%).

**Table 7** Causes of cessation of the EST in subjects with negative and positive EST

	<b>Negative EST (n =32)</b>	<b>Positive EST (n =18)</b>
Reaching 85 % maximal HR	65.63% (21)	5.56% (1)
Dyspnea	15.63% (5)	11.11% (2)
ST change	-	16.67% (3)
Chest pain (angina)	-	5.56% (1)
ST change and chest pain	-	11.11% (2)
Fatigue, tired	18.75% (6)	44.44% (8)
Leg pain	-	5.56% (1)

Values are expressed as percent (n)

EST, exercise stress test

**Table 8** Causes of cessation of the EST in CAD patients with negative and positive EST

	<b>CAD patients with negative EST (n =4)</b>	<b>CAD patients with positive EST (n =4)</b>
Reaching 85 % maximal HR	25% (1)	-
Dyspnea	50% (2)	-
ST change and chest pain	-	25% (1)
Fatigue, tired	25% (1)	75% (3)

Values are expressed as percent (n)

EST, exercise stress test; CAD, coronary artery disease; HR, heart rate

### 3. Lipid profiles

Results of plasma lipid profiles were shown in Table 9.

There were no significant differences in plasma TG, TC, LDL and HDL between subjects with negative and positive EST.

**Table 9** Lipid profiles in subjects with negative and positive EST

	Negative EST		Positive EST		p value
	min,max	mean±SD	min,max	mean±SD	
<b>TG</b> <b>(mg/dL)</b>	63,676	221.29±158.99(14)	79,353	161.75±129.52(4)	NS
<b>TC</b> <b>(mg/dL)</b>	113,274	202.00±48.58(14)	129,318	201.50±85.71(4)	NS
<b>LDL</b> <b>(mg/dL)</b>	38,175	114.93±42.24(14)	51,101	79.00±25.53(4)	NS
<b>HDL</b> <b>(mg/dL)</b>	33,65	44.43±10.52(14)	32,61	44.75±12.12(4)	NS

Values are expressed as mean ± SD (n).

NS, no significantly different; EST, exercise stress test; TG, triglyceride; TC, total cholesterol; LDL, low density lipoprotein; HDL, high density lipoprotein

#### 4. Aerobic capacity

$\dot{V}O_{2,max}$  of all subjects determined by calculation from expired gas and from Bruce protocol formula are shown in Figure 6.

Their  $\dot{V}O_{2,max}$  of all subjects calculated from the Bruce protocol formula (20.56 $\pm$ 9.13 ml/kg/min of positive EST, 23.24 $\pm$ 7.70 ml/kg/min of negative EST).

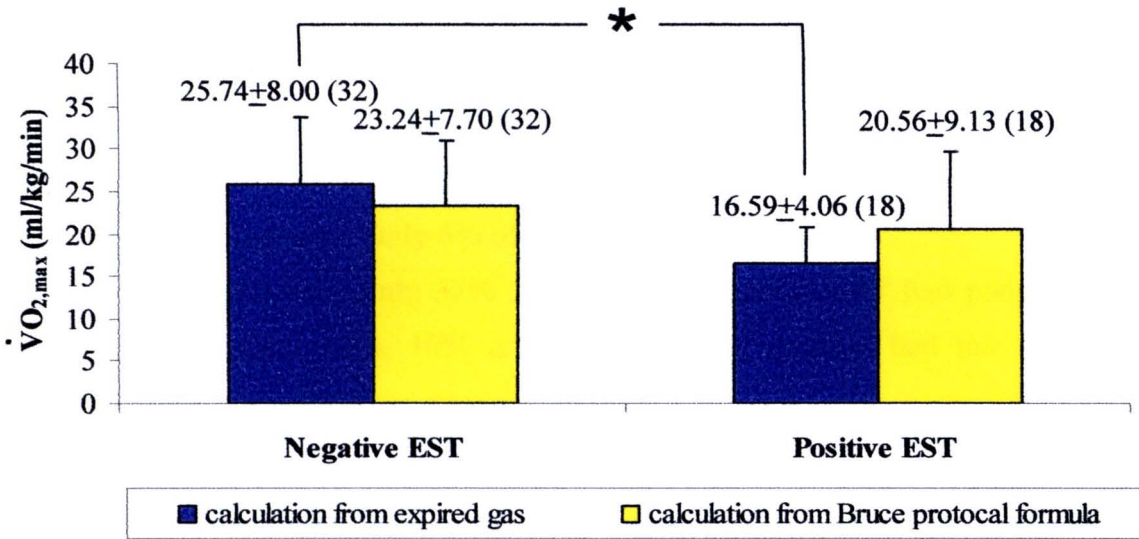
Subjects with positive EST had lower  $\dot{V}O_{2,max}$  than those with negative EST that calculated from expired gas (16.59 $\pm$ 4.06 and 25.74 $\pm$ 8.00 ml/kg/min).

There was significant difference in  $\dot{V}O_{2,max}$  between subjects with negative and positive EST that calculated from expired gas ( $p < 0.001$ ) (Figure 6).

There was no significant difference in  $\dot{V}O_{2,max}$  between subjects with positive and negative EST that calculated from Bruce protocol formula ( $p=0.281$ ).

There was no significant difference in  $\dot{V}O_{2,max}$  between the Bruce protocol formula and the calculation from expired gas in subjects with positive EST ( $p=0.111$ ).

There was no significant difference in  $\dot{V}O_{2,max}$  between the Bruce protocol formula and the calculation from expired gas in subjects with negative EST ( $p=0.236$ ).



**Figure 6**  $\dot{V}O_{2,max}$  of subjects with negative and positive EST calculated from the Bruce protocol formula and calculated from expired gas

Values are expressed as mean  $\pm$  SD (n).

\* significantly different from subjects with negative EST ( $p < 0.05$ ).

$\dot{V}O_{2,max}$ , maximum oxygen consumption; EST, exercise stress test

#### 4.1 Levels of aerobic capacity calculated from expired gas during the EST

Levels of aerobic capacity determined  $\dot{V}O_{2,max}$  by calculation from expired gas of subjects with positive and negative EST are shown in Figure 7.

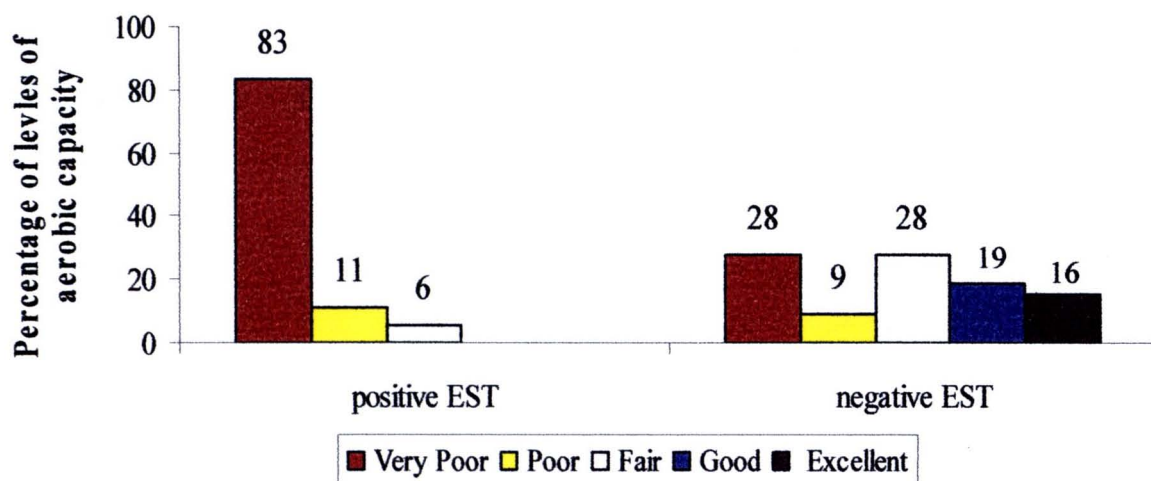
Ninety four percentages of subjects with positive EST had poor and very poor aerobic capacity. Only 6% of these subjects had fair.

In contrast, only 37% subjects with negative EST had poor and very poor aerobic capacity, 28%, 19% and 16% of these subjects had fair, good and excellent aerobic capacity respectively (Figure 6).

Levels of aerobic capacity determined  $\dot{V}O_{2,max}$  by calculation from expired gas of CAD patients with positive and negative EST are shown in Table 10.

Fifty percentages of CAD patients with negative EST had fair aerobic capacity, 25% of poor level and 25% of good level of aerobic capacity.

Approximately, 75% of CAD patients with positive EST had very poor aerobic capacity and 25% of these patients had poor aerobic capacity.



**Figure 7** Percentage of levels of aerobic capacity of subjects with negative and positive EST

Values are expressed as percent.

EST, exercise stress test

**Table 10** Percentage of levels of aerobic capacity of CAD patients with negative and positive EST

	<b>CAD patients with negative EST (n =4)</b>	<b>CAD patients with positive EST (n =4)</b>	<b>All CAD patients (n =8)</b>
Very poor level	-	75% (3)	37.5% (3)
Poor level	25% (1)	25% (1)	25% (2)
Fair level	50% (2)	-	25% (2)
Good level	25% (1)	-	12.5% (1)
Excellent level	-	-	-

Values are expressed as percent (n)

CAD, coronary artery disease; EST, exercise stress test

## 4.2 Effect of age

$\dot{V}O_{2,max}$  of all subjects at various ages were shown in Table 11.

Subjects with negative EST aged 30-39, 40-49, 50-59, 60-75 years had  $\dot{V}O_{2,max}$  30.07 $\pm$ 4.06, 29.22 $\pm$ 12.39, 24.98 $\pm$ 6.35, 22.92 $\pm$ 7.71 ml ml/kg/min.

Subjects with positive EST aged 30-39 year, 50-59, 60-75 had  $\dot{V}O_{2,max}$  19.39, 17.22 $\pm$ 4.40, 15.53 $\pm$ 3.86 ml/kg/min. Furthermore, there was no subjects aged 40-49 years had positive EST. Only subjects aged between 50-59 years had significant different in  $\dot{V}O_{2,max}$  between groups with the EST aged 50 to 59 years ( $p=0.004$ ). However, there were no significant difference in  $\dot{V}O_{2,max}$  between subjects with negative and positive EST aged 30 -39 years, and 60 -75 years (Table 11).

**Table 11**  $\dot{V}O_{2,max}$  at various ages in subjects with negative and positive EST

	<b>Negative EST (n =32)</b>	<b>Positive EST (n =18)</b>	<b>p value</b>
30-39 years	30.07 $\pm$ 4.06 (3)	19.39 (1)	NS
40-49 years	29.22 $\pm$ 12.39 (6)	-	-
50-59 years	24.98 $\pm$ 6.35 (15)	17.22 $\pm$ 4.40 (9)	0.004*
60-75 years	22.92 $\pm$ 7.71 (8)	15.53 $\pm$ 3.86 (8)	NS

Values are expressed as mean  $\pm$  SD (n).

\* significantly different from subjects with negative EST ( $p < 0.05$ ),

NS, no significantly different; EST, exercise stress test

#### 4.3 The correlation between $\dot{V}O_{2,max}$ and measured peak HR during EST

$\dot{V}O_{2,max}$  tended to be correlated with measured peak HR during the EST in subjects with positive EST ( $r=0.397$ ,  $p=0.051$ ) (Figure 8).

There was no correlation between  $\dot{V}O_{2,max}$  and measured peak HR during the EST in subjects with negative EST ( $r=0.067$ ,  $p=0.358$ ) (Table 12).

#### 4.4 The correlation between $\dot{V}O_{2,max}$ and BP during the EST

There was no correlation between  $\dot{V}O_{2,max}$  and SBP during the EST in subjects with positive EST ( $r=-0.188$ ,  $p=0.227$ ) (Table 12).

There was no correlation between  $\dot{V}O_{2,max}$  and SBP during the EST in subjects with negative EST ( $r=0.037$ ,  $p=0.421$ ) (Table 12).

There was no correlation between  $\dot{V}O_{2,max}$  and DBP during the EST in subjects with positive EST ( $r=-0.153$ ,  $p=0.272$ ) (Table 12).

There was no correlation between  $\dot{V}O_{2,max}$  and DBP during the EST in subjects with negative EST ( $r=-0.100$ ,  $p=0.294$ ) (Table 12).

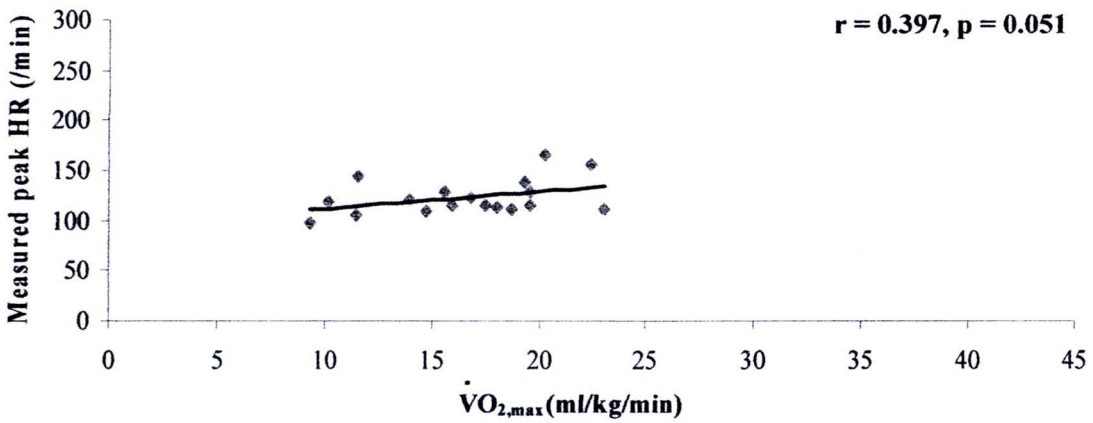
#### 4.5 The Correlation between $\dot{V}O_{2,max}$ and HRR at 1 minute

There was correlation between  $\dot{V}O_{2,max}$  and HRR at 1 minute in subjects with positive EST ( $r=0.426$ ,  $p=0.039$ ) (Figure 9).

There was no correlation between  $\dot{V}O_{2,max}$  and HRR at 1 minute in subjects with negative EST ( $r=0.096$ ,  $p=0.300$ ) (Table 12).

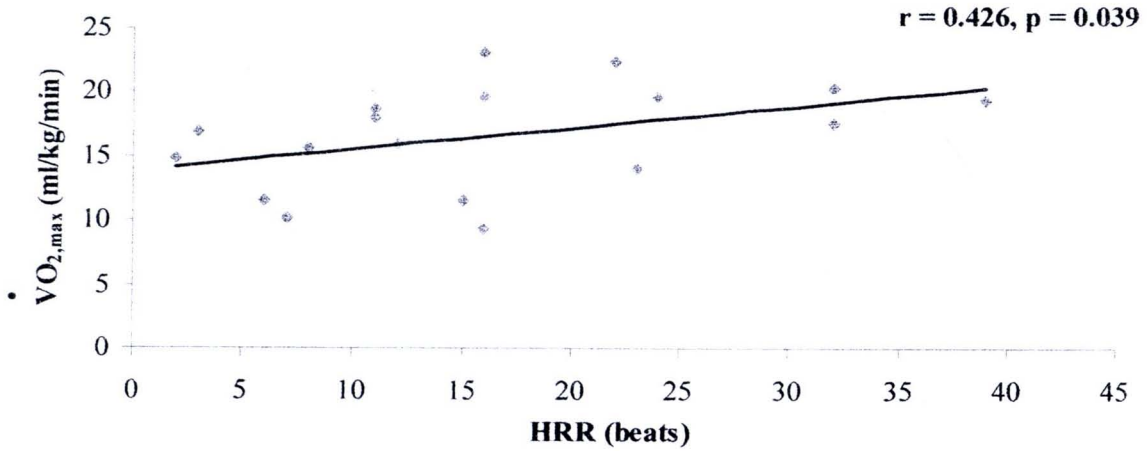
**Table 12** The correlation between  $\dot{V}O_{2,max}$  and peak HR, peak SBP, peak DBP and HRR at 1 minute in subjects with negative and positive EST

	Negative EST (n=32)		Positive EST (n=18)	
	r	p value	r	p value
Peak HR (/min)	0.067	NS	0.397	NS
Peak SBP (mmHg)	0.037	NS	-0.188	NS
Peak DBP (mmHg)	-0.100	NS	-0.153	NS
HRR at 1minute (beats)	0.096	NS	0.426	0.039



**Figure 8** The correlation between  $\dot{V}O_{2,max}$  and measured peak HR during the EST in subjects with positive EST

HR, heart rate;  $\dot{V}O_{2,max}$ , maximum oxygen consumption; EST, exercise stress test



**Figure 9** The correlation between  $\dot{V}O_{2,max}$  and HRR at 1 minute in subjects with positive EST

HRR, heart rate recovery;  $\dot{V}O_{2,max}$ , maximum oxygen consumption; EST, exercise stress test

#### 4.6 The correlation between $\dot{V}O_{2,max}$ and lipid profiles

There were no correlation between  $\dot{V}O_{2,max}$  and lipid profiles in subjects with negative and positive EST (Table 13).

**Table 13** The correlation between  $\dot{V}O_{2,max}$  and lipid profiles in subjects with negative and positive EST

	Negative EST (n=14)		Positive EST (n=4)	
	r	p value	r	p value
Triglyceride (mg/dL)	-0.553	NS	-0.104	NS
Total cholesterol (mg/dL)	0.340	NS	0.152	NS
Low density lipoprotein (mg/dL)	0.575	NS	0.191	NS
High density lipoprotein (mg/dL)	-0.982	NS	0.195	NS

NS, no significant difference; EST, exercise stress test

#### 4.7 The correlation between $\dot{V}O_{2,max}$ and cardiovascular risk factors

There was correlation between  $\dot{V}O_{2,max}$  and smoking ( $\geq 2$  packs of cigarette/week) in subjects with negative EST (Table 14).

There were no correlation between  $\dot{V}O_{2,max}$  and alcohol consumption ( $\geq 25$  g/day), DM, HT, family history of CAD and physical activity ( $\geq 3$  times/week) in subjects with negative and positive EST (Table 14).

No CAD patients had alcohol consumption ( $\geq 25$  g/day) and family history of CAD.

**Table 14** The correlation between  $\dot{V}O_{2,max}$  and cardiovascular risks in subjects with negative and positive EST

Cardiovascular risks	Negative EST		Positive EST		All CAD	
	r	p value	r	p value	r	p value
Smoking ( $\geq 2$ packs of cigarette/week)	-0.308	0.043	0.265	NS	-0.106	NS
Alcohol consumption ( $\geq 25$ g/day)	-0.205	NS	0.177	NS	-	-
DM	-0.225	NS	0.177	NS	0.220	NS
HT	0.022	NS	0.004	NS	-0.014	NS
Family history of CAD	-0.155	NS	0.244	NS	-	-
Physical activity ( $\geq 3$ times/week)	0.087	NS	-0.260	NS	-0.508	NS

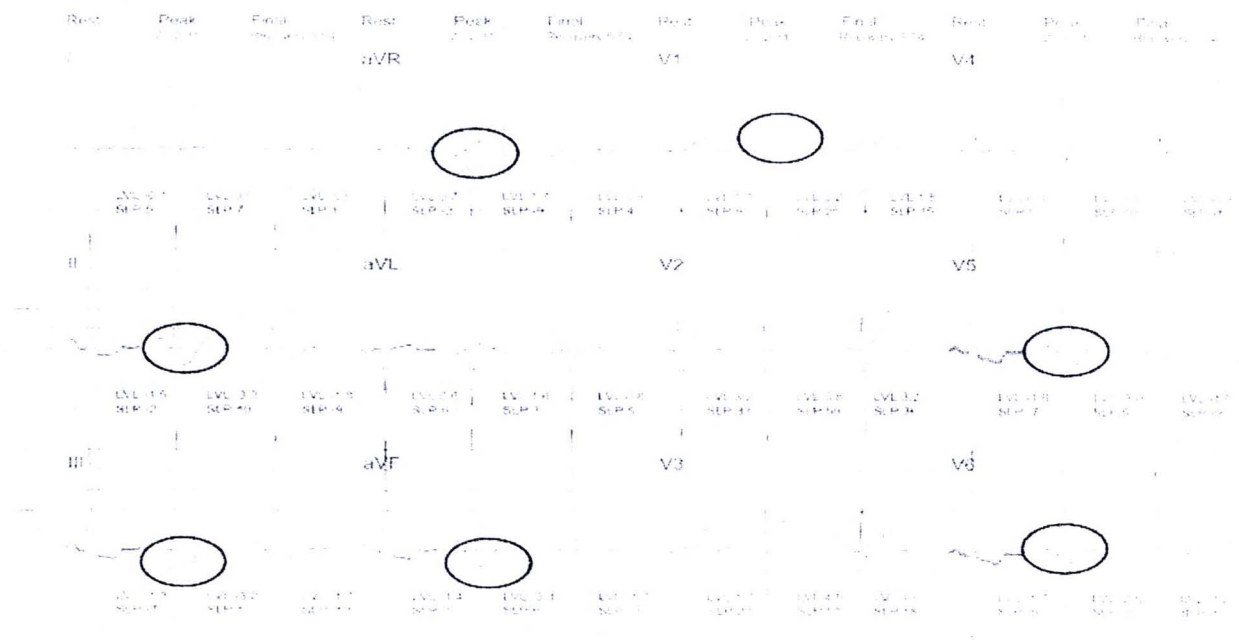
NS, no significantly different; EST, exercise stress test; DM, diabetes mellitus; HT, hypertension; CAD, coronary artery disease



## 5. ECG

All subjects with negative EST had no ST change during the EST. However, 5 subjects with positive EST had ST change leading to cessation the EST. When confirmed by other tests for CAD diagnosis only 1 had CAD (Figure 10).

Interestingly, 80% of subjects in positive EST who had ST change during the EST had very poor level of aerobic capacity. Only 20% of these subjects had poor level of aerobic capacity. Approximately 61.11% in subjects with positive EST had prolonged QT interval whereas 15.62% in subjects with negative EST had prolonged QT interval. In addition, 2 CAD patients with positive EST had prolonged QT. However, CAD patients with negative EST had no prolonged QT. All subjects had no abnormal PR interval.



**Figure 10** ECG shows ST depression in leads II, III, aVF, V5, and V6 at exercise phase. Moreover, ECG shows ST elevation in leads aVR, and V1 at exercise phase of CAD patients with positive EST

## 6. The relative risk of CAD

An explanation for the risk of CAD, of 8 CAD patients had smoking ( $\geq 2$  packs of cigarette/week) (RR =0.23; 95% CI=0.03-1.75), HT (RR=1.27; 95% CI=0.35-4.69), DM (RR=2.05; 95% CI=0.51-8.19) and physical activity ( $\geq 3$  times/week) (RR=1.08; 95% CI=0.30-3.86) (Table 15).

**Table 15** Relative risk for CAD of associated cardiovascular risk factors and aerobic capacity levels

	<b>Relative risk</b>	<b>95% CI</b>
Smoking ( $\geq 2$ packs of cigarette/week)	0.75	0.11 -5.29
DM	2.05	0.51-8.19
HT	1.27	0.35-4.69
Physical activity ( $\geq 3$ times/week)	1.08	0.30-3.86

DM, diabetes mellitus; HT, hypertension