

THE CORRELATION BETWEEN THE FEMORAL ARTERY INTIMA-MEDIA THICKNESS AND THE SEVERITY OF CORONARY ARTERY DISEASES

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DOI: 10.38103/jcmhch.2021.69.14

ABSTRACTS

Background: A pre-clinical sign of atherosclerosis is hypertrophy of arterial wall. F.IMT (Femoral intima-media thickness) is non-invasive marker of arterial wall alteration, which can easily be assessed by high resolution B mode ultrasound. We aim to investigate the correlation between femoral intima-media thickness (F.IMT) and the severity of coronary artery disease (CAD).

Methods: 111 consecutive patients with coronary artery disease (CAD) were enrolled. Femoral IMT (F.IMT) was assessed by B mode ultrasound with 7.5 - 10 MHz probe about 10 -15 mm before bifurcation to profound and superficial femoral arteries. The F.IMT < 1.0 mm is named as "normal", F.IMT ≥ 1.0 mm and < 1.5 mm is "thick" and ≥1.5 mm is defined as "atherosclerotic femoral plaque". The severity of CADs was calculated by Gensini Score.

Results: Mean F.IMT is 1.57 ± 1.23 mm, 55% patients with abnormal F.IMT (male 57.0% và female 50.0%), 36.9% of patients with CAD have atherosclerotic femoral plaque. There is a good correlation between F.IMT and severity of CAD by Gensini score and its risk factors (age, plasma glucose, smoking, hypertension...)

Conclusion: Hospitalised patients with CAD are likely to have concomittant PAD with high frequency of femoral artery wall changes. F.IMT could be a helpful diagnostic marker and therapeutic points.

Keywords: Coronary artery diseases femoral artery, intima-media thickness

I. INTRODUCTION

Atherosclerosis has been discovered in Egypt since the 50s BC. The pathogenesis of atherosclerosis is not entirely clear. Peripheral vascular disease is an important complication of atherosclerosis. The risk factors for atherosclerosis such as smoking, diabetes, dyslipidemia, hypertension and elevated

homocysteine... are also considered major risk factors for lower limb artery disease [1-3]. Lower extremity atherosclerosis, which early sign in the preclinical stage as thickening of the intima-media layer, can be detected early and accurately by Doppler ultrasound. The femoral artery intima-media thickness (F.IMT) is considered to be an

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- Received: 15/03/2021; Revised: 11/05/2021;

- Accepted: 22/05/2021

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overall cardiovascular risk factor, was strongly correlation with coronary artery damage and cardiovascular events [4-6].

From the clinical practice, the lower limb artery disease is often not properly focused, leading to a missed diagnosis, which can lead to dangerous complications for the patients because treatment is too late. Therefore, we implement this study for two purposes: (i) To assess the characteristic of lower extremities artery lesions by Femoral artery intima-media thickness under Doppler ultrasound in patients with coronary artery disease; (ii) To evaluate the correlation between lower extremities artery lesions with several cardiovascular risk factors and severity of lesions to coronary artery lesions according Gesini score.

II. MATERIALS AND METHODS

2.1. Study design

Patients (n = 111) who were diagnosed CAD by coronary angiography were enrolled. Patients with insignificant lesions of coronary artery were excluded. Patients with significant lesions of coronary artery (evaluated the severity with stenosis diameter and Gesini score [7]) were included, then ultrasound echo were performed, the mean F.IMT were evaluated. We evaluated the diagnostic value of the F.IMT.

- Assess the F.IMT ≥ 1.0 mm is named "thick" [1]
- Determine of atherosclerotic plaque: Atherosclerotic plaque is the local thickening, over 1.5mm from the median - outer layer interface to the lumen separator [1,8].
- Evaluate the degree of lower limb artery stenosis: according to Cossman criteria [9]

2.2. Statistical analysis

Setting in a descriptive cross-sectional study. Continuous variables were presented as mean ($\pm$ standard deviation) and categorical variables as n (%). The measure of correlation in stats were Pearson's correlation. All statistical analyses were performed using SPSS software ver. 20.0.

III. RESULTS

3.1 Demographics

Study subjects include 79 male patients (71.2%) and 32 female patients (28.8%). The mean age was 65.74 ± 10.84 years. There was a 58.6% patients with hypertension (55.7% male and 65.6% female). The proportion of patients who smoke was 51.4%, of which 72.2% was male and there was no female patients smoke. There was 25.2% patients with type 2 diabetes (25.32% male and 28.6% female) (**Table 1**).

Table 1: General characteristics of study subjects

General features	Male (n=79)		Female (n=32)		Total		P
	n	%	n	%	n	%	
n	79	71.2	32	28.8	111	100	< 0.05
Mean age	64.48 ± 11.10		68.84 ± 9.65		65.74 ± 10.84		> 0.05
Hypertension	44	55.7	21	65.6	67	58.6	
History of coronary artery disease	32	40.51	16	50	48	43.2	
Smoking	57	72.2	0	0.0	57	51.4	
Diabetes	20	25.32	8	28.6	28	25.2	> 0.05
Hypertotalcholesterolemia	29	36.7	18	56.3	47	42.3	
Hypertriglyceridemia	35	44.9	15	46.9	50	45.5	
Hyper-LDLCholesterolemia	23	29.1	9	28.1	32	28.8	
Hypo-HDLCholesterolemia	12	15.2	4	12.5	16	14.4	

3.2. Coronary artery lesions on DSA

LAD lesion is the highest at 81.3%, followed by RCA with 74.1% and LCX with 51.8%. Only 2.7% had a mild stenosis of the left main coronary artery (**Table 2**).

Table 2: Rate of lesions to the main branches of coronary arteries:

Gender	Left Main (1)		Right Coronary Artery (2)		Left Anterior Descending Artery (3)		Left Circumflex Artery (4)		p
	n	%	n	%	n	%	n	%	
Male (1)	1	1.3	56	71.8	64	82.1	43	55.1	$p_{3,4} < 0.05$
Female (2)	2	6.3	27	79.4	27	79.4	15	44.1	$p_{2,4; 3,4} < 0.05$
Total	3	2.7	83	74.1	91	81.3	58	51.8	$p_{2,4; 3,4} < 0.001$
$p_{1,2}$	> 0.05								

The rate of 1-vessel disease of coronary artery was 27.03%, (male and female were 29.1% and 21.9%, respectively), 2-vessel disease accounted for 36.04% (male and female were 34.2% and 40.6%, respectively). There was 35.13% of patients (36.7% male and 31.3% female) have 3-vessel disease. Thus, the proportion of patients who have multiple vessel diseases were 72.97% (**Table 3**).

Table 3: Rate of the number of lesion to the main branches of coronary arteries

	1-vessel (1)		2-vessel (2)		3-vessel (3)		P
	n	%	n	%	n	%	
Male (1)	23	29.1	27	34.2	29	36.7	$p > 0.05$
Female (2)	7	21.9	13	40.6	10	31.3	
Total	30	27.03	40	36.04	39	35.13	
$P_{(1),(2)}$	$p > 0.05$		$p > 0.05$		$p > 0.05$		

The severity of coronary artery lesions calculated on the Gensini score of study subjects was 22.00 ± 20.70 points, of which 24.48 ± 22.2 points for male and 15.94 ± 14.82 points for female (**Table 4**).

Table 4: The severity of coronary artery lesions by the Gensini score

Diagnosis	Male (1)		Female (2)		Total (3)		$p_{(1),(2)}$
	n	Gensini	n	Gensini	n	Gensini	
Stable angina	29	14.41 ± 16.10	13	8.92 ± 6.76	42	12.71 ± 14.04	< 0.01
Unstable angina	27	24.82 ± 24.66	16	20.25 ± 17.09	43	23.12 ± 22.04	
NSTEMI	7	34.67 ± 11.50	2	30.00 ± 22.63	9	33.50 ± 13.13	
STEMI	16	37.37 ± 22.88	1	10.00 ± 0.00	17	36.71 ± 23.21	
Total	79	24.48 ± 22.2	32	15.94 ± 14.82	111	22.00 ± 20.70	

3.3. Lesions of the lower limb arteries on B-mode and Doppler ultrasound

When representative of the highest F-IMT selected, the mean F-IMT in male was 1.56 ± 1.10 (mm), in female it was 1.59 ± 1.19 (mm) and for both gender was 1.57 ± 1.23 (mm) (**Table 5**).

Table 5: Average femoral intima-media thickness by gender

	Male (1)	Female (2)	Total	$P_{(1),(2)}$
	M $\pm$ SD (mm)	M $\pm$ SD (mm)	M $\pm$ SD (mm)	
Right side (1)	1.47 $\pm$ 1.06	1.54 $\pm$ 1.18	1.49 $\pm$ 1.09	> 0.05
Left side (2)	1.40 $\pm$ 1.01	1.40 $\pm$ 1.04	1.40 $\pm$ 1.02	
F.IMT (3)	1.56 $\pm$ 1.10	1.59 $\pm$ 1.19	1.57 $\pm$ 1.23	
$P_{(1),(2)}$	> 0.05	> 0.05	> 0.05	

The mean of the F.IMT in patients with 1-vessel coronary disease was 1.18 $\pm$ 0.93 (mm), 2-vesselsdisease was 1.36 $\pm$ 0.92 (mm) and 3-vesselsdisease was 2.06 $\pm$ 1.25 (mm). The F.IMT in patients tends to increase with the number of coronary artery lesion (**Table 6**).

Table 6: Mean F.IMT by number of damaged coronary vessels

Age group	1-vessel (1)		2- vessel (2)		3-vessel (3)		$P_{(1), (2), (3)}$
	n	X $\pm$ SD (mm)	n	X $\pm$ SD (mm)	n	X $\pm$ SD (mm)	
Male	23	1.10 $\pm$ 0.86	27	1.43 $\pm$ 0.90	29	2.07 $\pm$ 1.28	< 0.05
Female	7	1.43 $\pm$ 1.15	13	1.22 $\pm$ 1.01	10	2.06 $\pm$ 1.26	
Total	30	1.18 $\pm$ 0.93	40	1.36 $\pm$ 0.92	39	2.06 $\pm$ 1.25	

The rate of patients with F.IMT was 55.0%, of which 57.0% for male and 50.0% for female. The detection rate of femoral atheroma (with F.IMT $\geq$ 1.5 mm) was 36.9%, of which 36.7% for male and 37.5% for female (**Table 7**).

Table 7: Ratio of F.IMT and atheroma

	Male (1)		Female (2)		Total (3)		$P_{(1),(2)}$
	n	%	n	%	n	%	
Thick IMT (IMT $\geq$ 1.0 mm)	45	57.0	16	50.0	61	55.0	< 0.05
Atheroma/femoral (IMT $\geq$ 1.5 mm)	29	36.7	12	37.5	41	36.9	> 0.05

In patients with history of CAD and hyperglycemia, F.IMT were statistically significantly higher than patients without these risk factors (**Table 8**).

Table 8: F.IMT according to several risk factors for coronary artery disease

Risk factor of CAD	Yes (1)		No (2)		$P_{(1),(2)}$
	n	M $\pm$ SD (mm)	n	M $\pm$ SD (mm)	
Hypertension	65	1.71 $\pm$ 1.26	46	1.38 $\pm$ 0.89	p=0.132
History of CAD	48	1.64 $\pm$ 1.14	63	1.49 $\pm$ 1.11	p=0.015
Hyperglycemia	28	2.02 $\pm$ 1.18	83	1.42 $\pm$ 1.08	p=0.019
Hyper-total Ch	47	1.57 $\pm$ 1.17	64	1.58 $\pm$ 1.10	P=0.532
Hypertriglyceridemia	50	1.51 $\pm$ 1.11	60	1.60 $\pm$ 1.14	p=0.66
Hyper-LDLCh	32	1.77 $\pm$ 1.24	79	1.49 $\pm$ 1.07	p=0.25
Hypo-HDLCh	48	1.49 $\pm$ 1.11	63	1.64 $\pm$ 1.14	p=0.511
Smoking	57	1.65 $\pm$ 1.14	54	1.49 $\pm$ 1.11	p=0.228

3.4. The correlation between lower extremity artery damage on B-mode and Doppler ultrasound and coronary artery disease

There was a statistically significant and positive correlation ($0.3 \leq r < 0.5$ and $p < 0.01$) between the thickness of F.IMT and age; plasma glucose level ($r = 0.404$ and $p < 0.001$) (Table 9) (Figure 1).

Table 9: Correlation between F.IMT and age, blood pressure, serum glucose and lipids concentration

	Age	Blood pressure	Glucose	Total - C	LDL_C	TG	HDL_C
F.IMT	$r=0.319$ $p<0.01$	$r=0.351$ $p<0.05$	$r=0.404$ $p<0.001$	$r=0.205$ $p<0.05$	$r=0.170$ $p>0.05$	$r=0.035$ $p>0.05$	$r=-0.001$ $p>0.05$

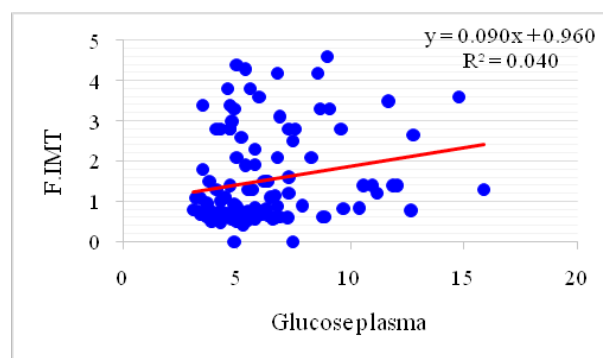
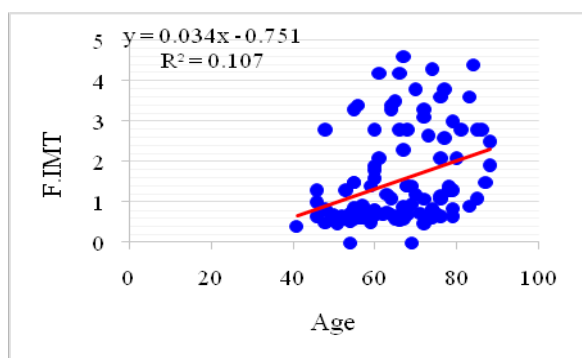


Figure 1: Correlation between F.IMT with age and plasma glucose

Correlation between F.IMT and the number of main coronary vessel damage was a weak positive correlation with $r = 0.282$ and $p < 0.001$ (Table 10).

Table 10: Correlation between the femoral intima-media thickness with the number of main coronary vessel damage

	Number of main coronary vessel	
	r	p
F.IMT	$r=0.282$	$p<0.001$

There was a weak positive Pearson correlation coefficient between F.IMT and the severity of coronary artery lesions according to the Gensini score with $r = 0.247$ and $p < 0.05$, and the linear regression equation $y = 0.014x + 1.2415$ (Figure 2).

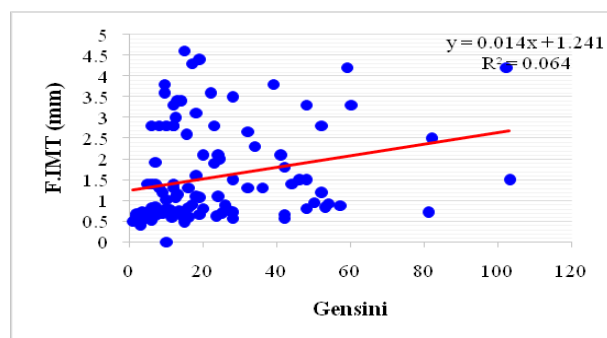


Figure 2: Correlation between F.IMT and Gensini score

IV. DISCUSSION

4.1. Femoral intima-media thickness on ultrasound

Compared to the study of Grozdinski (2009) on 87 patients with CAD, the mean F.IMT was 1.46 ± 0.41 (mm) compared with the group of patients without stenosis was 0.85 ± 0.16 (mm) as well as the control group of 32 healthy subjects was 0.81 ± 0.14 (mm). This difference compared to our study is not statistically significant with $p > 0.05$ [10].

The mean F.IMT of patients with 1-vessel coronary disease was 1.18 ± 0.93 (mm), 2-vessel was 1.36 ± 0.92 (mm) and 3-vessel was 2.06 ± 1.25 (mm). F.IMT in patients with 1, 2 and 3 of the main vessels tended to increase and differ from statistical significance (Table 6).

Lagroodi R. M. et al (2010), studied on 100 patients with CAD divided into 4 groups: group with 1, 2, 3 vessel diseases and group with left main coronary diseases. Results: 1-vessel lesion group: mean F.IMT was 0.64 ± 0.11 mm, 2 vessel was 0.73

$\pm 0.10\text{mm}$; 3-vessel was 0.84 ± 0.15 and the left main lesion group was 0.85 ± 0.08 (mm). F.IMT increased gradually with the number of vessel lesions, ($p < 0.001$) [11].

Regarding the F.IMT value, currently there is no value approved universally on F.IMT value for each age group or gender. Many authors agree to choose the reference value (cut-off) F.IMT is 1 (mm) as Khoury Z. et al [1], Simon A. et al [12].

In this study, we defined two value of F.IMT, when $\text{F.IMT} \geq 1$ (mm) and called femoral atherosclerosis, when $\text{F.IMT} \geq 1.5$ (mm). Table 7 showed that: The proportion of patients with thick layer of the inner lining of the femoral artery on ultrasound accounted for 55.0 %, (male 57.0% and female 50.0%). The difference of F.IMT between the sexes was statistically significant with $p < 0.05$ and the detection rate of femoral atherosclerosis was 36.9%, (male 36.7% and women 37.5%). Khoury Z. et al studied on 64 patients with CAD was of similar age to our study (68.4 versus 68.84 years), the rate of patients with evidence of atherosclerosis (F.IMT thickening and atherosclerosis) was statistically significant higher than the normal coronary arteries group (77% vs 42%) [1]. This result was statistically significant higher than our study (the rate with F.IMT thickness was 55% with $p < 0.01$). These differences may be because atherosclerosis usually occurs earlier in the Western countries, or the author's study subjects had a higher incidence of diabetes and metabolic syndrome, two risk factors strongly promote the rapid development of atherosclerosis.

4.2. Femoral intima-media thickness and cardiovascular risk factors

In patients with hypertension, the mean F.IMT was 1.71 ± 1.26 (mm), with no statistically significant difference compared to the group without hypertension (**Table 9**). According to Grozdinski et al, in a group of 74 patients with CAD, there were 93.2% of hypertension (temporarily considered as patients with hypertension). The average F.IMT was 1.46 ± 0.41 (mm). This difference was not statistically significant compared with our study [10].

There was a moderately positive Pearson correlation coefficient between age and F.IMT ($0.3 \leq r < 0.5$ and $p < 0.01$). This result was similar to some other authors: Depairon et al [13], Junyent M et al [14]. Study by Lugwig et al showed that F.IMT had a strong positive correlation with age, diabetes, smoking, and several other risk factors [4].

There was a moderately positive correlation between systolic blood pressure and F.IMT on ultrasound ($0.3 \leq r < 0.5$ and $p > 0.05$). This result was similar to the study of Kirhmajer et al [15], Lekakis et al [16].

There was a weak positive correlation between F.IMT and the number of coronary artery lesions (with $r = 0.282$ and $p < 0.001$ and $y = 0.3069x + 0.8404$) (Table 10). According to Sosnowski et al, studied on 410 patients with CAD showed that F.IMT was an independent risk factor that predicted lesions of coronary arteries, whereas atherosclerosis femoral artery was often associated with multiple coronary artery diseases [17].

4.4. Femoral intima-media thickness and the severity of coronary artery diseases according to the Gensini score

There was a weak positive Pearson correlation coefficient between the F.IMT and the severity of CAD on the Gensini score ($r = 0.247$ and $p < 0.05$, and $y = 0.014x + 1.2415$).

Lekakis et al studied on 202 patients with CAD, multivariate regression analysis showed that F.IMT abnormality was strongly correlated with coronary artery lesions on Gensini score, age and glucose plasma level [16]. The author concludes that patients with higher F.IMT are more likely to be associated with multivessel CADs and have a higher incidence of coronary artery events or stroke. Lugwig et al have the same conclusion as Lekakis, and furthermore, treatment to slow progression or degeneration of the F.IMT reduces significantly the cardiovascular events [4]. Doppler ultrasound is a non-invasive, popular, reliable, and an easy-to-apply technique to monitor changes in arterial intima-media thickness.

V. CONCLUSION

F.IMT was increased gradually with the number of coronary artery lesions. There was a moderately positive Pearson correlation coefficient between age/

systolic blood pressure and F.IMT. There was a weak positive Pearson correlation coefficient between the F.IMT and the severity of coronary artery diseases on the Gensini score.

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