

# MYOCARDIAL INFARCTION IN PATIENTS AGED 40 YEARS AND BELOW : AN ANGIOGRAPHIC REVIEW

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## ABSTRACT

Over a period of 27 months, 32 patients aged 40 and below were admitted for acute myocardial infarction. Twenty-nine had coronary angiography with a mean of  $15.7 \pm 10.0$  days following infarction. Fourteen patients had single vessel, 10 multi-vessel and 5 had only minor coronary disease. Disease in the left anterior descending (LAD) artery was more common than in the circumflex or right coronary artery (RCA), but myocardial infarction occurred with near equal frequency in both the LAD and RCA territories. Only 2 infarct-related vessels were collateralized. Spontaneous coronary dissection was detected in 2 patients. The left ventricular function was significantly impaired in about half of the patients.

**Keywords:** myocardial infarction, young, coronary angiogram

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## INTRODUCTION

Coronary artery disease (CAD) and cancers have consistently been the two commonest causes of death in Singapore<sup>(1)</sup>. While CAD usually manifests at or beyond middle age, myocardial infarction (MI) occasionally affects the young. Earlier studies<sup>(2-5)</sup> have indicated that post-infarct patients can be risk-stratified using variables that reflect the extent of MI, potential life-threatening arrhythmias, extent of post-infarction left ventricular dysfunction, and continuing ischaemia. Coronary arteriographic findings in addition help to define a subgroup of patients who might benefit from myocardial revascularization<sup>(5)</sup>.

## METHODS

### Patient selection

From the Coronary Care Unit Registry at the National University Hospital, Singapore, patients 40 years or less admitted for MI over a 27-month period from January 1990 to March 1992 were selected for study. Non-fatal MI was diagnosed if at least 2 of the following 3 criteria were present: (1) chest pain suggestive of myocardial ischaemia lasting 30 minutes or more; (2) rise in cardiac enzymes [creatinine kinase (CK) and CK-MB] exceeding twice the upper limit of the normal range in our laboratory; and (3) electrocardiographic abnormalities typical of or consistent with MI.

### Selective coronary angiography

Coronary angiography was performed via the percutaneous transfemoral approach using standard Judkins technique.

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Angiograms were obtained in multiple views, with varying degrees of cranial and caudal tilting depending on the coronary segment being imaged. Biplane left ventriculograms were usually obtained after the coronary angiography.

### Analysis of coronary lesions

Coronary stenoses were scored in terms of percentage luminal diameter reduction by visual analysis. We employed 2 coronary scoring systems:

#### (1) Vessel score

As visual analysis is at best an approximation, we reported the luminal diameter reduction as 0% (normal), 10% (minor irregularity), 25% (one-quarter), 35% (one-third), 50% (half), 65% (two-third), 75% (three-quarters), 90% (high-grade), 95% (subtotal), and 100% (total occlusion). The presence of a lesion of  $\geq 75\%$  in a major epicardial artery or its main branches implied significant disease. We thus scored the coronary tree as single, double, or triple vessel disease.

#### (2) Atheroscore

We divided the coronary arteries into a total of 15 segments as described by the American Heart Association Coronary Artery Disease reporting system<sup>(6)</sup>. The highest percentage stenosis score in each segment was added up yielding an "atheroscore", which correlated approximately with the extent and severity of coronary atheromatosis.

### Left ventriculogram

Biplane ventriculography was performed using 30°RAO and 60° LAO angulation with cranial tilting. The left ventricular wall was divided into 5 segments in each of the two planes, and segmental wall motion qualitatively assessed using a modification of the CASS scoring system<sup>(7)</sup>.

### Identification of infarct related artery/lesion

The infarct related arteries were identified by correlation angiographic findings with biplane left ventriculogram. These lesions were carefully analysed and classified using the American Heart Association/American College of Cardiology classification of lesion type<sup>(8)</sup>.

### Statistical analysis

The StatView 512TM software (BrainPower, Inc., Calabasas, CA) was used for the statistical analysis. Continuous data were descriptively summarised using means and standard deviations. Discrete variables were summarised in terms of frequencies and

percentages.

## RESULTS

### (A) Clinical correlations

Thirty-two patients fulfilled the criteria for inclusion in the study. None had prior MI. Cocaine usage, which is associated with MI in young patients, is uncommon in Singapore and not identified in any of our patients. Their clinical features are summarised in Table I. All were males, and one-third were ethnic Indians. They had an average of 2.4 of five major coronary risk factors (hypertension, diabetes mellitus, smoking, elevated low-density lipoprotein > 3.4 mmol/L, and family history of premature coronary artery disease). There were 2 early in-hospital deaths, both on the day of admission - one had post-mortem which revealed triple vessel disease, while the other had extensive Q waves anterior MI on admission ECG. In-patient stay averaged  $10.1 \pm 7.0$  days. Sixteen patients had ECG evidence of anterior MI, 12 had inferior, 3 lateral, and one had ST depression in multiple leads. Twenty-two patients (69%) showed ST elevation, while 10 had only ST depression and T inversions. Thirteen of the 15 eligible patients were thrombolysed. The remaining 17 were not given thrombolytics for the following reasons: ST depression infarction (9 patients), late presentation (5 patients), prolonged resuscitation (2 patients), and active peptic ulcer on treatment (1 patient).

**Table I – Clinical characteristics of patients**

Age	37.5 ± 2.4 years
Sex	32 males; 0 female
Ethnic group	16 Chinese; 5 Malays; 11 Indians
Duration of hospitalisation	10.2 ± 7.0 days
Coronary risk factors:	
Hypertension	6 patients
Diabetes mellitus	5 patients
Smoking	26 patients
LDL-cholesterol > 3.4 mmol/L*	22 patients
Family history of premature CAD	6 patients
Mean group cholesterol	6.27 ± 1.07 mmol/L
ECG	ST elevation 22; ST depression 10
Infarct location by ECG	16 Ant; 12 Inf; 3 Lat; 1 multiple
Group creatinine kinase level**	3129.0 ± 2738.6 IU/L
Thrombolysis	13 out of 15 eligible patients

\* Only 24 patients had LDL-cholesterol measured (specimens collected with a mean of  $27.0 \pm 20.0$  hours from infarct onset).

\*\* This refers to the peak CK value of 31 of the patients; one patient died before blood samples were sent off. Specimens of patients given thrombolytic agents were included in the analysis.

LDL-cholesterol, Low density lipoprotein-cholesterol; CAD, Coronary artery disease; Ant, Anterior; Inf, Inferior; Lat, Lateral.

### (B) Coronary angiographic findings

Only 29 patients had selective coronary angiography done (excluding the 2 deaths and refusal in 1). The average time from infarct onset to arteriography was  $15.7 \pm 10.0$  days. Twenty-five percent had a positive treadmill post-MI, and 3 had post-MI angina. One patient developed acute mitral regurgitation and moderate congestive heart failure. Coronary arteriography was carried out in the rest of the patients because of their young age.

No congenital coronary anomalies were identified. Fourteen (48.4%) patients had single vessel CAD (Fig 1), five (17.2%) had two vessel and 5 had triple vessel disease. Another 5 patients had only minor coronary atheromatous change. None of the patients had significant left main CAD. The LAD was the most commonly diseased epicardial artery (21 of the 29 patients studied, and 9 of the 14 patients with single vessel disease) but infarcts occurred with near equal frequency in the LAD and RCA

(13 and 14 patients respectively). Only 2 patients infarcted in the circumflex (Cx) territory (Table II).

**Table II – Angiographic findings in the young infarcts; by vessel score, atheroscore, and also degree of stenosis in infarct-related artery (IRA).**

S/No	Vessel Score	Vessel(s) with atherosclerosis	Atheroscore*	Stenosis in IRA
1.	1 VD	LAD	225	95% mid LAD
2.	minor CAD	(Cx; RCA)	265	50% proximal RCA
3.	1 VD	LAD	110	90% proximal LAD
4.	2 VD	LAD; RCA	340	95% distal RCA
5.	1 VD	RCA	90 + AN	90% proximal RCA
6.	Minor CAD	(RCA)	25	25% RPL
7.	1 VD	RCA	285	90% distal RCA
8.	2 VD	LAD; Cx	275	75% mid LAD
9.	Minor CAD	(LAD; RCA)	265	50% proximal LAD
10.	1 VD	RCA	140	95% proximal LAD
11.	1 VD	LAD	130 + AN	95% proximal LAD
12.	1 VD	LAD	120	95% proximal LAD
13.	1 VD	LAD	150	90% mid LAD
14.	1 VD	LAD	175	90% proximal LAD
15.	3 VD	LAD; Cx; RCA	245	75% RPDA
16.	3 VD	LAD; Cx; RCA	505	100% proximal RCA
17.	3 VD	LAD; Cx; RCA	390	95% mid RCA
18.	1 VD	LAD	150	75% proximal LAD
19.	1 VD	RCA	145	100% proximal RCA
20.	Minor CAD	(LAD; Cx; RCA)	210	35% proximal; 10% mid; 25% dist RCA
21.	3 VD	LAD; Cx; RCA	290	95% mid Cx
22.	1 VD	LAD	135	75% mid LAD
23.	1 VD	LAD	110	100% mid LAD
24.	Minor CAD	(LAD; RCA)	70	25% proximal RCA
25.	2 VD	LAD; Cx	350	95% proximal Cx
26.	2 VD	LAD; RCA	529	100% mid LAD
27.	1 VD	RCA	160	90% mid RCA
28.	3 VD	LAD; Cx; RCA	495	95% mid LAD
29.	2 VD	Cx; RCA	250	100% mid RCA

\* Atheroscore: Total sum of the highest % stenoses in each of the 15 segments of the patient's coronary arteries.

VD, vessel disease; AN, aneurysmal area; LAD, left anterior descending artery; RCA, right coronary artery; Cx, circumflex artery; RPL, right posterolateral branch; RPDA, right posterior descending artery; CAD, coronary artery disease.

**Fig 1 – Single vessel (proximal left anterior descending artery) coronary artery disease. This infarct-related lesion is type A by AHA/ACC classification and the distal flow was TIMI grade III.**



The 29 catheterized patients had a mean atheroscore of  $299 \pm 131.3$ . This indicates that atheromatosis in the coronary tree is diffused even in this group of young MI patients.

### (C) Infarct-related lesion analysis

The infarct-related (IR) vessel / lesion was identified by reviewing the biplane left ventriculogram and admitting ECGs. Of the 29 IR arteries, 13 were LADs, 14 were RCAs and 2 were Cx arteries. Twenty-four (82.8%) lesions were significantly narrowed (luminal diameter reduction  $\geq 75\%$ ). Seventeen patients had TIMI<sup>(9)</sup> grade III flow distal to the lesion, while there were 4 patients in each of the other three TIMI grades (0, I, II) of flow. Of the significantly stenosed lesions, 8 (33.3%) were class A by the AHA/ACC classification<sup>(7)</sup>, 15 (62.5%) class B and only 1 was class C (diffuse lesion  $> 20$  mm). Ten of the class B lesions were eccentric, one was tubular and another was bifurcating. There were 5 totally occluded lesions, and thrombi were visualised in only 3 patients (Fig 2). Two patients had angiographic evidence of spontaneous dissection (Fig 3). Collaterals to the IR artery were present only in 2 patients.

### (D) Left ventriculography

Fourteen (48.3%) of the 29 patients had significant left ventricular (LV) dysfunction. Of the rest, 12 patients had mild left ventricular dysfunction and 3 had normal LV function (these 3 patients had non-Q MI on ECG). The mean LV end-diastolic pressure was  $19.6 \pm 9.8$  mmHg. Two patients had apical thrombus on left

**Fig 2 – A totally occluded right coronary artery. The rounded contrast edge suggests the presence of a thrombus causing total occlusion.**



**Fig 3 – Spontaneous coronary dissection occurring in the circumflex artery. Note that the distal flow was TIMI grade II.**



ventriculogram.

## DISCUSSION

The incidence of MI in patients less than 40 years of age has been reported by various authors previously to be between 2% - 6% of all infarctions<sup>(10-12)</sup>. Whilst the percentage is small, the occurrence of CAD in young patients is particularly disturbing owing to its potential for premature death and socio-economic repercussions for the patients, their families and society.

In our study group, none were female. Ethnic Indians were over represented (34%, 11/32) as compared to 7.1% in the general Singapore population. This finding is consistent with an earlier report by Hughes et al<sup>(13)</sup>. This increased in coronary mortality among Singapore Indians is not explained by an excess of the major recognised risk factors<sup>(14)</sup>.

Single vessel CAD was the most common angiographic finding in our young MI patients. This is similar to previous reported series<sup>(11, 15-17)</sup>. The LAD was the most frequently involved vessel. Although the RCA was less frequently diseased, it is as likely to be the culprit IR artery when involved. Earlier reports<sup>(18, 19)</sup> have also noted that the RCA is more likely to be totally occluded in young patients with CAD than the left coronary circulation. In patients who were given tissue-plasminogen activator, failure to achieve coronary reperfusion was noted to be more frequent in the RCA<sup>(20)</sup>. There are no ready explanations for these intriguing observations relating to the RCA.

The high atheroscore in this group of patients is revealing. It indicates that even young myocardial infarcts, as in our cohort, have significant atheromatous load. An earlier study by Little et al<sup>(21)</sup> had shown that the angiographic severity of coronary disease is inadequate to accurately predict the time or location of a subsequent coronary occlusion that will produce an MI. This finding of frequent non-critical lesions elsewhere in the coronary tree suggests that aggressive risk factors modification, and pharmacological interventions (if necessary) should be employed early.

While it is true that some patients can be managed only medically and a few would require coronary bypass surgery because of multi-vessel involvement, most of our patients have lesions that are amenable to Percutaneous Transluminal Coronary Angioplasty (PTCA). PTCA in these young patients, when indicated, has the advantage of a shorter hospital stay and less morbidity and disruption from work, and the possibility of avoiding a 'redo' surgery later on in life, which carries a higher mortality and morbidity. However, it is expected that a number of patients treated with PTCA will require further revascularization procedure, or cross-over to have bypass surgery with time as a result of restenosis, and native disease progression.

The low incidence of collaterals supplying the IR vessels (2/29) is due to the fact that most of the coronary occlusions occurred suddenly. As a result of poorly developed collaterals, of the 14 patients with significant left ventricular dysfunction, 7 had single and 3 had only non-critical coronary stenosis, while only 4 patients had multi-vessel coronary artery disease.

Only two patients in this series were noted to have angiographic spontaneous coronary dissection at the IR lesion (Fig 3). This finding is likely to be more prevalent with the use of intra-coronary ultrasound instead of angiography, which is a 'luminogram' and hence, insensitive in detecting them. We had previously reported a 20-year-old man with large anterior MI due to the same mechanism<sup>(22)</sup>. Spontaneous coronary dissection may occur in early coronary lesions, which are more lipid laden and 'unstable', instead of those which are angiographically critical. From our earlier study on risk factors analysis, hypercholesterolaemia (56%) is a prevalent risk factor in this

group of patients<sup>(23)</sup>. In addition, we have shown in this study that they have significant, and in many, widespread coronary atheromatous loads. Hence, our therapeutic goals should include active measures which might induce plaque stabilisation, retard lesion progression, or even to induce their regression. While aggressive cholesterol reduction reduces total and cardiac mortality in patients with coronary atherosclerosis as recently reported by the Scandinavian Simvastatin Survival Study (4S)<sup>(24)</sup>, the long term safety of the newer, more powerful lipid lowering agents in these younger patients is not known, and the cost, considerable.

### LIMITATIONS

Our study population only involved young, non-fatal MI patients who survived the index infarct and were admitted to the hospital. Although some may have succumbed to ventricular arrhythmias, patients with more severe coronary lesions or severe left ventricular dysfunction might be selectively excluded. Secondly, as the angiogram was performed at a mean of 15.7 days from day of MI, some features relating to the IR lesions (eg presence of thrombus) might have resolved. In addition, some remodelling of the IR lesion might have taken place when the angiogram was performed.

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