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Relation between left ventricular myocardial performance index and severity of coronary artery disease in patients with unstable angina

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Abstract
Objectives: To investigate the relation between severity of coronary artery disease (CAD) assessed with Friesinger score (FS) and vessel score and myocardial performance index (MPI), also known as Tei index, in patients with Unstable Angina (UA).
Methods: The study included 50 patients with UA who were candidate for coronary angiography. All subjects underwent full history taking, complete clinical examination, echocardiographic examination for calculation of MPI and Ejection fraction (EF), and coronary angiography for calculation of FS and vessel score.
Results: study population included 23 female (46.0%) and 27 male (54.0%) with mean age (55.9±6.3), Mean MPI was (0.5±0.11), Mean EF was (56.8±6.3), Mean FS was (5.64±2.99), Mean Vessel score was (1.7±0.84). There is statistically significant positive correlation between MPI and severity of CAD as assessed by FS *(p* value <0.001*)* and vessel score *(p* value = 0.001*)* in patients with UA.
Conclusion: Echocardiographic evaluation of MPI in patients undergoing coronary angiography may be applied as a new surrogate marker of the extent of coronary atherosclerosis. It is strongly correlated to severity of CAD as its value was impaired in proportion to increased value of FS & vessel score.

Keywords: myocardial performance index, TEI index, friesinger score, coronary artery disease, unstable angina

Introduction

CAD is a major cause of death and disability in developed countries. Although CAD mortality rates have declined over the past four decades in the United States (and elsewhere), CAD remains responsible for about one-third of all deaths in individuals over age 35. It has been estimated that nearly one-half of all middle-aged men and one-third of middle-aged women in the United States will develop some manifestation of CAD [1].

Unstable angina is defined as myocardial ischaemia at rest or minimal exertion in the absence of cardiomyocyte necrosis. Among unselected patients presenting with suspected Non ST segment elevation Acute coronary syndrome (NSTE-ACS) to the emergency department, the introduction of high-sensitivity cardiac troponin measurements in place of standard troponin assays resulted in an increase in the detection of myocardial infarction (MI) (4% absolute and 20% relative increase) and a reciprocal decrease in the diagnosis of unstable angina [2].

There are many limitations to the use of classical echocardiographic indices for the estimation of systolic and diastolic left ventricular (LV) function. The EF, an index of systolic function, and LV volumes are subject to large errors when the ellipsoid shape of the heart becomes spherical. Age, rhythm and conduction disturbances and changes in loading all affect the Doppler signal of transmitral flow which is the most commonly used method [3].

A number of studies have documented that the Tei index (MPI) is independent of arterial pressure, heart rate, ventricular geometry, atrioventricular valve regurgitation, afterload, and preload in patients who are in a supine position [4].

Aim of the study

The Aim of this study was to assess the relation between the severity of CAD and LV MPI in patients with unstable angina.

Patients and Methods

We had selected 50 patients with UA, undergoing echocardiographic assessment and diagnostic coronary angiography in Azhar Assiut University Hospital.

Criteria for Exclusion: Patients with End stage renal disease, Patients with End stage liver disease, Haemodynamically unstable patients, patients with previous MI, patients with previous percutaneous coronary intervention (PCI) or Coronary artery bypass grafting (CABG), patients with Ischemic Dilated Cardiomyopathy, patients with significant rheumatic vavular heart disease, patients with pericardial disease and patients with congenital intracardiac shunt.

All patients in this study were subjected to:

Full history taking

Especially history of risk factors for CAD as: hypertension (HTN), diabetes mellitus (DM), positive family history of CAD, smoking, and dyslipidemia.

Complete physical examination: general and local cadiac examinations for signs of heart failure (HF) and valvular affection.

Electrocardiography: 12 lead ECG for all patients to detect signs of ischaemia. Also to exclude patients with previous MI.

Echocardiography

All patients underwent full echocardiographic study using different modalities such as: two dimensional (2D) echo, M mode, Colour Doppler, Continuous wave Doppler (CW), pulsed wave Doppler (PW) and tissue Doppler imaging (TDI).

All measurements obtained online and Echocardiographic parameters measured according to the American Society of Echocardiography Values for each parameter obtained by averaging measurements from three successive cardiac cycles [5].

EF was measured by biplane method by manual tracing of the endocardial border of LV in the apical four chambers (A4C) and apical two chambers (A2C) views for detecting Left Ventricular end Diastolic Volume (LVEDV), Left Ventricular end Systolic Volume (LVESV) in both views.

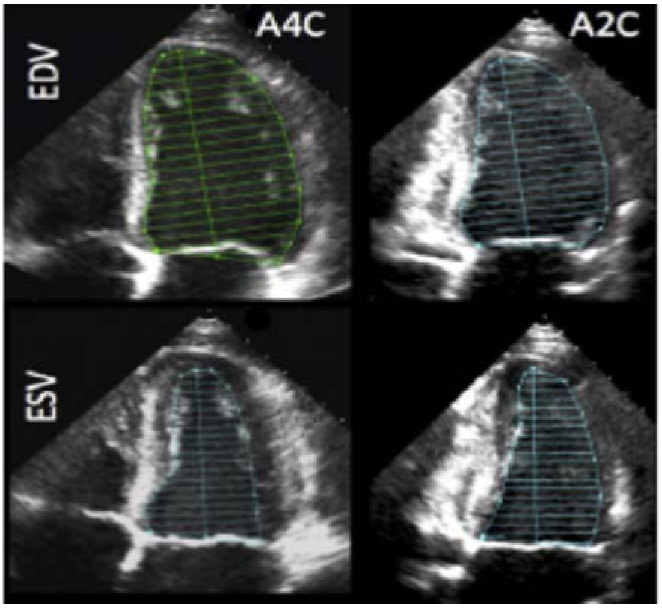

Fig 1: Measurement of LV volumes by biplane method. EDV: end Diastolic Volume, ESV: end Systolic Volume, A4C: apical four chambers veiw, A2C: apical two chambers view.

MPI was calculated by measuring TDI velocity time intervals from the sites at mitral annulus at the septal &lateral segments [6].

- TDI isovolumetric contraction time (ICT) was measured between cessation of A' wave and onset of S´ wave
- TDI ejection time (ET) was obtained between onset and cessation of S´ wave
- TDI isovolumetric relaxation time (IRT) was obtained between cessation of S wave and onset of E' wave.
- MPI-TDI was calculated as (ICT+IRT)/ (ET).

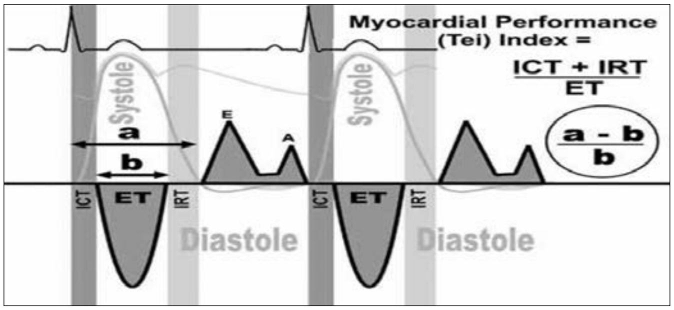

Fig 2: Measurement of myocardial performance (Tei) index, ICT= isovolumic contraction time, IRT= isovolumic relaxation time, ET=ejection time.

Coronary angiography: Diagnostic coronary artery catheterizations were done to all patients to confirm and assess the severity and the extent of CAD.

Evaluation of all coronary angiograms was made by two observers. Interpretations of coronary angiogram were done by visual estimation by two cardiologists to assess the severity of CAD, which were graded according to FS & Vessel score.

A. Friesinger score

Ranges from 0 to 15. Each of the three main coronary arteries is scored separately from 0 to 5

Score 0: No arteriographic abnormality
Score 1: Trivial irregularities (lesion from 1-29%)
Score 2: Localized 30-68% luminal narrowing
Score 3: Multiple 30-68% luminal narrowing of same vessel.
Score 4: 69-100% luminal narrowing without total occlusion of proximal segment.
Score 5: Total obstruction of a proximal segment of a vessel. [7].

B. Vessel score

This is the number of vessels with a significant stenosis (for LMCA 50% or greater and for others 70% or greater reduction in luminal diameter).Score ranges from 0 to 3, depending on the number of vessel involve. LMCA was scored as single vessel disease.

Score 0: no vessel involvement.
Score 1: single vessel involvement.

Score 2: double vessel involvement.
Score 3: triple vessel involvement [8].

Statistical Methods

The collected data were analyzed using the professional Statistical package for Social Science (SPSS 23). Categorical data were expressed by frequencies and percentages, while continuous data were expressed as mean ± standard deviation (SD). Bivariate Spearman correlation test (TWO tailed) was used to relate continuous data. Results were considered significant if "P" value was below (0.05) and was considered highly significant if (P < 0.01).

Results

Study population included 50 patients, 23 of them were females (46.0%) while 27 were males (54.0%) with mean age (55.9±6.3)

Echocardiographic data

LV systolic function by Simpson method: Mean EF ± SD was (56.8±6.3) %., MPI by Tissue Doppler: Mean MPI-TDI ± SD was (0.5±0.11).

Coronary Angiographic data: Friesinger score: Mean ± SD was (5.64±2.99), Vessel score: Mean ± SD was (1.7±0.84), Affected vessels: LM was affected in 2 Patient (4%), LAD was affected in 34 Patient (68%), LCX was affected in 20 Patient (40%) and RCA was affected in 27 Patient (54%).

Table 1: Basic charceristics of patients

Age	**(55.9±6.3) (mean +/- Std)**
Smoking	21 (42%)
HTN	26 (52%)
DM	28 (56%)
TIMI risk score	3.6 +/- 1.3 (mean +/- Std)

Table 2: Echocardiographic & Angiographic data of patients as Mean (+/- Std)

EF	**56.8 +/- 6.3**
MPI-TDI	0.5 +/- 0.11
Friesinger score	5.64+/- 2.99
Vessel score	1.7+/- 0.84

Table 3: Affected vessel as Number of Cases (%)

LM	**2 (4%)**
LAD	34 (68%)
LCX	20 (40%)
RCA	27 (54%)

Correlation between Friesinger & Vessel scores and MPI-TDI: there was statistically highly significant correlation between FS and MPI-TDI. The FS increases as the MPI-TDI increases and vice versa (P value = <0.001, r value = 0.55), Also there was statistically highly significant correlation between vessel score and MPI-TDI. The vessel score increases as the MPI-TDI increases and vice versa (*P* value = 0.001, r value = 0.45).

Correlation between Friesinger & Vessel scores and EF: there was statistically highly significant correlation between Friesinger score and EF by sipmson method. The Friesinger score increases as the EF decreases and vice versa (P value = 0.002, r value = -0.42), Also there was statistically highly significant correlation between vessel score and EF by sipmson method. The vessel score increases as the EF decreases and vice versa (*P* value = 0.005, r value = -0.388).

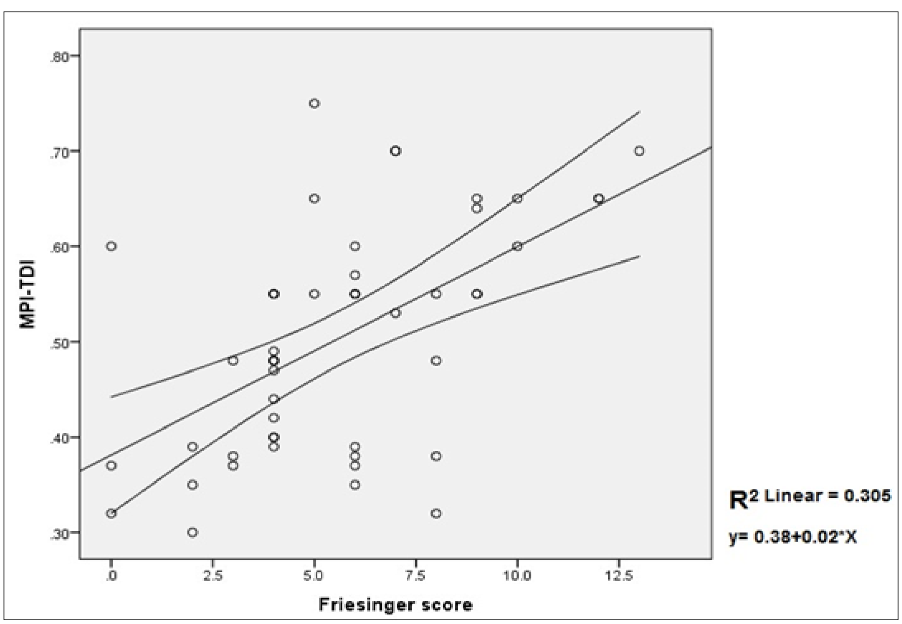

Fig 3: MPI-TDI vs. Friesinger score in Unstable Angina patients. Shows highly significant correlation. The Friesinger score increases as the MPI-TDI increases and vice versa (r = 0.55, *p* = 0.00003).

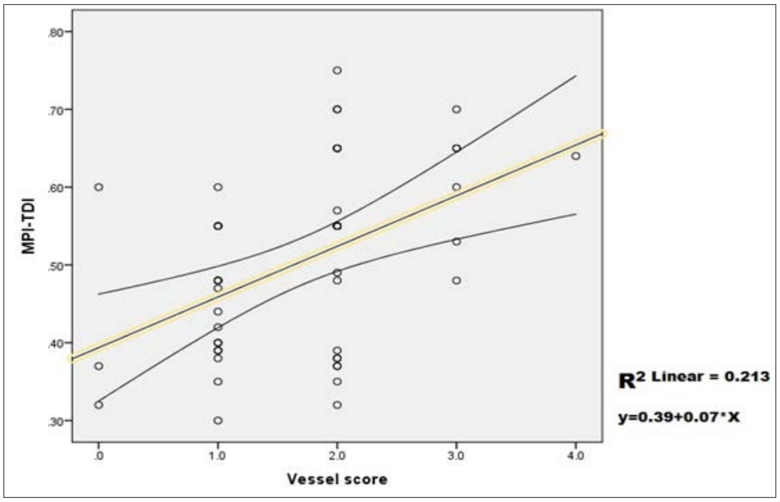

Fig 4: MPI-TDI vs. Vessel score in Unstable Angina patients shows highly significant correlation. The vessel score increases as the MPI-TDI increases and vice versa (r = 0.45, *p* = 0.001).

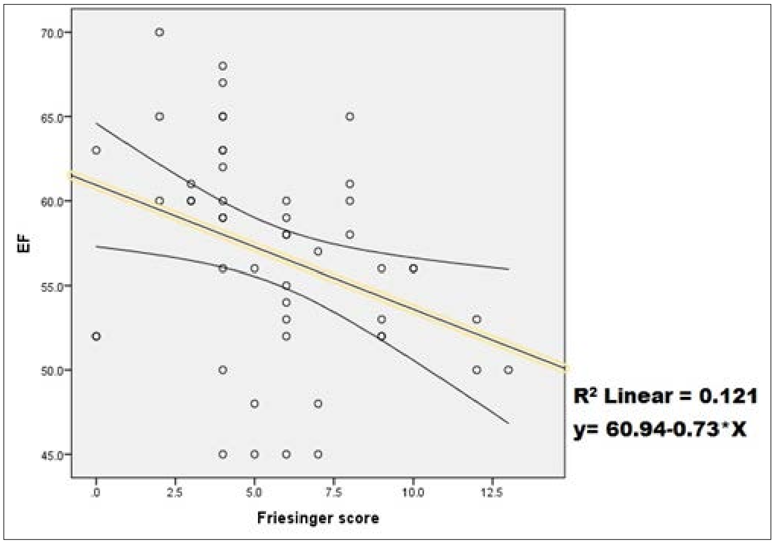

Fig 5: EF vs. Friesinger score in Unstale Angina patients shows highly significant correlation. The Friesinger score increases as the EF decreases and vice versa (r = - 0.42, *p* = 0.002).

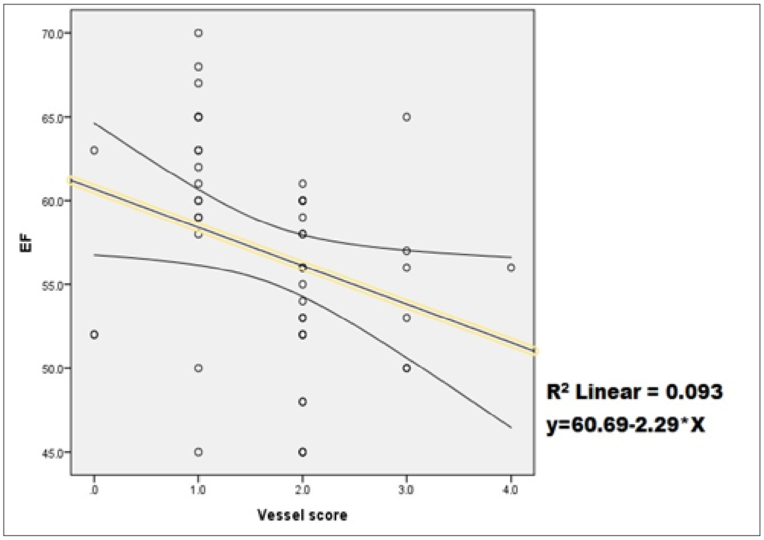

Fig 6: EF vs. Vessel score in Unstable Angina patients shows highly significant correlation. The vessel score increases as the EF decreases and vice versa (r = - 0.388, *p* = 0.005).

Correlation between Friesinger & Vessel scores and TIMI risk score: there was statistically highly significant correlation between FS and TIMI risk score**.** The FS increases as the TIMI risk score increases (*P* value <0.001, r value = 0.596), Also there was statistically highly significant correlation between vessel score and TIMI risk score. The vessel score increases as the TIMI risk score increases (*P* value = <0.001, r value = 0.532).

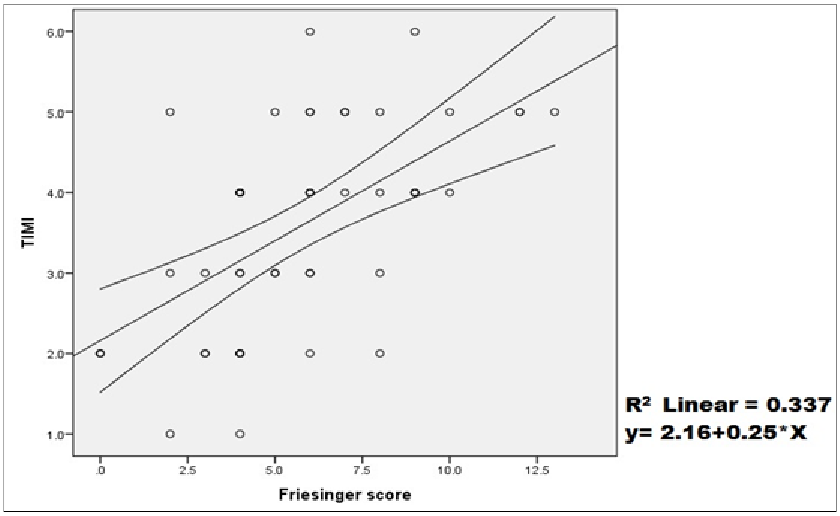

Fig 7: TIMI risk score vs. Friesinger score in Unstable Angina patients shows highly significant correlation. The Friesinger score increases as the TIMI risk score increases and vice versa (r = 0.596, *p* = 0.000005).

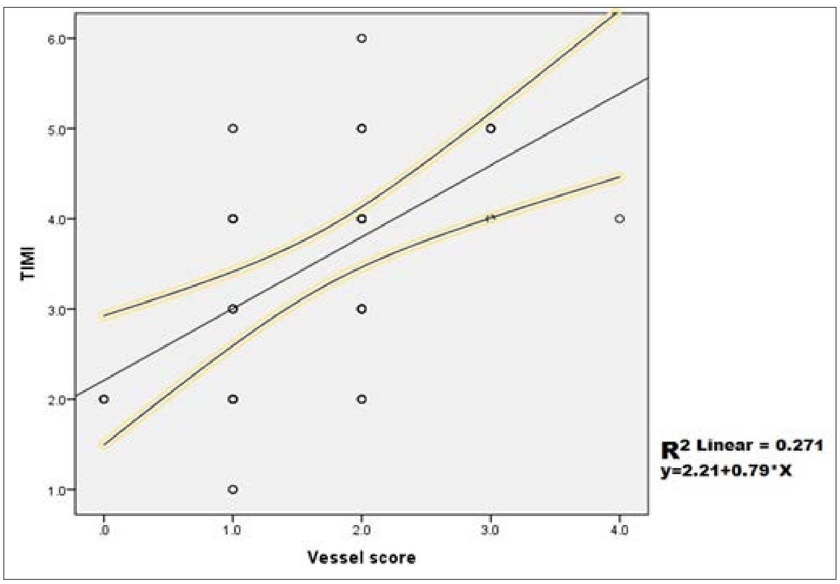

Fig 8: TIMI risk score vs. Vessel score in Unstable angina patients shows highly significant correlation.The vessel score increases as the TIMI risk score increases and vice versa (r = 0.532, *p* = 0.00007).

Discussion

In this study we found that There is statistically highly significant correlation between MPI and severity of CAD expressed by friesinger score *(p* value = <0.001*)* & vessel score *(p* value = 0.001*)*. Patients with higher MPI had higher friesinger score (r value = 0.55) & higher vessel score (r value = 0.45).

Also the LV EF as measured by biplane method is statistically highly significant correlated to the severity of CAD expressed by the same two scores: friesinger score *(p* value = 0.002*)* & vessel score *(p* value = 0.005*)*. Patients with higher EF had Lower friesinger score (r value = -0.42) & lower vessel score (r value = -0.388).

MPI, as it has lower *p* value, was statistically more significant than EF in correlation to the severity of CAD.

These results came in agreement with The study of Ammar, *et al*., (2016) who found that among study population 49 female (49.0%) and 51 male (51.0%) with mean age (48.96±7.30), 80 patients (80.0%) were had angiographically proven obstructive CAD, whereas 20 (20.0%) patients were had normal coronary angiography. There was statistically significant positive correlation between MPI and Syntax Score (SS) in patients with obstructive CAD (P-value < 0.001). As regard the number of diseased vessel; the study found that the more number of vessel diseased the more increase in the mean MPI denoting more impairment of myocardial function (one vessel 47.85±4.34, two vessel 50.08±3.79, three vessel 55.63±3.90, P-value <0.001).In addition patients with multi-vessel disease and those with high SS had a higher incidence of abnormal MPI compared to those with single vessel CAD or low SS [9].

Also our results came in agreement with The study of Abaci O, *et al*., (2017) that enrolled Ninety patients with an initial diagnosis of NSTE-ACS and aimed to investigate the relation between MPI and severity of CAD as assessed by the Gensini score (GS), found that MPI and IRT were significantly higher in the high-GS group than in the low- and mid-GS groups ($p < 0.001$ and $p = 0.005$, respectively). Furthermore, the high-GS group had a significantly lower EF and ET ($p = 0.01$ and $p < 0.001$, respectively). MPI was positively correlated with the GS ($r = 0.47$, $p < 0.001$), and multivariate regression analysis showed that MPI was an independent predictor of the GS ($\beta = 0.358$, $p < 0.001$) [10].

In agreement with our results; Sahin *et al*., (2012) found that although the normal EF, MPI value was impaired in proportion to the severity of CAD in patients with stable CAD. MPI value was significantly correlated with SS ($r = 0.564$, $P < 0.001$), diabetes ($r = 0.355$, $P < 0.001$), HT ($r = 0.326$, $P < 0.001$), EF ($r = −0.224$, $P = 0.018$), and number of diseased vessels ($r = 0.376$, $P < 0.001$) on bivariate analysis. Multivariate regression analysis showed that MPI was independently associated with SS ($\beta = 0.486$, $P < 0.001$) and diabetes ($\beta = 0.205$, $P = 0.028$) in stable CAD [11].

In disagreement with our results, The study of Hole T & Skjærpe T (2003) concluded that MPI did not accurately reflect changes in Doppler and 2D echocardiographic measures of diastolic or systolic function during a 2-year follow-up after AMI, and did not have any independent prognostic impact [12].

Conclusion

MPI is strongly correlated with the coronary angiographic FS & vessel score to yield a measure of the extent and severity of coronary atherosclerosis.

Echocardiographic evaluation of MPI in patients undergoing coronary angiography may be applied as a new surrogate marker of the extent of coronary atherosclerosis.

There was inverse correlation between EF estimated by biplane method and coronary angiographic FS & vessel score.

In our view, MPI may represent an important, non‐invasive marker in the risk stratification of patients undergoing coronary angiography.

Echocardiographic evaluation of MPI may help to determine the severity of CAD at rest using a non‐invasive procedure that requires only a few minutes.

The present findings call for future research to determine if MPI screening is superior to the current CAD risk assessment of individuals.

Limitations

This study has some limitations which should be addressed in further studies; limitations are summarized in the following points:

- Relatively small study sample.
- Potential limitations of MPI as Pseudo-normalization Phenomenon, partial preload dependence and inaccurate measurement in some situations as in AF, tachycardias and conduction disturbances
- The medications including antidiabetic and antihypertensive treatments were continued during the study. These medications could possibly have influenced our results.

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