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ORIGINAL ARTICLE

Acute myocardial perfusion imaging – A useful tool for evaluation of therapeutic modalities & a predictor of urgent need for revascularization in acute coronary syndromes

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Abstract We have been evaluating different therapeutic modalities using acute MPI, & we aimed at the use of acute MPI as a predictor of patients in need for urgent revascularization.
Methods: A total of 85 patients with ACS were included in our study, 57 males, mean age 52.9 ± 10.6 years, 35% were diabetics, 50% hypertensive, 54% smokers, 30% dyslipidemic & 33% had + ve family history of CAD. Acute MPI was done by SPECT technique using triple head Gamma Camera. Every patient had two sets of images, first set done on admission by injecting 25 mCi Tc^{99m} SestaMIBI intravenously before initiating therapeutic intervention and acquired within 6 h of injection. Second set of images was acquired 2 days later. Myocardium at risk (MAR) was calculated using 20 segment scoring system from the 1st set of images (scale 0–4/segment). Residual ischemia (RI) was calculated from the second set of images. Salvage index (SI = MAR − RI/MAR × 100) was taken as an end point for successful reperfusion (SI > 30%).

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All risk factors and MPI parameters were analyzed as independent predictors for the need for urgent revascularization vs. conservative strategy.

Results: Patients were subdivided according to therapeutic modalities used into three groups, group I: (50 pts) received unfractionated heparin, group II: (20 pts) received low molecular weight heparin & group III: (15 pts) received GPIIb/IIIa. There was no statistical difference as regards risk factors, age, sex, & MAR. Salvage index was highest in group II & lowest in group I (39 ± 21% vs. 64 ± 33.6% vs. 58 ± 25%) $P = 0.07$. Successful reperfusion was achieved in 67.3% in group I & 90% of group II, 86.7% in group III ($P = 0.06$). Out of 85 pts, 31 patients (group A) were in need for inhospital target vessel revascularization & 54 patients (group B) showed a good response on medical treatment (conservative strategy). Compared to group B, group A had higher values of RI (11 ± 7 vs. 5 ± 4%, $P < 0.0001$) & lower SI (15 ± 6 vs. 67 ± 24%, $P < 0.0001$) despite similar MAR (14 ± 7 vs. 15 ± 8) $P > 0.05$. High SI > 60%, and absence of diabetes (DM) were good predictors for conservative management strategy (specificity 96%); however, SI < 30% as well as presence of DM may recognize patients in need for urgent revascularization (sensitivity 50%) with overall predictive accuracy of 78.8%.

Conclusion: Acute MPI is a useful tool for evaluating therapeutic interventions. SI > 60% as well as absence of DM could recognize the subset of patients who can be managed conservatively whereas SI < 30% as well as presence of DM may recognize patients in need for urgent revascularization.

1. Introduction & aim of work

Acute myocardial perfusion imaging (MPI) has been recommended to confirm the diagnosis of non-ST elevation acute coronary syndromes (NSTEACS) in patients with chest pain and inconclusive electrocardiogram.[1,2] However, risk stratification of acute coronary syndromes (ACS) patients usually requires stress MPI prior to discharge. Patients who are admitted on clinical background and negative biomarkers need stress evaluation and or other imaging modalities.[1,3,4]

Over the past decade many therapies had emerged for the treatment of NSTEACS starting with unfractionated heparin (UFH), low molecular weight heparin (LMWH), and glycoprotein IIb/IIIa (GPIIb/IIIa) inhibitors.[3,4] Acute MPI may be used in patients with ACS not only for diagnostic purposes but to evaluate the extent of the myocardium at risk and to determine the effects of therapeutic interventions.[5–7,1] Strong correlation has been noted between infarct related artery patency and decrease in perfusion defect size.[5–7]

1.1. Aim

Over the last 12 years we have been using acute technetium Hexa – methoxy isobutyryl isonitrile (Tc^{99m} SestaMIBI) MPI to compare different emerging therapies of ACS.[8–13] In this study we aimed at searching the value of a second rest image after medical treatment to evaluate three main treatment modalities, and if rest–rest MPI can be used to select patients in need for urgent invasive vs. elective invasive strategies.

2. Patients & methods

- A retrospective study involving 85 NSTEACS patients admitted to the Critical Care Center, Cairo University, and subjected to two sets of rest MPI which aimed at evaluating certain therapeutic interventions. We reviewed patient records for:
  - Detailed history & physical examination.
  - Twelve lead electrocardiograms (ECGs) on admission & follow-up.
  - Biomarkers including cardiac enzymes creatinine kinase (CK), creatinine kinase myocardial band (CK-MB), lactate dehydrogenase (LDH) & or troponin T during the admission period.
- Acute MPI was acquired as follows: every patient had two sets of images.[5,6]

2.1. First set

The patient was injected on admission by 10–12 mCi of Tc^{99m} SestaMIBI, images were acquired after initial stabilization & within 6 h by single photon emission computed tomography (SPECT) technique, using triple head Siemens gamma camera 20 images were acquired, 20 s each, over 120° arc starting at 45° to obtain the classic short axis, vertical long axis & horizontal long axis slices.

The defect size was quantified using the 20 segment scoring system (six segments in apical, mid ventricular & basal short axis slices & two segments in apical vertical long axis slices).[14,15]

Each segment received a score of 0–4 according to its involvement where:

0 = normal uptake,
1 = mild defect,
2 = moderate defect,
3 = severe defect and
4 = no photon activity.

The defect size was estimated as a percent of the myocardium and calculated as follows: sum of scores in the 20 segments/80 × 100 to get the myocardium at risk (MAR).

2.2. Second set of images

Obtained 48–72 h after starting therapy using the same technique at rest. The scoring system was applied and calculated in the same way to obtain the residual ischemia (RI).

Salvage index (SI) was calculated as follows:

$$SI = MAR - RI/MAR \times 100$$

The physicians & patients were blinded to the results of acute MPI.

All data were analyzed & processed using the Emory tool box version 5.1:

2.3. Therapy

All patients received:

- Intravenous infusion of nitroglycerin.
- Aspirin 300 mg orally on admission then 150 mg once daily.
- Beta blockers starting with propranolol 10 mg orally every 8 h & dose titrated as needed unless contraindicated.
- Fifty patients studied received unfractionated heparin.
- Initial bolus dose of 80 IU/kg followed by heparin intravenous infusion of 18 IU/kg/h.
- Twenty patients included received low molecular weight heparin (enoxaparine 1 mg/kg/12 h) & 15 included patients received combined half dose unfractionated heparin & tirofiban (0.4 ug/kg over 30 min followed by 0.1 ug/kg/h for 48 h).

2.4. Need for revascularization

Patients were subjected to urgent revascularization in cases of[2,3,15]:

- Refractory angina.
- Development of myocardial infarction as evidenced by ECG & or elevated cardiac enzymes.
- Newly developed left ventricular dysfunction.

2.5. End points

- If salvage index was >30% therapy was considered successful.[17]
- Need for revascularization.

3. Results

Eighty-five unstable angina patients were included in the study including 57 males & 28 females (mean age 52.9 ± 10.6 years, range 39–80 years) (Table 1).

3.1. Acute MPI parameters

Mean MAR was 15 ± 7.6%, mean RI was 7.36 ± 6.5% & mean SI was 48.5 ± 52%.

Table 1 Risk factors for coronary artery disease in studied patients.

Risk factor	%
DM	35
HTN	50
Smoking	54
Dyslipidemia	30
+ve FH	33

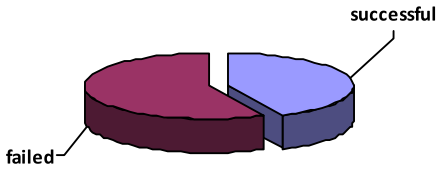

Figure 1 Scintigraphic success.

Therapy was considered scintigraphically successful (SI > 30%) in 65 pts (Fig. 1).

3.2. Clinical parameters

According to clinical criteria 31 patients were subjected to urgent revascularization procedure due to:

- Refractory angina in 25 pts.
- Progression to MI in six patients.

Accordingly patients were subdivided into two groups.

Group A (*31 patients*): who needed urgent revascularization.
Group B(*54 patients*): who were stable on medical treatment & scheduled for elective angiography after discharge.

Group B showed significantly higher salvage index & significantly lower residual ischemia with similar myocardium at risk (Table 2).

Scintigraphic success rate after initial medical treatment alone was significantly higher in group B when compared to group A.

When analyzed acute MPI parameters as predictor for urgent need of revascularization. Patients with salvage index >60% can be managed conservatively while patients with SI < 30% may need urgent revascularization.

However in patients with SI between 31% & 59% MPI had no predictive value (specificity 96%, sensitivity 50%) & overall predictive accuracy of 78.8% (Fig. 2, Table 3).

3.3. Acute MPI for evaluating different therapies

According to initial therapy used patients were classified into three groups:

Group I: (UFH group) 50 patients.
Group II: (LMWH group) 20 patients.
Group III: (GPIIb/IIIa inhibitors) 15 patients.

3.4. Risk factors in three groups

There was no significant difference between three groups as regards risk factors for coronary artery disease (CAD) (Table 4).

Table 2 Acute imaging parameters in two groups myocardium at risk (MAR), residual ischemia (RI) and salvage index (SI).

	Group A (%)	Group B (%)	*P* value
Myocardium at risk	14 ± 7	15 ± 8	0.7
Residual ischemia	11 ± 7	5 ± 4	0.0001
Salvage index	15 ± 6	67 ± 24	0.0001

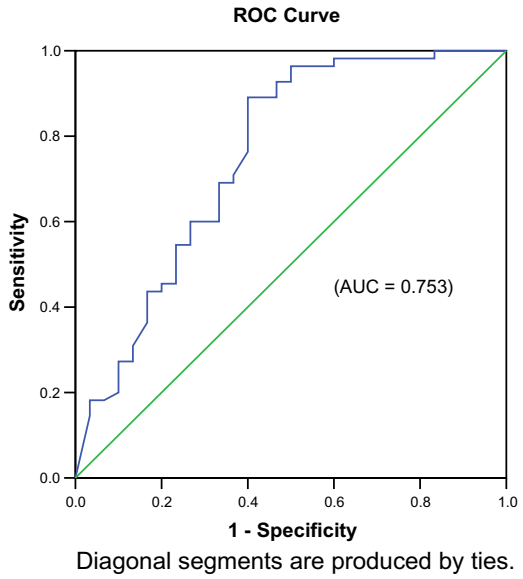

Figure 2 The ROC curve showing the predictive value of rest MPI NSTEACS.

Table 3 Patients distribution according to salvage index.

SI	< 30	> 30–59	> 60
No. of pts	20	23	42

Table 4 Risk factors in different groups according to therapy.

Risk factor	G I (%)	G II (%)	G III (%)	*P* value
DM	28	45	46.70	0.24
HTN	23	55	60	0.57
Dyslipidemia	24	30	53.30	0.09
Smoking	56	40	66.7	0.27
+ ve FH	34	25	40	0.627

3.4.1. Clinical outcome

Need for urgent revascularization was similar in groups I & II & lower in group III (Table 5).

3.5. Comparison between acute MPI parameters in three groups

Endpoint therapy was considered scintigraphically successful (SI > 30%) in 67.3% of group I, 90% of group II & 86.7% of group III, $P = 0.07$ (Table 6).

When compared to the unfractionated heparin group the LMWH group showed insignificant difference in the MAR ($P = 0.8$) with significantly lower residual ischemia (0.008) & higher salvage index (0.05).

4. Discussion

Our study demonstrated the possible value of acute myocardial perfusion imaging using Tc^{99m} SestaMIBI, in hospital planning of patients with unstable angina. At least patients who had salvage index > 60% after 24–48 h can be managed conservatively with medical treatment alone without subjecting them to stress modalities.[2]

American Society of Nuclear Cardiology (ASNC) and American Heart Association (AHA) guidelines recommended acute MPI as a diagnostic tool in ACS patients with normal or inconclusive ECG & biomarkers presenting to the emergency department.[2]

However, these patients still need further re-assessment by stress–rest MPI prior to discharge.[2,3,16]

We suggest that patients with SI > 60% in rest/rest images may be deferred to future elective coronary angiography specially in busy cath. labs.

Our study has postulated that acute MPI parameters namely salvage index > 60% after 24–48 h of medical treatment can effectively exclude those patients from need for urgent revascularization without need for further stress–rest testing and as adjunctive or even as a placement to clinical risk stratification or positive biomarkers. In addition acute MPI can be used as a subjective evidence of improvement in myocardial ischemic burden with its known superiority over ECG & symptomatology.

Our study lacks the long term follow-up for those patients managed conservatively so it is recommended to conduct a larger clinical trial with longer term follow-up to verify these results.

Based on the current results we recommend a follow-up clinical study for patients presenting to ER with chest pain

Table 5 Patients referred for urgent revascularization in different therapeutic groups.

	UFH	LMWH	GPIIb/IIIa inhibitors
Refractory angina	16 (32%)	7 (35%)	2 (13.3%)
Progression to MI	4 (8%)	2 (10%)	–
Need for revascularization	20 (40%)	9 (45%)	2 (13.3%)

Table 6 Acute scintigraphic parameters in different therapeutic groups.

Scintigraphic parameter	UFH	LMWH	GPIIb/IIIa inhibitor	*P* value
MAR (%)	13.6 ± 8	13.2 ± 4.4	22.1 ± 5.8	0.001
RI (%)	8.15 ± 7.5	4.5 ± 3.5	8.5 ± 4.7	0.078
SI (%)	39 ± 21	64 ± 33.6	58 ± 25	0.07

and inconclusive ECG with positive rest MPI to have a second rest image after medical treatment alone for 24 h.

4.1. Different therapies

Despite inhomogeneity in the MAR between the three groups tested which could be attributed to inhomogeneous sample size, LMWH & GPIIb/IIIa inhibitors seem to be at least as equal to or superior to UFH in management of ACS.

The accurate estimation of salvage index as actual measurement of response at tissue level is a superior endpoint to clinical & ECG improvement. MPI can be used safely & effectively for monitoring the response to treatment after 24 h; however, it lacks hour to hour monitoring where clinical & ECG are superior.

Currently GPIIb/IIIa inhibitors are of limited use in the management of NSTEACS and that they are stratified in class III before subjecting patients to coronary angiography yet in our study they showed superiority over other antithrombotics used.

Despite higher MAR in the GPIIb/IIIa inhibitors group, those patients showed better clinical & scintigraphic outcomes when compared to those patients receiving UFH or LMWH alone with a lower need for urgent in hospital revascularization. This may point toward the additional value of GPIIb/IIIa in the management of unstable angina (UA) patients apart from their use as a preparatory step for urgent revascularization.

5. Conclusion

- Acute MPI before & after initial medical treatment used for stabilization of ACS patients can clearly identify those patients who can be managed conservatively & may act as additional information for those who are in need for urgent target vessel revascularization (TVR).
- LMWH & GPIIb/IIIa inhibitors may be superior or at least equal to unfractionated heparin in improving myocardial perfusion.

6. Recommendations

- Use acute rest MPI & rest MPI after 24–48 h may be an additional useful tool for risk stratifying patients with UA and to guide in hospital management strategy.
- A longer term follow-up may show us more data about the reliability of acute MPI as a prognostic modality.
- Larger trials are recommended to verify the predictive role of acute MPI & to postulate the value of GPIIb/IIIa as an initial treatment in UA patients.
- Glycoprotein IIb/IIIa inhibitors may have a role in initial management of patients with unstable angina & may decrease the need for urgent revascularization.

References

1. Hendel RC, Berman DS, Di Carli MF, Heidenreich PA, Henkin PA, Pellikka PA, et al. ACCF/ASNC/ACR/AHA/ASE/SCOT/SCMR/SNM 2009 appropriate use criteria for cardiac radionuclide imaging: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine. *Circulation* 2009;**119**:e561–87.
2. Wackers Frans JTh, Brown Kenneth A, Heller Gary V, Kontos Michael C, Tatum James L, Udelson James E. American Society of Nuclear Cardiology position statement on radionuclide imaging in patients with suspected acute ischemic syndromes in the emergency department or chest pain center. *J Nucl Cardiol* 2002;**9**:246–50.
3. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-elevation myocardial infarction. *J Am Coll Cardiol* 2007;**50**(7):652–726.
4. Bassand Jean-Pierre, Hamm Christian W, Ardissino Diego, Boersma Eric, Budaj Andrzej, Fernández-Avilés Francisco. Guidelines for the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes The Task Force for the Diagnosis and Treatment of Non-ST-Segment Elevation Acute Coronary Syndromes of the European Society of Cardiology. *Eur Heart J* 2007;**28**:1598–660.
5. Sinusas AJ, Trautman KA, Bengin JD, Watson DD, et al. Quantification of area at risk during coronary occlusion and degree of myocardial salvage after reperfusion with technetium 99m methoxyisobutyl isonitrile. *Circulation* 1990;**82**:1424–37.
6. Gibbons RJ, Verani MS, Behrenbeck T, Pellika PA, O'Connor JJ, Mahmarian JJ, et al. Feasibility of tomographic 99mTc hexakis 2-methoxy 2-methylpropyl isonitrinile imaging for the assessment of myocardial area at risk and the effect of treatment in acute myocardial infarction. *Circulation* 1989;**80**:1277–86.
7. Schomig A, Ndrepepa G, Mehilli J, Scwaiger M, Schuler TT, Nekolas S, et al. Therapy dependent influence of time to treatment Interval on myocardial salvage in patients with acute myocardial Infarction treated with coronary artery stenting or thrombolysis. *Circulation* 2003;**108**:1084–8.
8. Abd El-Bary Akram, El-Naggar Ayman, El-Ghawaby Helmy, Abd El-Fattah Alia, Mokhtar Sherif, Abdulaziz Ahmed. Intravascular ultrasound thrombolysis of acutely occluded coronary arteries. A useful adjunctive to primary percutaneous transluminal coronary angioplasty. New Egypt J Med 2002;26.
9. Abdelbary AM, Sami W, Tayeh O, Hussien A, Hamed L, Allam A, et al. Acute myocardial perfusion imaging (MPI) – a useful tool for evaluation of therapeutic modalities & a predictor of urgent need for revascularization in acute coronary syndromes (ACS). In: International conference of nuclear cardiology (ICNC 8) JNC; 2007 April S4.
10. Abdelbary A, AbdelAal A, Battah A, et al. Thrombolysis or acute PCI in STEMI. A dilemma solved by acute myocardial perfusion imaging. *Egypt Heart J* 2009;**61**:40–3.
11. Abdelbary A, AbdelAal A, Abdelfattah A, et al. Can successful mechanical reperfusion achieve comparable myocardial salvage to successful thrombolysis in acute STEMI? A question answered by acute myocardial perfusion Tc99m sestaMIBI imaging. *Acute Cardiac Care* 2008;**10**(3):162.
12. Abdelbary AM, Kamal HS, El-Aassar H, El-Naggar A, Abdelfattah A. Improvement in left ventricular functional parameters before and after primary PCI in acute STEMI and its relation to angiographic parameters: Gated Single Photon Emission Computed Tomography (GSPECT) Study. *JNC* 2009;**16**(4): 669.
13. Kamal HS, Abdelfattah A, Abdelbarry AM, Al-Aassar H, El-Naggar A. Assessment of left ventricular stunning and its relation to myocardial perfusion before and after primary PCI. A gated SPECT myocardial perfusion study. *Acute Cardiac Care* 2010;**12**(Suppl. 12) (abs).

14. Germano G, Kavanagh PB, Waechter P, Areeda J, Van Kriekinge T, Sharir T, et al. A new algorithm for the quantitation of myocardial perfusion SPECT. I: Technical principles and reproducibility. *J Nucl Med* 2000;**41**(4):712–9.
15. Sharir T, Germano G, Waechter PB, Kavanagh PB, Areeda JS, Gerlach J, et al. A new algorithm for the quantitation of myocardial perfusion SPECT. II: Validation and diagnostic yield. *J Nucl Med* 2000;**41**(4):720–7.
16. Gibbons RJ, Verani MS, Behrenbeck T, Pellikka PA, O'Connor JJ, Mahmarian JJ, et al. Feasibility of tomographic 99mTc-hexakis-2-methoxy-2-methylpropyl-isonitrile imaging for the assessment of myocardial area at risk and the effect of treatment in acute myocardial infarction. *Circulation* 1989;**80**(5):1277–86.
17. Era William E. Boden. ''Routine invasive'' versus ''selective invasive'' approaches to non-ST-segment elevation acute coronary syndromes management in the post-stent/platelet inhibition. *J Am Coll Cardiol* 2003;**41**(4 Suppl. S).