



An analysis of patients receiving emergency CAG without PCI and the value of GRACE score in predicting PCI possibilities in NSTEMI-ACS patients

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Abstract

Background There are patients who underwent emergency coronary angiography (CAG) but did not receive percutaneous coronary intervention (PCI). The aim of this study was to analyze these reasons. **Methods** This is a single-center retrospective study. We recruited 201 consecutive patients who received emergency CAG but did not receive PCI. To investigate the value of the Global Registry of Acute Coronary Events (GRACE) score in predicting PCI possibilities in non-ST segment elevation acute coronary syndrome (NSTEMI-ACS) patients, we recruited 80 consecutive patients who presented with NSTEMI-ACS and received emergency CAG as well as emergency PCI. **Results** Among the 201 patients who received emergency CAG but did not receive PCI, 26% patients had final diagnosis other than coronary heart disease. In the patients with significant coronary artery stenosis, 23 patients (11.5%) were recommended to coronary artery bypass grafting (CABG), one patient (0.5%) refused PCI; 13 patients (6.5%) with significant thrombus burden were treated with glycoprotein IIb/IIIa receptor antagonist; 74 patients (36.8%) were treated with drug therapy because no severe stenosis (> 70%) was present in the crime vessel. Moreover, 80 of the 201 patients were presented with NSTEMI-ACS (excluding those patients with final diagnosis other than coronary heart disease, excluding those patients planned for CABG treatment), referred as non PCI NSTEMI-ACS. When comparing their GRACE scores with 80 consecutive patients presented with NSTEMI-ACS who received emergency CAG as well as emergency PCI (referred as PCI NSTEMI-ACS), we found that PCI NSTEMI-ACS patients had significantly higher GRACE scores compared with non PCI NSTEMI-ACS patients. We then used Receiver Operator Characteristic Curve (ROC) to test whether the GRACE score is good at evaluating the possibilities of PCI in NSTEMI-ACS patients. The area under the curve was 0.854 ± 0.030 ($P < 0.001$), indicating good predictive value. Furthermore, we analyzed results derived from ROC statistics, and found that a GRACE score of 125.5, as a cut-off, has high sensitivity and specificity in evaluating PCI possibilities in NSTEMI-ACS patients. **Conclusions** Our findings indicate that the GRACE score has predictive value in determining whether NSTEMI-ACS patients would receive PCI.

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Keywords: Acute coronary syndrome; Coronary angiography; GRACE score; Percutaneous coronary intervention

1 Introduction

Ischemic heart disease continues to be the leading cause of death worldwide,^[1] and acute coronary syndrome (ACS) is the critical condition of ischemic heart disease. Current treatment of ACS and acute myocardial infarction (AMI) associates with emergency coronary angiography (CAG) and percutaneous coronary intervention (PCI). However, we noticed that some suspected ACS or AMI patients under-

went emergency CAG but did not receive PCI due to various reasons. Here, we analyzed the reasons why these patients did not receive PCI, for better allocation of medical resources.

ACS is comprised of unstable angina, non-ST elevation myocardial infarction (NSTEMI) and ST-elevation myocardial infarction (STEMI) according to the clinical symptoms, electrocardiographic findings and laboratory markers.^[2] Apart from ST elevation ACS, patients with non-ST elevation ACS (NSTEMI-ACS) are a heterogeneous population with various risks of death and major cardiac events, in long-term as well as short-term follow-up.^[3] The Global Registry of Acute Coronary Events (GRACE) score was developed from the registry,^[4] which has been shown potent in predicting both short and long term death and major cardiac event.^[4,5]

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Thus, it was recommended that patients with a GRACE score > 140 were considered as high risk categories and early CAG was suggested for these patients.^[6,7] However, so far as we know there is no published report on the value of GRACE score in predicting the possibility of receiving PCI in NSTEMI-ACS patients, and therefore in this article we explored whether the GRACE score could predict such possibility.

2 Methods

2.1 Study population

This is a single-center retrospective study of 201 consecutive patients presented with suspected ACS according to American and European guidelines,^[2,8] who received emergency CAG, but did not receive emergency PCI in the Cath-lab of Peking University Third Hospital from 2005/05/01 to 2014/12/20. The inclusion criteria were (1) age > 18 years; (2) symptoms compatible with ACS within 24 h; and (3) at least one of electrocardiographic (ECG) changes, abnormal cardiac biomarkers, with/without history of coronary artery disease. ST segment elevation ACS or myocardial infarction were characterized in ECG by new or presumed new ST-segment elevation at the J point in two or more contiguous leads with the cut-off points of ≥ 0.2 mV in leads V1, V2, or V3 and ≥ 0.1 mV in other leads.^[9] In contrast, NSTEMI-ACS patients present with acute chest pain but without persistent ST-segment elevation.^[6] The ECG shows persistent or transient ST-segment depression or T-wave inversion, flat T waves, pseudo-normalisation of T waves, or no ECG changes at presentation. NSTEMI-ACS is further divided into unstable angina which has normal cardiac injury marker levels, and NSTEMI with elevated cardiac markers. To investigate the value of GRACE score in predicting PCI possibilities in NSTEMI-ACS patients, we recruited 80 consecutive patients who presented with NSTEMI-ACS and received emergency CAG as well as PCI in our Cath-lab during the same time period with the same criteria. All procedures were performed according to institutional guidelines and conformed to the principles outlined in the Declaration of Helsinki. The study protocol was approved by the local human subjects committee.

2.2 Treatment

The CAG, PCI and echocardiography procedures were the same as previously reported.^[10,11] The patients were diagnosed and treated according to guidelines.^[7,9] Creatine kinase MB (CK-MB) level higher than 24 IU/mL, troponin T (TnT) level higher than 0.1 ng/mL were considered to be positive. The risk factors for coronary heart disease (CHD)

were identified as hypertension, diabetes, hyperlipidemia, smoking, family history of premature CHD, age > 60 years old, and menopause. The number of total risk factors was analyzed.

2.3 GRACE score

The demographic and clinical characteristics and data contributing to the GRACE risk score^[4] (e.g., age, heart rate, systolic blood pressure, Killip class, ST deviation, cardiac arrest, serum creatinine, and cardiac biomarker status on admission) were compared. A program for personal computer use was downloaded at the site of the GRACE project, and was used to calculate each patient score.

2.4 Statistical analysis

Continuous variables with a normal distribution were expressed as mean \pm SD. Discrete variables were expressed as frequencies and per cent values. Statistical comparison of baseline characteristics was performed using the χ^2 test, when appropriate, for categorical variables, and the two-tailed Student's *t*-test for continuous variables. Receiver operating characteristic (ROC) curves were used to relate the calculated GRACE scores to the percentage of PCI. The area under the curve (AUC), was used as a measure of the predictive accuracy. The goodness of fit was evaluated by calculating the Hosmer–Lemeshow statistic. The cut-off GRACE score was determined by highest specificity plus sensitivity, which was derived from the ROC curve. The studied population was assigned into two groups according to GRACE score. Binary logistic analysis was performed to test for an interaction between the GRACE score and the possibility of PCI. Two-tailed tests of significance are reported. For all comparisons, $P < 0.05$ was considered statistically significant. When appropriate, 95% CIs were calculated. Statistical analysis was performed with SPSS version 19.0 (SPSS Inc., Chicago, IL, USA).

3 Results

Among the 201 patients who received emergency CAG but did not receive PCI, 77.6% were male, 22.4% were female (all baseline characteristics were listed in Table 1); the average age was 60.2 years old. About 31.4% patients experienced recurrent chest pain, while 51.4% demonstrated with typical ST elevation or Q wave formation in ECG. Echocardiography found segmental wall motion abnormality in 34.2% patients. CAG results showed that 30.3% patients had no significant (> 50%) stenosis in the major coronary arteries. Some 22.2% patients had mono-vessel disease (> 50% stenosis in one of the three major coronary

arteries), 15.5% patients had double-vessel disease, and 17.6% patients had triple-vessel disease. Also, 3.4% patients had only coronary artery spasm with no significant stenosis, 2.5% was diagnosed coronary artery myocardial bridge. In the patients with significant coronary artery stenosis, 23 patients (11.5%) were recommended to coronary artery bypass grafting (CABG), one patient (0.5%) refused PCI; 13 patients (6.5%) with significant thrombus burden were treated with glycoprotein IIb/IIIa receptor antagonist as well as dual antiplatelet at first; 74 patients (36.8%) were treated with drug therapy because no severe stenosis (> 70%) was present in the crime vessel. As to the final diagnosis, 44.5% were acute STEMI, 7.5% were NSTEMI, 19.0% were unstable angina, 4.0% were hypertension, 3.5% were myocarditis or pericarditis, 3.0% were variant angina, 3.0% were coronary artery sclerosis, 2.5% were coronary artery myocardial bridge, 2.0% were stress induced cardiomyopathy, 2.0% were arrhythmia, 2.0% were aortic dissection, 1.5% were cholecystitis, 1.5% were heart neurosis, 1.0% were valvular heart disease, 1.0% were pulmonary embolism, 0.5% was early repolarization syndrome, 0.5% was heart failure, 0.5% was pacemaker failure, 0.5% was gastritis (Table 2). Subgroup analysis found that in the final diagnosed AMI patients (STEMI and NSTEMI), average levels of TnT, CKMB, CK, the percentage of characteristic ST elevation or Q wave formation in ECG, or segmental wall motion abnormality were significantly higher than patients with a final diagnosis other than AMI (Table 1). There were also significant differences between AMI and non-AMI patients in gender, number of risk factors (Table 1).

During analysis, we noticed that among the 201 patients who received emergency CAG but did not receive PCI, 80 patients were presented with NSTE-ACS (68.75% male,

Table 1. Clinical characteristics.

	Entire population, n = 201	AMI, n = 100	Non-AMI, n = 101	P(AMI & Non-AMI)
Male	77.63%	78%	77.20%	0.64
Average age, yr	60.24	61.30	59.22	0.33
Recurrent chest pain	31.35%	33.20%	29.52%	0.22
Number of risk factors	2.67	2.95	2.4	0.001
ST elevation or Q wave	51.42%	77.23%	25.62%	< 0.001
Average CK, IU/mL	577.62	1042.9	114.21	0.005
Average CK-MB, IU/mL	55.28	96.42	14.15	< 0.001
Average TnT, ng/mL	0.54	0.97	0.11	< 0.001
Echocardiography positive	34.19%	62.22%	6.16%	< 0.001
LDL, mmol/L	2.57	2.67	2.46	0.38

AMI: acute myocardial infarction; CK-MB: creatine kinase MB; TnT: troponin T; LDL: low density lipoprotein.

Table 2. Final diagnosis.

AMI	
STEMI	44.5%
NSTEMI	7.5%
Angina	
Unstable	19.0%
Variant	3.0%
Hypertension	4.0%
Myocarditis or pericarditis	3.5%
Coronary artery sclerosis	3.0%
Coronary artery myocardial bridge	2.5%
Stress induced cardiomyopathy	2.0%
Arrhythmia	2.0%
Aortic dissection	2.0%
Valvular heart disease	1.0%
Heart neurosis	1.5%
Heart failure	0.5%
Pacemaker failure	0.5%
Early repolarization	0.5%
Non-cardiogenic	3%

AMI: acute myocardial infarction; STEMI: ST-elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction.

31.25% female, average age 60.4 years old), excluding those patients with final diagnosis other than CHD and those patients planned for CABG treatment, referred as non PCI NSTE-ACS. We found these patients have significantly lower GRACE score (99.92 ± 26.77), comparing with 80 patients (GRACE score 135.3 ± 29.7) presented with NSTE-ACS who received emergency CAG as well as PCI during the same time period (65.7% male, 34.4% female, average age 62.4 years old, referred as PCI NSTE-ACS), ($P < 0.001$), (Figure 1). No significant difference in key clinical characteristics was noticed between non PCI NSTE-ACS and PCI NSTE-ACS patients. We then used Receiver Operator Characteristic Curve (ROC) to test whether the GRACE score is good at evaluating the possibility of PCI in NSTE-ACS patients. The AUC was 0.854 ± 0.030 ($P < 0.001$), (Figure 2), with 95% CI (0.796–0.913), indicating good predictive value. Furthermore, we analyzed the results derived from ROC statistics, and found that GRACE score 125.5 as a cut-off has highest sensitivity plus specificity in evaluating PCI possibility in NSTE-ACS patients. We then divided the 160 NSTE-ACS patients (80 non-PCI NSTE-ACS patients, and 80-PCI NSTE-ACS patients) into two groups (GRACE > 125.5 and GRACE < 125.5). Interestingly, we found that in binary logistic regression model, GRACE score was significantly related with the possibility of PCI in these NSTE-ACS patients, with a prediction accuracy of 79.4%. In our statistics, GRACE score > 125.5 was valued as “1”, while GRACE

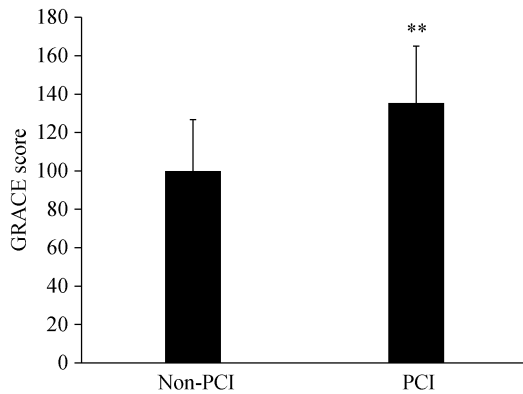


Figure 1. GRACE scores of NSTE-ACS patients who received PCI compared with those who didn't receive PCI. $P < 0.001$.** GRACE: Global Registry of Acute Coronary Events; NSTE-ACS: Non-ST elevation acute coronary syndrome; PCI: percutaneous coronary intervention.

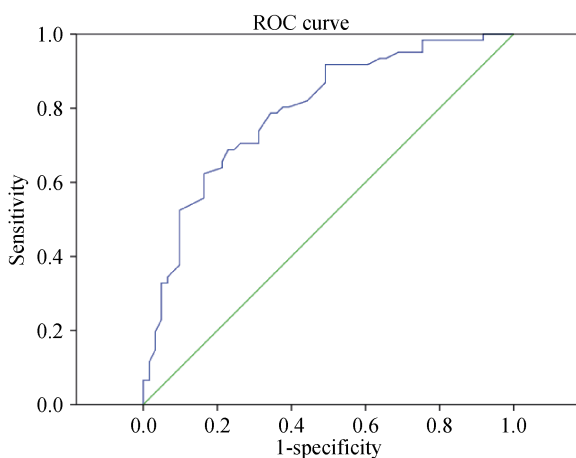


Figure 2. Receiver operator characteristic curve (blue line) of GRACE score related to PCI possibility. GRACE: Global Registry of Acute Coronary Events; PCI: percutaneous coronary intervention; ROC curve: receiver operator characteristic curve.

score < 125.5 was valued as “0”. The Wald value is 47.105 ($P < 0.001$), OR value is 15.921, with 95% CI (7.22–35.092). The PCI possibility could be predicted with “ $PCI = 1/[1+e^{-(2.768*GRACE-1.175)}]$ ”. If the result is larger than 0.5, the NSTE-ACS patient would probably receive PCI, otherwise the NSTE-ACS patient would probably not receive PCI with an overall prediction accuracy of about 79.4%.

4 Discussion

This study found among patients who received emergency CAG but did not receive PCI, about 26% patients had final diagnosis other than CHD, indicating the importance of clarifying diagnosis before emergency CAG. Through subgroup analysis, we found that a combination of ECG, cardiac injury markers, and echocardiography had higher

diagnostic accuracy. In the patients with significant coronary artery stenosis, 36.8% patients did not receive PCI because no severe stenosis was found in the crime vessel, however, autolysis of the thrombus may be one cause or other mechanisms need further investigation. In high risk patients, a heart team was consulted and 11.5% patients with high SYNTAX score were recommended for CABG. About 6.5% patients with significant thrombus burden were treated with GP IIb/IIIa receptor antagonist. During analysis, we found the patients presented with NSTE-ACS, but did not receive emergency PCI and had a lower GRACE score compared with those NSTE-ACS patients who received emergency PCI. Previous research showed that NSTE-ACS patients with a GRACE score higher than 140 had significantly higher rates of in-hospital mortality and cardiovascular events, thus early CAG and PCI (if necessary) was suggested for these patients.^[6,7] However, no research has shown the value of GRACE scores in predicting PCI possibilities. In the current research, we showed that in patients presented with non ST segment elevation acute coronary syndrome, the GRACE score is significantly related with the possibility of PCI. Patients with a GRACE score higher than 125.5 were more likely to receive PCI. We also developed a model to predict the PCI possibility. Our findings indicate that the GRACE score has predictive value in determining whether NSTE-ACS patients would need PCI, which could have beneficial effect in administering medical resources. Due to the relative small sample size, our results need to be tested in other large scale research.

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