Comparison of GRACE Score and SYNTAX Score in Predicting Complexity of Coronary Artery Disease in Patients with NST-ACS

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ABSTRACT

Objective: To compare the GRACE score and SYNTAX score in predicting Coronary Artery Disease (CAD) severity and the variation of GRACE score with respect to SYNTAX score to assess severity of CAD.

Study Design: Analytical, Cross-sectional study.

Place and Duration of Study: Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi Pakistan, from Jan 2023 to Jun 2023.

Methodology: Data was gathered from n=139 participants by using consecutive sampling technique on a data collection tool. Study variables such as demographics, comorbids, clinical characteristics and SYNTAX and GRACE score were noted to asses their role in determining CAD severity. An experienced cardiologist was assigned to analyze the coronary angiogram findings, performed by using conventional techniques through radial artery, ulnar or femoral artery access. SPSS version-24.00 was used for data management and analysis. Chi square test and Pearson correlation was applied to find the association and correlation respectively.

Results: Mean age of study participants was 62.09±9.74 years and males were more in number 114(82.0%). Ninety three (66.9%) patients had NSTEMI. Gender (p=0.011,0.007), was significantly associated with SYNTAX score as well as GRACE score respectively and diabetic status (p=0.003) with GRACE score. There was a strong and positive correlation between GRACE score and SYNTAX score (r=0.64; p<0.001). Both scores showed significant association with CAD severity (p<0.05).

Conclusion: There exists a statistically significant and positive correlation between GRACE score and SYNTAX score in non-ACS (NSTEMI and UA) patients who had confirmed diagnosis of CAD on coroangiogram. The greater the GRACE score, the greater was the syntax score depicting greater risk of CAD.

Keywords: Acute Coronary Syndrome, Coronary Artery Disease, GRACE Score, SYNTAX Score.

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INTRODUCTION

Globally, the deaths caused by the cardiovascular burden accounts for greater than 17 million and this numeric can be expected to increase up to 23.6 million by the year 2030. Solely, the Coronary Artery Disease (CAD) caused 7 million deaths in 2010 around the globe which was estimated to be 35% increase in deaths since 1990.[1] This predominant grow up of CAD from Non-ST Elevation Myocardial Infarction (NSTEMI) to ST-Elevation Myocardial Infarction (STEMI), can be due to gradual change in demographic characteristics involving progressive increase in count of aged persons and increasing rate of comorbids such as diabetes and hypertension.[2,3]

Numerous tools have been developed to predict the extent of CAD and its short, intermediate and longterm outcomes such as Thrombolytic Myocardial Infar-ction score (TIMI score), Framingham Risk score, SYNTAX score and Global Registry of Acute Coronary Events score (GRACE score).[4-6]

An ample angiographic scoring system can be due to the synergy between SYNTAX score and Percutaneous Coronary Intervention (PCI). However, it is a strong predictor to take a good decision of selecting between PCI and Coronary Artery Bypass Grafting (CABG) surgery. Safarian *et al.*, has proved the SYNTAX score to be an appropriate tool in predicting inter-mediate term outcomes of PCI followed by extent of CAD in triple vessel diseased patients and can be used appropriately in selecting the required and effective revascularization strategy.[7]

Currently the American and European guidelines have suggested GRACE score to be the major adverse cardiac events' predictor in ACS patients. However,

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this tool was also proven to detect the high risk patients of NSTEMI who can be benefited non-invasively from an early invasive procedure. Yet, it is not proposed to ascertain the CAD complexity.[8]

Till date, a number of literatures have explored the correlation of risk stratification scoring with the extent of CAD,[4-6,9] but to the best of our knowledge, limited literature is available on using GRACE score in predicting CAD severity along with its authenticity. Nevertheless, the use of GRACE score could also demonstrate the necessity to shift the NSTEMI patients from hospital having no PCI facility available to a PCI center right after thrombolytic therapy.[10]

Our study was aimed at a thorough investigation of correlation of GRACE score and SYNTAX score and their association with the extent of CAD in patients who were coro-angiographically confirmed cases of non-acute coronary syndrome (Non-ACS) i.e., NSTEMI and unstable angina. Hence, the current study aspired to investigate the angiographic CAD severity with the use of GRACE score which can be the non-invasive and almost costless technique.

METHODOLOGY

The given study with analytical cross-sectional study design was conducted from January 2023 to June 2023 in a reputed Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi, where a wide variety of patients from different regions of Pakistan, are reported with various cardiac illnesses. Among those patients, n=139 patients were selected who were confirmed cases of CAD on coroangiogram. Non-probability consecutive sampling technique was used for this purpose. Prior to data collection, an ethical approval from Institutional Ethical Review Board was taken under the officially assigned approval letter# (9/2/R&D/2023/244)

WHO calculator was used to find out the sample size for the research purpose and it came out to be n=139 by keeping confidence interval (95%) and margin of error (5%) and 10% prevalence of NST-ACS.[11]

Inclusion Criteria: All NST-ACS (STEMI and unstable angina) patients who underwent coro-angiography, having age in range of 18-60 years regardless of gender were included.

Exclusion Criteria: All the STEMI patients, NST-ACS patients who were emergency cases, NST-ACS patients with creatinine clearance <30 ml/min and past history of CABG procedure were not included in study participants list.

SYNTAX score was defined as an angiographic tool which helps the interventionists, cardiologists, and surgeons to grade the extent of coronary artery lesions. It was categorized into three grades i.e., Low (0-22), Intermediate (23-32), High(>32).[11] GRACE score was defined in terms of a tool that scores the laboratory and clinical parameters to predict in-hospital and 6 months mortality in ACS patients and identify the CAD severity. This tool was also graded into Low risk GRACE (1-107), Intermediate Risk GRACE(108-140) and High Risk GRACE (>140).[12]

After seeking written informed consent from the patients falling in eligibility criteria of our study protocols, a detailed history and complete physical examination of all the patients was performed. Detailed history including age, diabetes, smoking history, hypertension and chronic kidney disease (CKD) was taken. An experienced cardiologist was assigned to analyze the coronary angiogram findings, performed by using conventional techniques through radial artery, ulnar or femoral artery access. The lesions were described on the basis of site, number, degree of involvement, extent of calcification, thrombus burden, tortuosity of involved segments, bifurcation/trifurcation involvement and total occlusion. Each lesion was scored. The SYNTAX Score Calculator software version 2.1. I was used to deduce its figures.[13]

The determinants of the GRACE risk score,[9] (i.e., age, systolic blood pressure, heart rate, concentration of serum creatinine, ST-segment deviation presence, cardiac arrest on admission, Killip class and raised serum cardiac biomarkers) was documented on admission and was assessed by cardiologist based on the patients' medical records. The GRACE 2.0 ACS risk calculator was used to deduce GRACE score.[14]

Gathered data was entered, managed, and analyzed by the computer software, Statistical Package for Social Sciences (SPSS) Version-24.00. The findings for all descriptive data, for example: age, GRACE score and SYNTAX Score were expressed as Mean± Standard deviation. Frequencies and percentages were analyzed for qualitative data like gender, smoking history, diabetes, and hypertension. Chi-square test & correlation analysis was done to find significance of result findings. Significant *p*-value was taken as <0.05.

RESULTS

In current study data was gathered from n=139 consecutive patients fulfilling the inclusion criteria. Descriptive statistics as well as inferential statistics were applied. In the light of descriptive analysis pre-

Table-I: Demographics and Clinical Characteristics of Study Participants (n=139)

Variables		Frequency(%)
Age (years) (Mean±SD)		**62.09±9.74**
Gender	Male	114(82.0)
	Female	25(18.00
Type of ACS	NSTEMI	93(66.9)
	Unstable Angina	46(33.1)
Diabetes Mellitus	Yes	66(47.5)
	No	73(52.5)
Hypertension	Yes	75(54.0)
	No	64(46.0)
Smoker	Yes	20(14.4)
	No	119(85.6)
Coronary Artery Disease	SVCAD	18(12.9)
	DVCAD	25(17.9)
	TVCAD	96(69.06)
Left Main Stem Disease	Yes	21(15.10
	No	118(84.9)
Left Ventricular Ejection Fraction (%)(Mean±SD)		47.56±12.00
Serum Creatinine (mg/dl) (Mean±SD)		1.10±0.52
SYNTAX Score		24.73±13.73
SYNTAX Score Grade	Low (≤22)	49(35.3)
	Intermediate (23-32)	60(42.4)
	High (>32)	30(21.6)
GRACE Score		118.05±32.41
GRACE Score Grade	Low Risk (1-107)	27(19.42)
	Intermediate Risk (108-140)	84(60.43)
	High Risk (>140)	28(20.14)
CAD severity	Mild	49(35.3)
	Moderate	60(42.4)
	Severe	30(21.6)

ACS=acute coronary syndrome; CAD=Coronary Artery Disease

sented in Table-I, there was male dominance 114 (82.0%). Mean age of study participants was 62.09±9.74 years. 93(66.9%) patients were presented with NSTEMI and 46(33.1%) with unstable angina. Majority of these were non-diabetic, hypertensive and non-smokers [73(52.5%), 75(54%), 119(85.6%) respectively]. Maximum count were having TVCAD 96(69.1%) and a small number of patients had LMS disease 21(15.1%). Mean values of LVEF, serum creatinine, SYNTAX score and GRACE score were 47.56±12.00%, 1.10±0.52 mg/dl, 24.73±13.73 and 118.05±32.41 respectively. Majority of the patients had SYNTAX Grade-II and GRACE score Grade-II i.e. in intermediate SYNTAX score and Intermediate risk GRACE score [60(42.4%); 84(60.43%) respectively]. Maximum patients had confirmed diagnosis of moderate level CAD 60 (42.4%).

Cross tabulation revealed insignificant association of demographics and comorbids except gender (p=0.011) and diabetic status (p=0.01) with GRACE score while with SYNTAX only gender was significantly associated with SYNTAX score (p=0.007) (Table-II).

Findings in Table-III has showed a strongly significant and positive correlation between SYNTAX score and GRACE score (r=0.61; p<0.001). Means of SYNTAX score among different grades of GRACE score were increasing. Figure has showed a positive and linear relationship between increasing numeric of SYNTAX score with increase in GRACE score.

Table-III: Correlation between GRACE score and SYNTAX Score (n=139)

	Mean±SD	Correlation Coefficient (r)	p-value
GRACE score	118.05±32.41	0.61	<0.001
SYNTAX Score	24.73±13.73		

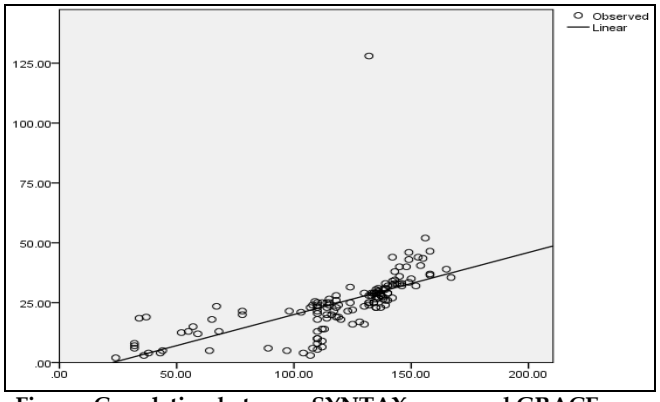

Figure: Correlation between SYNTAX score and GRACE score (n=139)

Table-II: Association of demographics and comorbids with SYNTAX score and GRACE score (n=139)

Demographic Variables		SYNTAX Score			p-value	GRACE Score			p-value
		Low(≤22) (Total=48) Frequency(%)	Intermediate (23-32) (Total=61) Frequency(%)	High (>32) (Total=30) Frequency(%)		Low (1-107) (Total=27) Frequency(%)	Intermediate (108-140) (Total=84) Frequency(%)	High (>140) (Total=28) Frequency(%)	
Age (Mean±SD)		59.60±9.30	63.0±10.00	64.0±9.20	0.10	59.6±9.24	61±6±9.87	65.6±9.10	0.06
Gender	Male	33(68.8)	56(91.8)	25(83.3)	0.007	17(63.0)	74(88.1)	23(82.1)	0.01
	Female	15(31.3)	5(8.2)	5(16.7)		10(37.0)	10(11.9)	5(17.9)	
Diabetes Mellitus		17(35.4)	33(54.1)	16(53.3)	0.12	5(18.5)	45(53.6)	16(57.1)	0.01
Hypertension		25(52.1)	37(60.7)	13(43.3)	0.28	12(44.4)	50(59.5)	13(46.4)	0.27
Smoking Status		11(22.9)	7(11.5)	2(6.7)	0.10	2(7.4)	16(19.0)	2(7.1)	0.23

Cross-tabulation was done to find the association of GRACE score and SYNTAX score with the extent of CAD as depicted in Table-IV. It was evaluated that both the aforementioned tools were significantly predicting CAD severity (p<0.001). Greater the GRACE score, the more severe is the CAD.

Table-IV: Association of GRACE score and SYNTAX Score with Severity of CAD (n=139)

Variables		Severity of Coronary Artery Disease			*p*-value
		Mild (n=49) Frequency (%)	Moderate (n=60) Frequency (%)	Severe (n=30) Frequency (%)	
GRACE Score	1-107	24(48.9)	3(5.0)	-	<0.001
	108-140	24(48.9)	56(93.3)	2 (6.7)	
	>140	-	4(6.67)	28 (93.3)	
Syntax Score Grades	Low	49(100.0)	-	-	<0.001
	Intermediate	-	61(100.0)	-	
	High	-	-	30(100.0)	

DISCUSSION

Study's findings have demonstrated significant correlation of age and diabetic status with SYNTAX and GRACE score. There was a significant and positive relationship between GRACE score and SYNTAX and both were strongly associated with the extent of coronary artery disease (CAD)(p<0.001). The greater was the GRACE score, the greater was the SYNTAX score followed by the higher risk of CAD and vice versa. These variations in tools' score were positively and significantly correlated (p<0.001). These interesting findings of our study had been compared with the past literature and found maximum consistent results and thus supported by the past studies.

A study to evaluate the relationship of comorbid with angiographic score of cardiac patients having CAD has reported results similar to our study's findings. Gender, age, diabetes mellitus and smoking are in significant correlation with SYNTAX score (p>0.05).[15] In current study all these parameters were statistically insignificant factors (p>0.05) affecting SYNTAX score except gender (p<0.05). However, diabetic status was strongly correlated to GRACE score (p<0.01). A number of studies revealed consistent findings while relating comorbids with SYNTAX score and GRACE score and explored significant results.[15-17] Another study done by Rahmani *et al*., have reported significant correlation of age gender, smoking and diabetes in significant correlation with angiographic scores while hypertension and dyslipidemia had non-significant relationship.[18] Similarly in our study, hypertension had non-significant correlation with formerly mentioned score.

Predictors of SYNTAX score were found by Sofidis *et al* and demonstrated GRACE score to be one of the predictors and had statistically significant and positive correlation between GRACE and SYNTAX score with correlation coefficient (r=0.32) and significance value (p<0.001).[12] These evaluations were in line to given study which has revealed (r=0.64; p<0.001). Thus the hypothesis was supported that increase in GRACE reflects increase in SYNTAX score.

Pool of studies, have investigated the relationship of GRACE score with several assessment tools for CAD.[18-24] Among these studies on GRACE score correlation with SYNTAX score revealed significant output followed by the CAD severity in NSTEMI and unstable angina patients. A research work on similar study participants as that of our study demonstrated, positive strong correlation between GRACE score and SYNTAX score (r=0.38, p<0.001).[21] While SYNTAX score was divided into two categories such as; <33 and ≥33. In contrast, our study had taken three grades of SYNTAX score such as; Low (≤22), Intermediate (23-32) and high (>32) and findings were in line to past literature.

A study inconsistent to current study was conducted on ACS patients to analyze the accuracy of GRACE and TIMI (Thrombolysis In Myocardial Infarction) score and reported that GRACE score can neither predict CAD severity (ROC=0.59; 95% CI=0.48–0.70) nor obstructive coronary artery disease (area under the ROC curve=0.57; 95% CI =0.46–0.69).[22] This variation might be due to change in study settings and the inclusion of accuracy element. However a number of past studies are in support of current study's findings as referenced earlier. Some other researches on NSTEMI patients have reported significant association of GRACE score and SYNTAX score with the extent of CAD. The increase in GRACE score reflects increase in syntax score and consequently greater the risk of CAD complexity.[25]

Moreover, it was evaluated that a combination of angiographic and clinical scoring systems (including GRACE and SYNTAX score) could improve the prognostic accuracy patients of CAD undergoing percutaneous coronary intervention (PCI). Thereby it is reported that GRACE score along with SYNTAX score together can help to recognize the CAD patients on early stage and can also predict the severity of coronary vessel disease outcomes following coronary revascularization. Conclusively, all these findings can assist the

cardiologists to make effective and efficient decision for the management of ACS patients

LIMITATIONS OF STUDY

Every research work has some limitations as encountered during its conduction. Similarly our study has also limitations related to sample size, single center study, no follow-up. Thereby, the findings are not generalizable to whole population. Nevertheless, longitudinal studies, with large sample size and randomized control trials could give more generalized results.

CONCLUSION

The study concluded that there exists a statistically significant and positive correlation between GRACE score and SYNTAX score of non-ACS (NSTEMI and UA) patients who had confirmed diagnosis of CAD on coroangiogram. The greater the GRACE score, the greater was the SYNTAX score and the greater risk of CAD.

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Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript:

AZK & SKS: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

MK & ZA: Data acquisition, data analysis, approval of the final version to be published.

MA & SSK: Critical review, concept, drafting the manuscript, approval of the final version to be published.

JK & NAS: Data acquisition, data analysis, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Wong ND. Epidemiological studies of CHD and the evolution of preventive cardiology. Nat Rev Cardiol 2014; 11(5): 276–289. https://doi: 10.1038/nrcardio.2014.26
2. Roy SS, Abu Azam STM, Khalequzzaman Md, Ullah M, Arifur Rahman M. GRACE and TIMI risk scores in predicting the angiographic severity of non-ST elevation acute coronary syndrome. Indian Heart J 2018; 70(1): S250–3. https://doi: 10.1016/j.ihj.2018.01.026
3. Mann DL, Zipes DP, Libby P, Bonow RO, Braunwald E. Braunwald's heart disease: a textbook of cardiovascular medicine 2015; 35(12): 2491-2495.
4. Eagle KA, Lim MJ, Dabbous OH, Pieper KS, Goldberg RJ, Van de Werf F, et al. A validated prediction model for all forms of acute coronary syndrome: estimating the risk of 6-month postdischarge death in an international registry. JAMA 2004; 291(22): 2727–2733. https://doi: 10.1001/jama.291.22.2727.
5. Tolunay H, Kurmus O. Comparison of coronary risk scoring systems to predict the severity of coronary artery disease using the SYNTAX score. Cardiol J 2016; 23(1): 51–56. https://doi: 10.5603/CJ.a2015.0074
6. Bashiruddin ABK, Chowdhury MI, Bhattacharjee B, Shahin AH, Ahsan SA, Mandal MRM, et al. Association of thrombolysis in myocardial infarction (TIMI) risk score with angiographic severity of coronary artery disease in patients with non-st elevation acute coronary syndrome. Univ Heart J 2019; 15(2): 68–73. https://doi: 10.4103/1995-705X.1652401
7. Safarian H, Alidoosti M, Shafiee A, Salarifar M, Poorhosseini H, Nematipour E. The SYNTAX score can predict major adverse cardiac events following percutaneous coronary intervention. Heart Views Off J Gulf Heart Assoc 2014; 15(4): 99. https://doi: 10.4103/1995-705X.151081
8. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Kardiologia Pol Pol Heart J 2018; 76(2): 229–313. https://doi: 10.1093/eurheartj/ehx393
9. Saha A, Kuila M, Sharma RK. Relationship of severity of coronary artery disease with fasting blood sugar and glycosylated hemoglobin. Asian J Med Sci 2022; 13(3): 38–42.
10. Chotechuang Y, Phrommintikul A, Kuanprasert S, Muenpa R, Ruengorn C, Patumanond J, et al. GRACE score and cardiovascular outcomes prediction among the delayed coronary intervention after post-fibrinolytic STEMI patients in a limited PCI-capable hospital. Open Heart 2020; 7(1): e001133. https://doi: 10.1136/openhrt-2019-001133
11. Nandi S, Mukherjee A, Khanra D, Biswas K. Association of severity of coronary artery disease by SYNTAX score (SS) and lower extremity arterial disease by duplex ultrasound (DUS) study-an Indian perspective. Egypt Heart Journal EHJ Off Bull Egypt Soc Cardiol 2020; 72(1): 56–56. https://doi: 10.1186/s43044-020-00091-z
12. Sofidis G, Otountzidis N, Stalikas N, Karagiannidis E, Papazoglou AS, Moysidis DV, et al. Association of GRACE risk score with coronary artery disease complexity in patients with acute coronary syndrome. J Clin Med 2021; 10(10): 2210. https://doi: 10.3390/jcm10102210
13. SYNTAX Score Calculator. [cited 2023 Apr 7]. Available at: http://syntaxscore.org/calculator/syntaxscore/frameset.htm
14. GRACE ACS Risk and Mortality Calculator [Internet]. MDCalc. [cited 2023 Apr 18]. https://www.mdcalc.com/calc/1099/grace-acs-risk-mortality-calculator
15. Mi SH, Su G, Li Z, Yang HX, Zheng H, Tao H, et al. Comparison of glycemic variability and glycated hemoglobin as risk factors of coronary artery disease in patients with undiagnosed diabetes. Chin Med J (Engl) 2012; 125(01): 38–43.
16. Kasaoka S, Okuda F, Satoh A, Miura T, Kohno M, Fujii T, et al. Effect of coronary risk factors on coronary angiographic morphology in patients with ischemic heart disease. Jpn Circ J 1997; 61(5): 390–395. https://doi: 10.1253/jcj.61.390
17. Giannoglou GD, Antoniadis AP, Chatzizisis YS, Damvopoulou E, Parcharidis GE, Louridas GE, et al. Sex-related differences in the angiographic results of 14-500 cases referred for suspected coronary artery disease. Coron Artery Dis 2008; 19(1): 9–14. https://doi: 10.1097/MCA.0b013e3282f2629c
18. Rahmani R, Majidi B, Ariannejad H, Shafiee A. The value of the grace score for predicting the syntax score in patients with unstable angina/non-ST elevation myocardial infarction.

Cardiovasc Revasc Med 2020; 21(4): 514–517. https://doi: 10.1016/j.carrev.2019.07.023
19. Hammami R, Jdidi J, Mroua F, Kallel R, Hentati M, Abid L, et al. Accuracy of the TIMI and GRACE scores in predicting coronary disease in patients with non-ST-elevation acute coronary syndrome. Rev Port Cardiol 2018; 37(1): 41–49. https://doi: 10.1016/j.repc.2017.05.012
20. Beigel R, Matetzky S, Gavrielov-Yusim N, Fefer P, Gottlieb S, Zahger D, et al. Predictors of high-risk angiographic findings in patients with non-ST-segment elevation acute coronary syndrome. Catheter Cardiovasc Interv 2014; 83(5): 677–683. https://doi: 10.1002/ccd.25081
21. Avci BK, Ikitimur B, Tok OO, Cimci M, Erturk E, Omar TB, et al. The role of GRACE score in the prediction of high-risk coronary anatomy in patients with non-ST elevation acute coronary syndrome. Kardiologia Pol Pol Heart J 2015; 73(8): 592–597. https://doi: 10.5603/KP.a2015.0030
22. Barbosa CE, Viana M, Brito M, Sabino M.Accuracy of the GRACE and TIMI scores in predicting the angiographic severity of acute coronary syndrome. Arq Bras Cardiol 2012; 99(1): 818–824. https://doi: 10.1590/S0066-782X2012005000080
23. Saha T, Khalequzzaman M, Akanda MAK, Saha S, Tushar AZ, Ahmed R, et al. Association of GRACE risk score with angiographic severity of coronary artery disease in patients with ST elevation myocardial infarction. Cardiovasc J 2015; 8(1): 30–34.
24. Neto AB, Sousa JP, Gil P, Henriques J. GRACE PLUS: A data fusion-based approach to improve GRACE score in the risk assessment of Acute Coronary Syndrome. Inf Fusion 2023; 91: 388–395. https://doi: 10.1016/j.inffus.2022.10.019
25. Cakar MA, Sahinkus S, Aydin E, Vatan MB, Keser N, Akdemir R, et al. Relation between the GRACE score and severity of atherosclerosis in acute coronary syndrome. J Cardiol 2014; 63(1): 24–28. https://doi: 10.1016/j.jjcc.2013.06.017