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Original Article

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Association Between Major Adverse Cardiovascular Events and the Gensini Score or Coronary Artery Calcification Score in Hypertensive Patients Who Have Undergone Coronary Computed Tomography Angiography

Yuhei Shiga[a, b], Kohei Tashiro[a], Erica Miura[c], Sara Higashi[a], Yuto Kawahira[a], Takashi Kuwano[a], Makoto Sugihara[a], Shin-ichiro Miura[a, d, e]

Abstract

Background: From the Fukuoka University Coronary Computed Tomography Angiography (FU-CCTA) registry, we present major adverse cardiovascular events (MACEs) in hypertensive patients who have undergone CCTA, and the association between MACEs and the Gensini score of coronary arteries or the coronary artery calcification (CAC) score.

Methods: Of the patients who underwent CCTA for coronary artery disease (CAD) screening at Fukuoka University Hospital, 318 hypertensive patients who had at least one cardiovascular risk factor or suspected CAD were enrolled. The patients were divided into two groups: MACEs and non-MACEs groups. The severity of atherosclerosis of coronary arteries was assessed by the Gensini score. The CAC score was also defined by computed tomography (CT) images at the time of CCTA. A primary endpoint was MACEs (all-cause death, ischemic stroke, acute myocardial infarction, coronary revascularization). The patients were followed for up to 5 years.

Results: The patients were 68 ± 10 years, and 50% were males. The percentages of smoking, dyslipidemia, diabetes, and chronic kidney disease were 39%, 70%, 26% and 37%, respectively. The %males, %smoking, CAC score and Gensini score in the MACEs group were significantly higher than those in the non-MACEs group. On the other hand, the differences in age, dyslipidemia, diabetes, or chronic kidney disease between the groups were not seen. A multivariate analysis was performed regarding the presence or absence of MACE by logistic regression analysis of the CAC score or Gensini score in addition to conventional risk factors as independent variables. A Cox regression analysis revealed significant relationships for both the CAC score (P = 0.043) and the Gensini score (P = 0.008).

Conclusions: The CAC score and the Gensini score could predict MACEs in hypertensive patients who have undergone CCTA.

Keywords: Coronary computed tomography angiography; Major adverse cardiovascular events; Gensini score; Coronary artery calcification score

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[a]Department of Cardiology, Fukuoka University Faculty of Medicine, Fukuoka, Japan
[b]Houmonsinryo Medical Heart Clinic Fukuoka, Fukuoka, Japan
[c]Department of Pharmacy, Fukuoka University Hospital, Fukuoka, Japan
[d]Department of Internal Medicine, Fukuoka University Nishijin Hospital, Fukuoka, Japan
[e]Corresponding Author: Shin-ichiro Miura, Department of Cardiology, Fukuoka University School of Medicine, Jonan-ku, Fukuoka 814-0180, Japan. Email: miuras@cis.fukuoka-u.ac.jp

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Introduction

The Gensini score is the sum of the coronary artery scores for all of the segments, where each segment score equals a segment weighting factor multiplied by a severity score [1]. Severity scores reflect the percentage reduction in the luminal diameter of the coronary artery segment. The Gensini score can predict the prognosis in patients with coronary artery disease (CAD) [2-5]. In addition, the Gensini score provides more valuable prognostic information regarding cardiovascular risk than either the Leaman score [6] or the American College of Cardiology/American Heart Association (ACC/AHA) score [7] in patients with acute coronary syndrome [2]. Among the risk factors for percutaneous coronary intervention (PCI)-related myocardial infarction (MI), the Gensini score, in addition to low-density lipoprotein cholesterol (LDL-C), age, total stent length, and intraoperative complications, has been shown to be positively correlated with the occurrence of PCI-related MI [3]. In addition, the Gensini score and interleukin-1 receptor antagonist better reflect the severity of CAD in patients with CAD [4]. A higher Gensini score, in addition to older age, type 2 diabetes, etc., may contribute to a worse clinical outcome in patients with non-obstructive CAD [5].

We have performed screening of CAD using coronary computed tomography angiography (CCTA) at Fukuoka University Hospital (FU-CCTA registry) and reported many important coronary risk factors for CAD [8-14]. Hypertension (HTN) is a critical coronary risk factor [15]. Mitsutake et al reported that

CAD was significantly associated with HTN in males and females by a multivariate logistic regression analysis [14].

Therefore, we hypothesized that the Gensini score at the time of CCTA may be one of critical predictor of major adverse cardiovascular events (MACEs) in patients with HTN. In this study, we analyzed the associations between the MACEs and the Gensini score in addition to the coronary artery calcification (CAC) score.

Materials and Methods

Study patients

We prospectively analyzed 318 patients who underwent CCTA at Fukuoka University Hospital. They were clinically suspected of having CAD or had at least one cardiovascular risk factor (smoking, abdominal obesity, dyslipidemia (DL), HTN, and/or diabetes mellitus (DM)) (FU-CCTA registry). They had a follow-up of up to 5 years. Patients with creatinine more than 2.0 mg/dL or contrast-induced allergy did not undergo CCTA. The included patients were divided into two groups: MACEs and non-MACEs groups. The study protocol was approved by the Institutional Review Board at Fukuoka University Hospital. All subjects gave their written informed consent to participate this study. The study was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration.

Assessment of coronary artery stenosis by CCTA

We assessed coronary artery stenosis by CCTA as previously described [8-14]. Coronary arteries were divided into 15 lesions for classification. Narrowing of the normal contrast-enhanced lumen of more than or equal to 50% was considered to be significant coronary stenosis. Moreover, the severity of atherosclerosis of CAD was evaluated by the Gensini score [1] and the number of significantly stenosis coronary vessels (VD). The CAC score was also assessed by computed tomography (CT) imaging. The CAC score for coronary arteries was evaluated by the Agatston method [16].

Evaluation of biochemical parameters and hemodynamics

Body mass index (BMI), blood pressure (BP) (systolic blood pressure (SBP) and diastolic blood pressure (DBP)), serum levels of high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), LDL-C, hemoglobin (Hb) A1c, fasting blood glucose (FBG), uric acid (UA) and estimated glomerular filtration rate (eGFR), family history (FH, MI, angina or sudden death), smoking history, prevalence of HTN, DM, chronic kidney disease (CKD) and DL at the time of CCTA were obtained from medical records.

BP was determined as the average of two measurements obtained in an office environment by the traditional cuff method using a mercury sphygmomanometer after at least 5 min of rest. BMI was calculated as body weight (kg)/height $(m)^2$. In the morning after an overnight fast, samples of blood were taken. Patients with SBP/DBP of 140/90 mm Hg equal to or higher, or who were receiving anti-hypertensive therapies, were defined as HTN [17]. Patients with DL were defined as those with TG $\geq$ 150 mg/dL, LDL-C $\geq$ 140 mg/dL, and/or HDL-C < 40 mg/dL, or in lipid-lowering therapies were administrated [18]. DM was considered using the American Diabetes Association standard [19] or receiving hypoglycemic therapies. Metabolic syndrome (MetS) was defined according to visceral fat area (VFA) $\geq$ 100 cm^2 and the presence of more than two of the following: high BP (SBP $\geq$ 130 mm Hg or DBP $\geq$ 85 mm Hg or receiving anti-hypertensive therapies) or dyslipidemia (TG $\geq$ 150 mg/dL, HDL-C > 40 mg/dL, LDL-C $\geq$ 140 mg/dL or receiving lipid-lowering therapies) or high fasting glucose levels (FBG $\geq$ 110 mg/dL or receiving glucose-lowering therapies). CKD was defined as the appearance of proteinuria and/or eGFR < 60 mL/min/1.73 m^2.

Medications

Data of medications at the time of CCTA were obtained from medical records. Medications included angiotensin II type 1 receptor blocker and/or angiotensin-converting enzyme inhibitor (ARB/ACEI), calcium channel blocker (CCB), diuretic (DU), β-blocker, ezetimibe, eicosapentaenoic acid (EPA), fibrate, statin, sulfonylurea (SU), dipeptidyl peptidase-4 inhibitor (DPP-4I), thiazolidine, biguanide and insulin.

Definition of MACEs

Primary endpoint was MACEs (all-cause death, ischemic stroke, acute MI, coronary revascularization). MACEs were followed for up to 5 years (mean 3.5 ± 0.7 years). When the patients had significant stenosis of coronary artery at the time of CCTA and underwent coronary intervention within about a month after CCTA, the intervention was not included in MACEs.

Statistical analysis

Statistical analysis was performed using StatView statistical software package (StatView 5, SAS Institute Inc, Cary, NC, USA). Continuous variables are shown as means ± standard deviation (SD). A P value of < 0.05 was considered significant. Continuous and categorical variables were compared between groups by a *t*-test and a Chi-square analysis, respectively. A multivariate analysis related to the presence or absence of MACEs was performed according to a logistic regression analysis of independent variables in all patients.

Results

Patient characteristics in all patients, and in the non-MACEs and MACEs groups

The average age was 68 ± 10 years and 50% were males in all

Table 1. Patient Characteristics in All Patients, the Non-MACE and MACE

	All patients (n = 318)	Non-MACEs group (n = 286)	MACEs group (n = 32)	P value (non-MACEs vs. MACEs group)
Age, years	68 ± 10	67 ± 10	69 ± 9	0.381
Gender (male), %	50	48	69	0.028
Family history, %	25	26	22	0.242
Smoking, %	39	37	56	0.034
BMI, kg/m^2	24 ± 4	24 ± 4	23 ± 4	0.179
HTN, %	100	100	100	1
SBP, mm Hg	140 ± 19	140 ± 19	144 ± 22	0.303
DBP, mm Hg	79 ± 13	79 ± 13	79 ± 14	0.97
DM, %	26	26	34	0.282
HbA1c, %	6.0 ± 1.1	6.0 ± 1.1	6.3 ± 1.2	0.101
FBG, mg/dL	111 ± 32	111 ± 32	115 ± 35	0.433
DL, %	70	70	72	0.82
TG, mg/dL	139 ± 90	139 ± 90	135 ± 96	0.796
HDL-C, mg/dL	54 ± 14	54 ± 14	50 ± 15	0.055
LDL-C, mg/dL	110 ± 31	110 ± 30	105 ± 35	0.377
L/H-C	2.2 ± 0.8	2.2 ± 0.8	2.4 ± 1.1	0.199
Non-HDL-C, mg/dL	140 ± 38	140 ± 37	133 ± 42	0.323
CKD, %	37	36	44	0.412
eGFR, mL/min/1.73 m^2	66 ± 18	66 ± 18	63 ± 13	0.346
MetS, %	49	49	61	0.192
CAD, %	62	60	81	0.02
VD, n	1.2 ± 1.1	1.1 ± 1.1	1.7 ± 1.2	0.004
CAC score	300 ± 792	253 ± 660	720 ± 1489	0.002
Gensini score	14 ± 16	13 ± 14	26 ± 27	< 0.001

Continuous variables are expressed as mean ± SD. MACE: major adverse cardiovascular event; BMI: body mass index; HTN: hypertension; SBP: systolic blood pressure; DBP: diastolic blood pressure; DM: diabetes mellitus; HbA1c: hemoglobin A1c; FBG: fasting blood glucose; DL: dyslipidemia; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; L/H-C: a ratio of LDL-C to HDL-C; Non-HDL-C: total cholesterol minus HDL-C; CKD: chronic kidney disease; eGFR: estimated glomerular filtration rate; MetS: metabolic syndrome; CAD: coronary artery disease; VD: the number of vessel disease; CAC: coronary artery calcification.

patients (Table 1). The percentages of smoking, dyslipidemia, diabetes, and chronic kidney disease were 39%, 70%, 26% and 37%, respectively. The %males, %smoking, CAC score and Gensini score in the MACEs group were significantly higher than those in the non-MACEs group, whereas there were no differences in age, DL, DM or CKD between the groups.

Medications in all patients, and in the non-MACEs and MACEs groups

In all patients, ACEI/ARB, CCB, DU, EPA, SU and DPP-4I were used in 55%, 53%, 14%, 3%, 12%, and 14%, respectively (Table 2). There were no differences in medications between the MACEs and non-MACEs groups.

Predictors of MACEs

Regarding the relationships between MACEs and various factors except for HTN (Table 3), the CAC score, and the Gensini score by a logistic regression analysis, significant relationships were observed for the CAC score (P = 0.043) and the Gensini score (P = 0.008). Although %fibrate and %SU in the MACEs group were significantly higher than those in the non-MACEs group as shown in Table 2, fibrate and SU were not associate with MACEs by a multivariate analysis related to the presence or absence of MACEs according to a logistic regression analysis of independent variables (data not shown).

Discussion

The main findings from our study demonstrate that the Gensini score and the CAC score at the time of CCTA are predictors of MACEs in patients with HTN.

The Gensini score is a critical contributing factor for worse clinical outcomes in patients with CAD [2-7]. This score provides more valuable prognostic information on cardiovascular risk than other systems for scoring the severity of coronary

Table 2. Medications in All Patients, the Non-MACE and MACE

Medications	All patients (n = 318)	Non-MACEs group (n = 286)	MACEs group (n = 32)	P value (non-MACEs vs. MACEs group)
ACEI/ARB, %	55	54	63	0.351
CCB, %	53	53	47	0.477
β-blocker, %	14	14	6	0.205
DU, %	14	14	16	0.844
Statin, %	42	42	44	0.816
Fibrate, %	1	0.4	6	0.001
Ezetimibe, %	1	1	0	0.501
EPA, %	3	2	3	0.817
SU, %	12	10	25	0.013
Biguanide, %	8	8	9	0.737
DPP-4I, %	14	13	19	0.396
Insulin, %	4	4	6	0.591

Continuous variables are expressed as mean ± SD. MACE: major adverse cardiovascular event; ACEI/ARB: angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; CCB: calcium channel blocker; DU: diuretic; EPA: eicosapentaenoic acid; SU: sulfonylurea; DPP-4I: dipeptidyl peptidase-4 inhibitor.

atherosclerosis [6, 7]. In this study, we also confirmed that a higher Gensini score was an important prognostic factor, as in previous reports [2-7]. As an important difference from previous reports, we found that the Gensini score was importantly independent of conventional risk factors at the time of CCTA. The CAC score was also a predictor of MACEs. In this study, there was a significant positive correlation between the Gensini score and CAC score, but the r value was rather low ($r = 0.244$, $P < 0.001$). These scores may have been independently associated with MACEs because of the low r value.

Table 3. Predictors for the Presence of MACE

	OR (95% CI)	P value
Age	1.006 (0.959 - 1.056)	0.792
Gender (males)	1.299 (0.452 - 3.730)	0.627
BMI	0.893 (0.777 - 1.026)	0.111
DL	0.460 (0.159 - 1.330)	0.152
DM	1.018 (0.400 - 2.589)	0.97
Smoking	1.594 (0.607 - 4.183)	0.344
Family history	0.929 (0.357 - 2.416)	0.88
CKD	1.080 (0.438 - 2.658)	0.868
MetS	2.720 (0.922 - 8.026)	0.07
CAC score	1.000 (1.000 - 1.001)	0.043
Gensini score	1.028 (1.007 - 1.050)	0.008

By logistic regression analysis of CAC score and Gensini score in addition to conventional coronary risk factors except for hypertension: multivariate analysis related to the presence or absence of MACEs was performed. MACE: major adverse cardiovascular event; BMI: body mass index; DL: dyslipidemia; DM: diabetes mellitus; CKD: chronic kidney disease; MetS: metabolic syndrome; CAC: coronary artery calcification; OR: odds ratio; CI: confidence interval.

With CCTA in a large, random sample of the general population without established disease, high CAC scores convey a significant probability of substantial coronary stenosis [19]. We previously reported that the CAC score determined by CCTA can predict CAD independent of other factors, such as age, metabolic diseases, and medications [20], but we did not analyze the association between the CAC score and MACEs. Finally, in this study, we reported that the CAC score was also important as a predictor of MACEs. Compared with conventional risk factors, the CAC score can be used to improve the accuracy of the prognosis for atherosclerotic cardiovascular disease [21-23]. CAC score has emerged as reproducible means of assessing risk for major cardiovascular outcomes, especially useful in asymptomatic people for planning primary prevention interventions [24]. In addition, a higher CAC score is associated with mortality and cardiovascular events in patients with idiopathic pulmonary fibrosis [25]. Thus, physician should aggressively treat those patients with higher CAC score with cardioprotective drugs including anti-hypertensive drugs and statins.

In this study, only hypertensive patients were analyzed, demonstrating that the CAC score plays an important role as a predictor of MACEs in these patients. CAD diagnosed by CCTA is more prevalent and severe in hypertensive patients than in normotensive patients [26]. The combination of elevated high-sensitivity C reactive protein and HTN greatly increased the cardiovascular risk in patients with stable, newly diagnosed CAD [27]. Even if the patients were in stage 1 HTN, they were independently associated with subclinical coronary atherosclerosis as assessed by CCTA [27]. In patients from the long-term CONFIRM registry, HTN and DM predicted the risk of MACEs in non-obstructive CAD [28]. While there is no doubt that HTN is one of the best predictors of MACEs, our analysis did not include patients without HTN.

There were several limitations in this study. The presence

or absence of MACEs was assessed under various medications, and the %MACEs was low. A multivariate analysis related to the presence or absence of MACEs by a logistic regression analysis of the Gensini score and CAC score in addition to conventional risk factors except for HTN as independent variables was performed. The presence of CAD and VD were not included as independent variables. Patients with CAD naturally also have a high Gensini score and VD, so it is not appropriate to include them in the analysis. A large-scale and longer follow-up will be needed to clarify these limitations.

In conclusion, the CAC score or Gensini score could be a predictor of MACEs in hypertensive patients who have undergone CCTA.

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Financial Disclosure

None to declare.

Conflict of Interest

The authors have no conflict of interest to disclose.

Informed Consent

Informed consent was obtained.

Author Contributions

Conceptualization: YS, SM. Validation: YS, KT, TK, MS. Formal analysis: YS. Analysis and investigation: YS, KT, EM, SH, YK. Data curation: YS, KT, EM, SH, YK. Writing - original draft: YS. Writing - review & editing: MS, SM. Supervision: SM.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. Am J Cardiol. 1983;51(3):606. doi pubmed
2. Huang G, Zhao JL, Du H, Lan XB, Yin YH. Coronary score adds prognostic information for patients with acute coronary syndrome. Circ J. 2010;74(3):490-495. doi pubmed
3. Huang ZS, Zheng ZD, Zhang JW, Tang LL, Zhou LL, Li SH, Xie XJ, et al. Association of major adverse cardiovascular events and cardiac troponin-I levels following percutaneous coronary intervention: a three-year follow-up study at a single center. Eur Rev Med Pharmacol Sci. 2020;24(7):3981-3992.
4. He Q, Zhang P, Li Y, Cai C, Wang C. The application of Gensini score and IL-1ra in assessing the condition and prognosis of patients with coronary artery disease. Am J Transl Res. 2021;13(9):10421-10427.
5. Szolc P, Niewiara L, Kleczynski P, Bryniarski K, Ostrowska-Kaim E, Szkodon K, Brzychczy P, et al. Clinical characteristics predicting worse long-term outcomes in patients with myocardial infarction and non-obstructive coronary arteries (MINOCA). J Cardiovasc Dev Dis. 2022;9(9):286. doi pubmed pmc
6. Leaman DM, Brower RW, Meester GT, Serruys P, van den Brand M. Coronary artery atherosclerosis: severity of the disease, severity of angina pectoris and compromised left ventricular function. Circulation. 1981;63(2):285-299. doi pubmed
7. Guidelines for coronary angiography. A report of the American College of Cardiology/American Heart Association Task Force on Assessment of diagnostic and therapeutic cardiovascular procedures (subcommittee on coronary angiography). J Am Coll Cardiol. 1987;10(4):935-950.
8. Nakamura A, Miura S, Shiga Y, Norimatsu K, Miyase Y, Suematsu Y, Mitsutake R, et al. Is pentraxin 3 a biomarker, a player, or both in the context of coronary atherosclerosis and metabolic factors? Heart Vessels. 2015;30(6):752-761. doi pubmed
9. Higashi S, Shiga Y, Yano M, Imaizumi T, Tashiro K, Idemoto Y, Kato Y, et al. Associations between smoking habits and major adverse cardiovascular events in patients who underwent coronary computed tomography angiography as screening for coronary artery disease. Heart Vessels. 2021;36(4):483-491. doi pubmed
10. Yano M, Miura S, Shiga Y, Miyase Y, Suematsu Y, Norimatsu K, Nakamura A, et al. Association between smoking habits and severity of coronary stenosis as assessed by coronary computed tomography angiography. Heart Vessels. 2016;31(7):1061-1068. doi pubmed
11. Shibata Y, Shiga Y, Suematsu Y, Tashiro K, Kawahira Y, Morita K, Kuwano T, et al. Association between major adverse cardiovascular events and the ratio of subcutaneous fat area to visceral fat area in patients who have undergone multidetector row computed tomography. Circ Rep. 2021;3(11):674-681. doi pubmed pmc
12. Inoue H, Shiga Y, Norimatsu K, Tashiro K, Futami M, Suematsu Y, Sugihara M, et al. Associations between high-density lipoprotein functionality and major adverse cardiovascular events in patients who have undergone coronary computed tomography angiography. J Clin Med. 2021;10(11):2431. doi pubmed pmc
13. Kawahira Y, Shiga Y, Inoue H, Suematsu Y, Tashiro K, Kato Y, Fujimi K, et al. Association between high-den-

sity lipoprotein cholesterol levels and major adverse cardiovascular events in patients who underwent coronary computed tomography angiography: FU-CCTA registry. Heart Vessels. 2021;36(10):1457-1465. doi pubmed
14. Mitsutake R, Miura S, Shiga Y, Uehara Y, Saku K. Association between hypertension and coronary artery disease as assessed by coronary computed tomography. J Clin Hypertens (Greenwich). 2011;13(3):198-204. doi pubmed pmc
15. Umemura S, Arima H, Arima S, Asayama K, Dohi Y, Hirooka Y, Horio T, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). Hypertens Res. 2019;42(9):1235-1481. doi pubmed
16. Agatston AS, Janowitz WR, Hildner FJ, Zusmer NR, Viamonte M, Jr., Detrano R. Quantification of coronary artery calcium using ultrafast computed tomography. J Am Coll Cardiol. 1990;15(4):827-832. doi pubmed
17. Kinoshita M, Yokote K, Arai H, Iida M, Ishigaki Y, Ishibashi S, Umemoto S, et al. Japan Atherosclerosis Society (JAS) guidelines for prevention of atherosclerotic cardiovascular diseases 2017. J Atheroscler Thromb. 2018;25(9):846-984. doi pubmed pmc
18. American Diabetes Association. Screening for type 2 diabetes. Diabetes Care. 2004;27(Suppl 1):S11-S14. doi pubmed
19. Bergstrom G, Persson M, Adiels M, Bjornson E, Bonander C, Ahlstrom H, Alfredsson J, et al. Prevalence of Subclinical Coronary Artery Atherosclerosis in the General Population. Circulation. 2021;144(12):916-929. doi pubmed pmc
20. Mitsutake R, Niimura H, Miura S, Zhang B, Iwata A, Nishikawa H, Kawamura A, et al. Clinical significance of the coronary calcification score by multidetector row computed tomography for the evaluation of coronary stenosis in Japanese patients. Circ J. 2006;70(9):1122-1127. doi pubmed
21. Mitchell JD, Paisley R, Moon P, Novak E, Villines TC. Coronary Artery Calcium and Long-Term Risk of Death, Myocardial Infarction, and Stroke: The Walter Reed Cohort Study. JACC Cardiovasc Imaging. 2018;11(12):1799-1806. doi pubmed
22. Mitchell JD, Fergestrom N, Gage BF, Paisley R, Moon P, Novak E, Cheezum M, et al. Impact of Statins on Cardiovascular Outcomes Following Coronary Artery Calcium Scoring. J Am Coll Cardiol. 2018;72(25):3233-3242. doi pubmed pmc
23. Liu HH, Cao YX, Sun D, Jin JL, Zhang HW, Guo YL, Zhu CG, et al. High-sensitivity C-reactive protein and hypertension: combined effects on coronary severity and cardiovascular outcomes. Hypertens Res. 2019;42(11):1783-1793. doi pubmed
24. Greenland P, Blaha MJ, Budoff MJ, Erbel R, Watson KE. Coronary Calcium Score and Cardiovascular Risk. J Am Coll Cardiol. 2018;72(4):434-447. doi pubmed pmc
25. Caminati A, Zompatori M, Fuccillo N, Sonaglioni A, Elia D, Cassandro R, Trevisan R, et al. Coronary artery calcium score is a prognostic factor for mortality in idiopathic pulmonary fibrosis. Minerva Med. 2022. doi pubmed
26. Zeina AR, Barmeir E, Zaid G, Odeh M. Coronary artery disease among hypertensive patients undergoing coronary computed tomography angiography. J Cardiovasc Med (Hagerstown). 2009;10(3):252-256. doi pubmed
27. Yoon YH, Park GM, Lee JY, Lee JH, Lee H, Roh JH, Kim JH, et al. Association of stage 1 hypertension defined by the ACC/AHA 2017 guideline with asymptomatic coronary atherosclerosis. Am J Hypertens. 2021;34(8):858-866. doi pubmed
28. van Rosendael AR, Bax AM, Smit JM, van den Hoogen IJ, Ma X, Al'Aref S, Achenbach S, et al. Clinical risk factors and atherosclerotic plaque extent to define risk for major events in patients without obstructive coronary artery disease: the long-term coronary computed tomography angiography CONFIRM registry. Eur Heart J Cardiovasc Imaging. 2020;21(5):479-488. doi pubmed pmc