Advances in Clinical Medicine 临床医学进展, 2024, 14(1), 1922-1928
Published Online January 2024 in Hans. https://www.hanspub.org/journal/acm
https://doi.org/10.12677/acm.2024.141271

Hans汉斯

冠状动脉病变严重程度与无创心血管指标的相关性研究进展

王婷萩，王志刚*

重庆医科大学附属第二医院超声医学科，重庆

收稿日期：2023年12月27日；录用日期：2024年1月21日；发布日期：2024年1月30日

摘　要

冠状动脉(冠脉)病变的严重程度与冠心病的发生、发展、治疗以及预后密切相关。SYNTAX评分(Synergy between PCI with Taxus and Cardiac Surgery score)作为冠脉病变严重程度的临床预测指标，从冠脉病变的解剖特点来对冠心病进行危险分层，指导治疗及预测预后。许多研究表明一些无创指标与冠脉病变特点方面也展现出了很好的相关性。本文拟对近年冠脉病变严重程度的无创预测指标最新研究进行综述。

关键词

冠心病，SYNTAX评分，超声心动图，冠脉CT血管造影，心电图

Research Progress on the Correlation between the Severity of Coronary Artery Disease and Non-Invasive Cardiovascular Indicators

Tingqiu Wang, Zhigang Wang*

Department of Ultrasound, The Second Affiliated Hospital of Chongqing Medical University, Chongqing

Received: Dec. 27th, 2023; accepted: Jan. 21st, 2024; published: Jan. 30th, 2024

Abstract

The severity of coronary artery disease is closely related to the occurrence, development, treat-

*通讯作者。

文章引用: 王婷萩，王志刚. 冠状动脉病变严重程度与无创心血管指标的相关性研究进展[J]. 临床医学进展，2024, 14(1): 1922-1928. DOI: 10.12677/acm.2024.141271

ment and prognosis of coronary heart disease. SYNTAX score (Synergy between PCI with Taxus and cardiac surgery score, SS), as a clinical predictor of the severity of coronary artery disease, classifies the risk of coronary heart disease from the anatomical characteristics of coronary artery disease, guides treatment and predicts prognosis. Many studies have shown that some non-invasive indicators also show good correlation with the characteristics of coronary artery disease. This article reviews the latest research on non-invasive predictors of coronary artery disease severity in recent years.

Keywords

Coronary Heart Disease, SYNTAX Score, Ultrasonic Cardiogram, Coronary Computed Tomography Angiography, Electrocardiogram

1. 引言

冠状动脉(冠脉)病变是一种主要由动脉粥样硬化引起，减少通过冠脉进入心脏的血流，从而导致心肌缺血的疾病。动脉粥样硬化是冠脉、颈动脉及外周动脉疾病最常见的潜在原因，导致中国心血管疾病负担大幅度增涨[1] [2]。目前公认冠心病的诊断金标准是冠脉造影(invasive coronary angiography, ICA)，由此应运而生许多以冠脉造影为基础的评分类型。其中以冠脉解剖为基础的 SYNTAX 评分(Synergy between PCI with Taxus and Cardiac Surgery score, SS)，ICA-SS，是根据病变血管数量、位置、累及的冠脉、钙化情况以及冠脉走行、闭塞程度、血栓等解剖病变形态学特点对冠心病进行危险分层以确定最佳血运重建策略以及进行预后预测的一种风险模型。此评分应用广泛，ICA-SS 越高，表明疾病越复杂，意味着更大的治疗挑战和潜在的更坏的预后[3] [4]。一项队列研究表明当 SS > 8 时，5 年内主要心血管不良事件的发生率显著增加[5]。临床上一般根据低(≤22 分)、中(23~32 分)、高(>32 分) ICA-SS 将冠脉病变严重程度分为轻、中、重度。

由于冠脉造影是有创操作，秉承兼顾对患者损伤小、简便以及诊断正确率高的原则，越来越多的研究找寻着无创临床指标与之的关联。本文拟对近年 ICA-SS 与无创指标的相关性进行综述。

2. 超声

超声作为非侵入性检查，具有实时、动态、对患者几乎无危害的特点，能对解剖及血流进行二维、三维成像。

超声心动图用于进行心脏成像，测量心脏大小，识别血流情况，分析心功能，识别先天或后天的心脏疾病。冠脉病变会减少心肌的供血，从而影响心脏功能，超声心动图利用多种技术，结合相关评分系统，通过动态观察心脏血流以及心肌运动情况反映心脏功能，间接评估冠脉病变。二维斑点追踪成像(two-dimensional speckle tracking imaging, 2D-STI)是利用图像像素作为心肌声学斑点，从而追踪与分析心肌的速度、应变等运动规律的技术。应变是测量心肌纤维主动收缩与松弛的程度，量化心肌旋转无量纲的量，与应变率以及组织速度相互关联。有研究证实冠心病的心肌运动会出现左心室旋转力学的紊乱[6]。由于不同冠脉供血区域不同，所以不仅是心室，心房也会受到影响。两项研究利用 2D-STI 分别发现左心

室中层心肌的收缩期峰值整体纵向应变以及左心室收缩末期的左房峰值应变与 ICA-SS 呈显著负相关，为独立预测因子[7] [8]，即冠脉病变越复杂，相应心肌纤维主动变形的程度越小。当左室纵向长轴整体应变峰值为 17.8 时，对低、高 SS 的灵敏度和特异度分别为 84%和 93%，比超声心动图中的视觉评估具有更高的诊断价值[9]。同时由于左心室肌纤维具有复杂的空间取向，在不同方向同时收缩，这导致左心室力学在本质上是一种三维现象，Cai Z 等人[10]使用三维 STI 得出整体峰值纵向应变同样与 ICA-SS 呈显著负相关，但是否三维较二维评估更为准确仍需进一步研究。运动或药物的应激通常引起心脏局部心肌的运动以及增厚率的增加。一项在多巴酚丁胺负荷超声心动图中进行的研究提出，虽然同是判断心室收缩功能的指标，室壁运动积分指数较 GLS 及射血分数更能预测冠心病患者的 ICA-SS，且应激状态下比静息更有诊断价值[11]。

动脉粥样硬化是涉及到多血管的免疫炎症疾病，有相似的病理过程，例如巨噬细胞能维持局部炎症反应，促进各血管斑块以及血栓的形成[12]。因此除了心脏功能，外周动脉以及主动脉也可以间接反映冠脉病变。相较于对冠脉的直接检查，评估外周动脉往往更为方便。血管内中膜厚度以及斑块的测量是超声用于衡量动脉粥样硬化的一种方式。Ikeda N 等人发现当平均颈动脉内中膜厚度 ≥ 0.9 mm 时对中高 ICA-SS 的阴性预测值高达 97.3% [13]。Cappelletti A 等[14]得到定义为存在 50%直径狭窄且收缩峰值流速大于 125 cm/s 的严重颈动脉疾病为高 ICA-SS 的独立危险因素。但相较于人工测量的内中膜厚度，自动化测量提高了颈动脉粥样硬化与冠脉病变复杂程度的相关性[15]。应用影像组学对颈动脉斑块进行特征提取的研究建立的诺模图对中高 ICA-SS 的预测具有良好的应用价值[16]。智能化的诊断手段在影像方面起着越来越重要的作用，但有关超声方面与冠脉粥样硬化相关性的探讨比较少，因此未来需要更多的探讨。除了外周血管，在一项非 ST 段抬高型心肌梗死患者中的研究得出，主动脉内中膜厚度 ≥ 1.25 mm 时 ICA-SS > 13 的风险增加[17]；另一项利用超声心动图计算出的主动脉弹性参数表示，主动脉弹性降低与 ICA-SS 增高相关[18]。相较于传统经胸超声心动图，经食道超声心动图(transesophageal echocardiography, TEE)通过直接将探头置入食道或者胃里避免了经胸超声心动图因肥胖、肺部气体干扰等原因导致成像质量差的问题。Vrublevsky AV 等人的研究[19]发现经食道超声心动图评估的主动脉粥样硬化不仅与 ICA-SS 成正相关，且使用三维 TEE 较二维 TEE 更精确。因此筛选适应不同患者的不同超声诊断方式有利于判断冠脉病变严重程度。

3. CT

冠脉 CT 血管造影(coronary computed tomography angiography, CTA)是注射造影剂后对冠脉进行 CT 成像的无创检查。由于 CTA 对诊断严重冠脉狭窄具有高准确性，已有研究证实结合了 CTA 的 CT-SS 可以替代 ICA-SS 推荐血运重建策略[20] [21]。但因为需要使用造影剂，因此 CTA 依然存在一定风险。心外膜脂肪组织(epicardial adipose tissue, EAT)是由冠脉供血的位于心肌与心外膜之间的脂肪组织，EAT 与冠脉粥样硬化密切相关，机制包括炎症、过度的免疫反应、氧化应激等，其中炎症是主要特征[22]。CT 可以评估 EAT 的分布情况，测量 EAT 的体积、厚度以及密度。随着 EAT 厚度的增加，距离冠脉越近，导致引起冠脉粥样硬化的炎症活动越强[23]。一项在中国进行的纳入了 81 例患者的单中心队列研究发现高 ICA-SS 组 EAT 体积显著增大[24]。这提示了临床工作者有必要在 CT 阅片时关注 ETA 体积。

4. 乳腺钼靶

尽管女性死因归因于冠心病的比例远低于男性，但预后却更差[25]。因此寻找属于女性的冠心病诊断方式尤为重要。乳腺动脉钙化(breast arterial calcification (BAC)是非闭塞性的中膜钙化，虽然冠脉粥样硬

化病变部位从是内膜开始，但有研究证实 BAC 与冠脉钙化存在相关性，确切原因不清，可能与之暴露于心血管危险因素有关[26]。一项纳入 102 名进行了乳腺钼靶的女性的研究对 BAC 采用半定量 Likert 量表表明，在中高 ICA-SS 患者中 BAC 评分显著增高[27]。乳腺钼靶诊断 BAC 较其他影像学方法更为敏感，因此针对女性也许使用乳腺钼靶也能筛选出冠心病患者。

5. 心血管相关参数

5.1. 心率

一项在稳定型冠心病患者中进行的研究利用单因素 Logistic 回归分析显示，静息心率每增加 10 次/分，ICA-SS > 23 的相对危险度也随着增加[28]。心率升高与冠脉粥样硬化独立相关，可能的机制包括因心率升高而改变应力、局部血液动力学，导致内皮细胞结构和功能受损而促进动脉粥样硬化形成[29]。除了静息心率外，另一项研究表明下降的心率恢复(heart rate recovery, HRR)是高 ICA-SS 的独立预测因子[30]。已有研究表明尽管具体机制不明，但自主神经系统失衡似乎直接或通过免疫的间接作用导致动脉粥样硬化，而 HRR 是评估自主神经系统功能的方式[31] [32]。

5.2. 心电图

心脏是一个有节奏的“泵”，其功能取决于动作电位的产生与传播，在心脏不同区域由于离子通道的表达差异，动作电位波形不同，从而促进电活动的正常单向传播和节律的产生[33]。心肌缺血以一种促进心律失常发生的方式改变了离子通道，即“致心律失常重塑”[34]。心电图可以记录心脏电活动从而判断各种心脏疾病。Burak C 等人的研究发现 P 波峰值时间(P wave peak time, PWPT)在 II 导联上每延长 1 ms，合并以 ICA-SS 为基础评为严重冠心病的可能性增加 0.066 倍[35]。PWPT 代表电活动从窦房结扩散到两个心房正性收缩的最大值之和所需的时间，心房内压力的增高表现为 PWPT 的延长，左房内压力直接因为冠脉无复流或者间接由左室舒张功能减低而导致增高[36] [37] [38]。除了 P 波，代表左右心室复极的 ST 段的异常也与冠心病的风险增高相关[39]。一项探索心电图参数对不稳定型心绞痛患者的 ICA-SS 风险分层预测作用的研究纳入 600 名患者，按照低、中、高 ICA-SS 将患者分为三组，最终得到右侧导联(aVR, III, V1) ST 段抬高的同时伴随其他导联 ST 段压低的患者具有高 ICA-SS，弥漫性 ST 段压低而无 ST 段抬高以及侧导联 T 波倒置是不稳定型心绞痛患者中度 ICA-SS 的危险因素[40]。

5.3. 血压

动脉壁压力、机械应力和内皮通透性的增加以及内皮细功能障碍有利于脂质沉积和动脉粥样硬化的形成[41]，高血压与冠脉狭窄、动脉粥样斑块易损性[42]以及血栓的形成相关[43]。Senthong V 等[44]的研究表明收缩期血压水平与 ICA-SS 呈显著负相关。Quisi A 等人[45]发现相比与低 ICA-SS，评分为中高 ICA-SS 的心血管患者晨起收缩压血压上升幅度更大(22.7 ± 13.2 vs 12.4 ± 7.5)。在讨论单一血压指标与联合血压指标预测心血管疾病的危险方面，有研究者提出后者优于前者[46]，因此研究脉压、平均动脉压、踝肱指数、臂间血压等与 ICA-SS 的相关性也有很大的意义。

6. 小结

心血管疾病在世界范围大流行，而冠脉病变的严重与复杂程度关系到患者的生存和预后，ICA-SS 作为应用广泛的评估冠脉病变严重和复杂程度的特殊工具，具有权威性。但获取更易被接受的以及简便的方式对患者进行筛查以及分层管理是大势所趋。炎症、免疫、氧化应激等机制导致血管内皮的损伤，进而引起动脉粥样硬化、斑块以及血栓形成，导致冠脉解剖结构特点改变，引发心肌缺血，而后通过异常

的心肌运动、心率、心脏节律、血压等方式体现。因此通过影像学、心电图、心率、血压测量等无创方式评估冠脉病变严重程度，对危险人群在做冠脉造影之前就得到筛查和危险分层，同时对治疗措施的选取以及预后监测有重要意义。

7. 前景与展望

早期、精确、简便的疾病筛查方式更能满足现代患者的需求，上述无创的冠脉病变严重程度的临床预测指标也许能达到目的。鉴于冠心病的复杂的病因与病理机制，相较于独立的无创指标对冠脉病变的严重和复杂程度进行预测，综合性指标可能更准确，如多模态超声。相信在未来会有更多的研究成果为患者提供更多优质的冠心病诊断服务。

参考文献

[1] Falk, E. (2006) Pathogenesis of Atherosclerosis. *Journal of the American College of Cardiology*, **47**, C7-C12. https://doi.org/10.1016/j.jacc.2005.09.068

[2] Zhao, D., Liu, J., Wang, M., Zhang, X. and Zhou, M. (2019) Epidemiology of Cardiovascular Disease in China: Current Features and Implications. *Nature Reviews Cardiology*, **16**, 203-212. https://doi.org/10.1038/s41569-018-0119-4

[3] Sianos, G., Morel, M.-A., Kappetein, A.P., Morice, M.-C., Colombo, A., Dawkins, K., *et al*. (2005) The SYNTAX Score: An Angiographic Tool Grading the Complexity of Coronary Artery Disease. *EuroIntervention*, **1**, 219-227.

[4] Sitia, S., Tomasoni, L., Atzeni, F., Ambrosio, G., Cordiano, C., Catapano, A., *et al*. (2010) From Endothelial Dysfunction to Atherosclerosis. *Autoimmunity Reviews*, **9**, 830-834. https://doi.org/10.1016/j.autrev.2010.07.016

[5] Vlieger, S., Oemrawsingh, R.M., Cheng, J.M., Schuurman, A.-S., Vroegindewey, M., Kardys, I., *et al*. (2022) Prognostic Value of Syntax Score, Intravascular Ultrasound and Near-Infrared Spectroscopy to Identify Low-Risk Patients with Coronary Artery Disease 5-Year Results from the ATHEROREMO and IBIS-3 Cohorts. *PLOS ONE*, **17**, e0275592. https://doi.org/10.1371/journal.pone.0275592

[6] Ng, A.C.T., Tran, D.T., Newman, M., Allman, C., Vidaic, J. and Leung, D.Y. (2008) Comparison of Left Ventricular Dyssynchrony by Two-Dimensional Speckle Tracking versus Tissue Doppler Imaging in Patients with Non-ST-Elevation Myocardial Infarction and Preserved Left Ventricular Systolic Function. *American Journal of Cardiology*, **102**, 1146-1150. https://doi.org/10.1016/j.amjcard.2008.06.033

[7] 李欣月. 超声二维分层应变与冠状动脉病变严重程度的关系及在评价行冠状动脉旁路移植术患者预后中的价值[D]: [硕士学位论文]. 沈阳: 中国医科大学, 2022.

[8] Bayramoğlu, A., Bektaş, O. and Yaman, M. (2017) Detection of Left Atrial Dysfunction with Speckle Tracking Echocardiography. *Herz*, **42**, 418-424. https://doi.org/10.1007/s00059-016-4485-6

[9] Abdelrazek, G., Yassin, A. and Elkhashab, K. (2020) Correlation between Global Longitudinal Strain and SYNTAX Score in Coronary Artery Disease Evaluation. *The Egyptian Heart Journal*, **72**, Article No. 22. https://doi.org/10.1186/s43044-020-00064-2

[10] Cai, Z., Dai, J., Wu, D., Qiu, J., Ma, J., Li, G., *et al*. (2016) The Value of 3-Dimensional Longitudinal Strain in the Evaluation of Complex Coronary Lesions in Non-ST-Segment Elevation Acute Coronary Syndrome Patient. *Medicine* (*Baltimore*), **95**, e4667. https://doi.org/10.1097/MD.0000000000004667

[11] Wierzbowska-Drabik, K., Picano, E., Simiera, M., Plewka, M., Kręcki, R., Peruga, J.Z., *et al*. (2020) A Head-to-Head Comparison of Wall Motion Score Index, Force, Strain, and Ejection Fraction for the Prediction of SYNTAX and Gensini Coronary Scores by Dobutamine Stress Echocardiography. *Kardiologia Polska*, **78**, 715-724. https://doi.org/10.33963/KP.15376

[12] Barrett, T.J. (2020) Macrophages in Atherosclerosis Regression. *Arteriosclerosis*, *Thrombosis*, *and Vascular Biology*, **40**, 20-33. https://doi.org/10.1161/ATVBAHA.119.312802

[13] Ikeda, N., Kogame, N., Iijima, R., Nakamura, M. and Sugi, K. (2012) Carotid Artery Intima-Media Thickness and Plaque Score Can Predict the SYNTAX Score. *European Heart Journal*, **33**, 113-119. https://doi.org/10.1093/eurheartj/ehr399

[14] Cappelletti, A., Astore, D., Godino, C., Bellini, B., Magni, V., Mazzavillani, M., *et al*. (2018) Relationship between Syntax Score and Prognostic Localization of Coronary Artery Lesions with Conventional Risk Factors, Plasma Profile Markers, and Carotid Atherosclerosis (CAPP Study 2). *International Journal of Cardiology*, **257**, 306-311. https://doi.org/10.1016/j.ijcard.2017.12.012

[15] Ikeda, N., Gupta, A., Dey, N., Bose, S., Shafique, S., Arak, T., *et al*. (2015) Improved Correlation between Carotid and Coronary Atherosclerosis SYNTAX Score Using Automated Ultrasound Carotid Bulb Plaque IMT Measurement. *Ultrasound in Medicine and Biology*, **41**, 1247-1262. https://doi.org/10.1016/j.ultrasmedbio.2014.12.024

[16] Wang, X., Luo, P., Du, H., Li, S., Wang, Y., Guo, X., *et al*. (2022) Ultrasound Radiomics Nomogram Integrating Three-Dimensional Features Based on Carotid Plaques to Evaluate Coronary Artery Disease. *Diagnostics* (*Basel*), **12**, Article No. 256. https://doi.org/10.3390/diagnostics12020256

[17] Icen, Y.K., Koc, A.S. and Sumbul, H.E. (2019) Coronary Artery Disease Severity Is Associated with Abdominal Aortic Intima-Media Thickness in Patients with Non-ST-Segment Elevation Myocardial Infarction. *Angiology*, **70**, 561-566. https://doi.org/10.1177/0003319718794833

[18] Karakurt, A., Yildiz, C., Yildiz, A. and Başbuğ, H.S. (2016) Assessment of Relation between Aortic Elastic Properties and the Complexity of Coronary Artery Disease. *Acta Cardiologica*, **71**, 267-273. https://doi.org/10.1080/AC.71.3.3152086

[19] Vrublevsky, A.V., Boshchenko, A.A. and Bogdanov, Y.I. (2019) Possibilities and Limitations of Three-Dimensional Transesophageal Echocardiography in the Diagnosis of Thoracic Aorta Atherosclerosis. *Kardiologiia*, **59**, 22-30. https://doi.org/10.18087/cardio.n692

[20] Serruys, P.W., Hara, H., Garg, S., Kawashima, H., Nørgaard, B.L., Dweck, M.R., *et al*. (2021) Coronary Computed Tomographic Angiography for Complete Assessment of Coronary Artery Disease: JACC State-of-the-Art Review. *Journal of the American College of Cardiology*, **78**, 713-736. https://doi.org/10.1016/j.jacc.2021.06.019

[21] Qiao, H.Y., Li, J.H., Schoepf, U.J., Bayer, R.R., Tinnefeld, F.C., Di Jiang, M., *et al*. (2020) Prognostic Implication of CT-FFR Based Functional SYNTAX Score in Patients with De Novo Three-Vessel Disease. *European Heart Journal—Cardiovascular Imaging*, **22**, 1434-1442. https://doi.org/10.1093/ehjci/jeaa256

[22] Iacobellis, G. (2022) Epicardial Adipose Tissue in Contemporary Cardiology. *Nature Reviews Cardiology*, **19**, 593-606. https://doi.org/10.1038/s41569-022-00679-9

[23] Mazurek, T., Zhang, L., Zalewski, A., Mannion, J.D., Diehl, J.T., Arafat, H., *et al*. (2003) Human Epicardial Adipose Tissue Is a Source of Inflammatory Mediators. *Circulation*, **108**, 2460-2466. https://doi.org/10.1161/01.CIR.0000099542.57313.C5

[24] 季宇萌，秦会园，陆小虎，李奔，王旭枫，刘朝阳，等. 心外膜脂肪体积与冠状动脉血管病变严重程度评估及预后的相关性研究[J]. 南京医科大学学报(自然科学版), 2023, 43(8): 1108-1114.

[25] Khamis, R.Y., Ammari, T. and Mikhail, G.W. (2016) Gender Differences in Coronary Heart Disease. *Heart*, **102**, 1142-1149. https://doi.org/10.1136/heartjnl-2014-306463

[26] Polonsky, T.S. and Greenland, P. (2017) Breast Arterial Calcification: Expanding the Reach of Cardiovascular Prevention. *Circulation*, **135**, 499-501. https://doi.org/10.1161/CIRCULATIONAHA.116.025277

[27] Ružičić, D., Dobrić, M., Vuković, M., Hrnčić, D., Đorđević, S., RužIčić, M., *et al*. (2018) The Correlation of SYNTAX Score by Coronary Angiography with Breast Arterial Calcification by Digital Mammography. *Clinical Radiology*, **73**, 454-459. https://doi.org/10.1016/j.crad.2017.12.002

[28] Zhang, B., Pei, C., Zhang, Y., Sun, Y. and Meng, S. (2018) High Resting Heart Rate and High BMI Predicted Severe Coronary Atherosclerosis Burden in Patients with Stable Angina Pectoris by SYNTAX Score. *Angiology*, **69**, 380-386. https://doi.org/10.1177/0003319717715579

[29] Palatini, P. and Julius, S. (1997) Heart Rate and the Cardiovascular Risk. *Journal of Hypertension*, **15**, 3-17.

[30] Emren, S.V., Gediz, R.B., Şenöz, O., Karagöz, U., Şimşek, E.Ç., Levent, F., *et al*. (2019) Decreased Heart Rate Recovery May Predict a High SYNTAX Score in Patients with Stable Coronary Artery Disease. *Bosnian Journal of Basic Medical Sciences*, **19**, 109-115. https://doi.org/10.17305/bjbms.2019.3725

[31] Mohanta, S.K., Peng, L., Li, Y., Lu, S., Sun, T., Carnevale, L., *et al*. (2022) Neuroimmune Cardiovascular Interfaces Control Atherosclerosis. *Nature*, **605**, 152-159. https://doi.org/10.1038/s41586-022-04673-6

[32] Halaris, A. (2013) Inflammation, Heart Disease, and Depression. *Current Psychiatry Reports*, **15**, Article No. 400. https://doi.org/10.1007/s11920-013-0400-5

[33] Nerbonne, J.M. and Kass, R.S. (2005) Molecular Physiology of Cardiac Repolarization. *Physiological Reviews*, **85**, 1205-1253. https://doi.org/10.1152/physrev.00002.2005

[34] Nattel, S., Maguy, A., Le, Bouter, S. and Yeh, Y.-H. (2007) Arrhythmogenic Ion-Channel Remodeling in the Heart: Heart Failure, Myocardial Infarction, and Atrial Fibrillation. *Physiological Reviews*, **87**, 425-456. https://doi.org/10.1152/physrev.00014.2006

[35] Burak, C., Yesin, M., Tanık, V.O., Çağdaş, M., Rencüzoğullari, İ., Karabağ, Y., *et al*. (2019) Prolonged P Wave Peak Time Is Associated with the Severity of Coronary Artery Disease in Patients with Non-ST Segment Elevation Myocardial Infarction. *Journal of Electrocardiology*, **55**, 138-143. https://doi.org/10.1016/j.jelectrocard.2019.05.015

[36] Çağdaş, M., Karakoyun, S., Rencüzoğullari, İ., Karabağ, Y., Yesin, M., Gürsoy, M.O., *et al*. (2017) P Wave Peak Time; a Novel Electrocardiographic Parameter in the Assessment of Coronary No-Reflow. *Journal of Electrocardiology*, **50**, 584-590. https://doi.org/10.1016/j.jelectrocard.2017.06.010

[37] Chang, H.-C. and Cheng, H.-M. (2019) P Wave Peak Time: A Time Window to Evaluate Left Ventricular Diastolic Function. *The Journal of Clinical Hypertension* (*Greenwich*), **21**, 616-617. https://doi.org/10.1111/jch.13528

[38] Sharifov, O.F., Denney, T.S., Girard, A.A., Gupta, H. and Lloyd, S.G. (2023) Coronary Artery Disease Is Associated with Impaired Atrial Function Regardless of Left Ventricular Filling Pressure. *International Journal of Cardiology*, **387**, Article ID: 131102. https://doi.org/10.1016/j.ijcard.2023.05.052

[39] Dekker, J.M., Schouten, E.G., Klootwijk, P., Pool, J. and Kromhout, D. (1995) ST Segment and T Wave Characteristics as Indicators of Coronary Heart Disease Risk: The Zutphen Study. *Journal of the American College of Cardiology*, **25**, 1321-1326. https://doi.org/10.1016/0735-1097(95)00017-X

[40] Hatamnejad, M.R., Heydari, A.A., Salimi, M., Jahangiri, S., Bazrafshan, M. and Bazrafshan, H. (2022) The Utility of SYNTAX Score Predictability by Electrocardiogram Parameters in Patients with Unstable Angina. *BMC Cardiovascular Disorders*, **22**, Article No. 8. https://doi.org/10.1186/s12872-022-02455-6

[41] Escobar, E. (2002) Hypertension and Coronary Heart Disease. *Journal of Human Hypertension*, **16**, S61-S63. https://doi.org/10.1038/sj.jhh.1001345

[42] Iannaccone, M., Quadri, G., Taha, S., D'Ascenzo, F., Montefusco, A., Omede, P., *et al*. (2016) Prevalence and Predictors of Culprit Plaque Rupture at OCT in Patients with Coronary Artery Disease: A Meta-Analysis. *European Heart Journal—Cardiovascular Imaging*, **17**, 1128-1137. https://doi.org/10.1093/ehjci/jev283

[43] Yildiz, G., Hür, E., Özçiçek, A., Candan, F. and Kayatas, M. (2013) The Mean Platelet Volume and Atherogenic Index of Plasma in Nondipper Normotensive Individuals Compared to Dippers. *Clinical and Experimental Hypertension*, **35**, 35-39. https://doi.org/10.3109/10641963.2012.689043

[44] Senthong, V., Kukongviriyapan, U., Settasatian, N., Settasatian, C. and Komanasin, N. (2018) Low Diastolic Blood Pressure Is Associated with a High Atherosclerotic Burden in Patients with Obstructive Coronary Artery Disease. *Cardiology Journal*, **25**, 345-352. https://doi.org/10.5603/CJ.a2017.0109

[45] Quisi, A., Alici, G., Harbalioglu, H., Genc, O., Kurt, I.H. and Cayli, M. (2021) Association between Morning Surge in Systolic Blood Pressure and SYNTAX Score I in Patients with Stable Coronary Artery Disease. *Texas Heart Institute Journal*, **48**, e197092. https://doi.org/10.14503/THIJ-19-7092

[46] Franklin, S.S., Lopez, V.A., Wong, N.D., Mitchell, G.F., Larson, M.G., Vasan, R.S., *et al*. (2009) Single versus Combined Blood Pressure Components and Risk for Cardiovascular Disease: The Framingham Heart Study. *Circulation*, **119**, 243-250. https://doi.org/10.1161/CIRCULATIONAHA.108.797936