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Case Report

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Clinical Management of Cardiometabolic Risks in A High Risk Individual: A Case Report

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Abstract

The South Asian phenotype is associated with a unique cluster of cardiometabolic risk factors, including visceral obesity, insulin resistance, and a heightened propensity for type-2 diabetes mellitus (DM) and cardiovascular disease. This case report presents a comprehensive 30-year longitudinal clinical profile of an 87-year-old South Asian male with a history of hypertension, left ventricular hypertrophy (LVH), and type-2 DM. Despite early-onset cardiac dysfunction and progressive vascular changes, the patient maintained good glycemic control and stable cardiovascular status through pharmacologic management, a heart-healthy diet, and regular exercise. Advanced diagnostic tools including wearable cardiac rhythm monitors, stress echocardiography, and technetium-99 myocardial perfusion imaging (MPI) were employed to assess myocardial function and ischemic risk. Although transient ST-segment depressions were observed during ambulatory and stress ECG monitoring, nuclear imaging revealed no inducible ischemia but did show a fixed perfusion defect indicative of a myocardial scar. Importantly, artificial intelligence (AI) tools played a key role in integrating and interpreting complex multimodal data enhancing the diagnostic process through automated ECG analysis, risk stratification, and pattern recognition in nuclear imaging. This case underscores the growing utility of AI in improving accuracy, efficiency, and early detection in elderly patients with complex cardiometabolic conditions. It also highlights the importance of continuous, multimodal monitoring and personalized care strategies in managing chronic disease in high-risk populations.

Keywords: cardiology; obesity; diabetes; ECG; chronic disease; cardiovascular disease

Introduction

The global burden of cardiovascular diseases (CVDs) is expected to rise significantly between 2025 and 2050. According to the World Health Organization (WHO), CVDs will continue to be the leading cause of death and disability worldwide during this time. By 2050, it is projected that more than 30% of global deaths exceeding 25 million annually will be due to CVDs. This anticipated increase is driven by factors such as population growth, aging, urbanization, and rising rates of obesity, physical inactivity, smoking, hypertension, endothelial dysfunction, obesity, diabetes, anthropometric measures, blood lipids, inflammation, socioeconomic status, family history.[1, 2] Data from the Global Burden of Diseases (GBD) 2019 indicates that CVDs are the leading cause of death globally, with 58% of these deaths occurring in Asia. In response to this growing concern, the U.S. House of Representatives recently passed the South Asian Heart Health Awareness and Research Act (H.R. 3771).[3] Initially introduced in June 2021, this legislation aims to address the elevated risk of cardiovascular disease among Asian subpopulations particularly South Asians where traditional risk models often fail to adequately identify risk. The bill authorizes the Department of Health and Human Services to implement programs promoting heart disease research and awareness in communities disproportionately affected by CVDs.

Analysis of four major databases, including GBD 2019, confirms that CVDs are the leading global cause of death, with South Asians bearing a particularly heavy burden. Over 80% of cardiovascular disease in this population is due to ischemic heart disease and stroke.[4–9] Extensive literature search reveals that South Asians including individuals of Indian, Pakistani, Bangladeshi, Sri Lankan, and Nepali descent experience the highest incidence of coronary artery disease (CAD) compared to any other ethnic group worldwide. To increase awareness and promote education and prevention, the South Asian Society on Atherosclerosis and Thrombosis (SASAT) was founded at the University of Minnesota in 1993. Since its inception, SASAT has organized 20 international conferences on CAD and thrombosis across India and other countries. The organization has also partially funded the India Heart Watch project and published over a dozen books on cardiometabolic diseases.[10–22] From the outset, SASAT members have been dedicated to improving education, raising awareness of chronic cardiovascular conditions, and developing preventive strategies. Global research supports the effectiveness of prevention: the INTERHEART study showed that nine modifiable risk factors account for over 90% of heart attack risk globally, across all regions and major ethnic groups.[23] Additionally, research by Khera and colleagues at Harvard University demonstrated that even individuals with high genetic risk for CAD could reduce their relative risk by nearly 50% through a healthy lifestyle.[24]

Case Study

The South Asian phenotype presents a unique set of clinical characteristics, including, typical visceral obesity, high triglycerides, increased low density lipoprotein cholesterol (LDL-Cholesterol), insulin resistance, high propensity for type-2 DM.[25-28] Such metabolic alterations are closely linked to the development and progression of vascular diseases and acute vascular events. Addressing these metabolic alterations through life style interventions is crucial for vascular disease prevention. The subject of this case study is of South Asian descent, who was born in India (08/23/1937), and migrated to the USA for his higher studies in 1965. In addition to diet and exercise, several other lifestyle factors can significantly impact the progression of cardiovascular disease. These include smoking and tobacco use, alcohol consumption, sleep quality, stress levels, adherence to prescribed medications, substance use, occupational and environmental exposures, social support, and regular health monitoring. The subject of this study led a life free from such unhealthy habits and consistently engaged in regular health monitoring throughout his adult life. The subject in question, developed early signs of heart dysfunction at the age of 57. The patient is a renowned researcher in the areas of cardiometabolic diseases, as such was willing to undergo approved diagnostic tests as well as those that were in the developmental stages. In 1994, during a sightseeing tour in India, subject noticed shortness of breath, while climbing a small hill (300 meters high). Primary physician in Minneapolis performed ECG tests and determined that probably left ventricular hypertrophy was the cause for observed shortness of breath during uphill climbing. The blood pressure of the patient was 160/80. Initially a combination of a thiazide diuretic and angiotensin-converting inhibitor was used to arrest and normalize LVH. Once this goal was achieved the use of Enalapril (Vasotec 5 Mg) once daily was recommended.

In 1999, patient developed a low-grade fever of unknown origin and suffered considerable loss of weight. He was administered wide spectrum antibiotic, Levaquin. During this time, it was noticed that his fasting glucose was also considerably high (170mgs/Dl). Therefore, in addition to antibiotic he also was administered Glucophage (750Mgs/day). This patient had both primary hypertensions, LVH and type-2 DM. In 2012, post-retirement, patient permanently moved to Potomac, Maryland and the medical records were transferred to the present family physician (Dr. Collin Cullen) in Washington DC. Although he continued the use of Metformin ER and blood pressure medications, Enalapril and Carvedilol, additional antiglycemics were added as and when needed. Current medications include Metformin ER 500Mg two tablets twice daily, Lisinopril 20Mg Twice daily, Carvedilol 6.25 Mg twice daily, Glipizide 10Mg twice daily, Jardiance 10 Mg once daily, Rybelsus 7Mg once daily, Atorvastatin 10 Mg once daily, Cyanocobalamin 1000mcg twice a month. Vitamin D 1000 IU daily. In 2024, at the age of 87, patient underwent following tests to follow the progress of the atherosclerotic arterial disease of the blood vessels, as well as heart health, and vascular function or dysfunction, 1) non-invasive lower limb vascular assessment, 2) bilateral lower limb arterial doppler study, bilateral peroneal and posterior tibial nerve conduction study, 3) carotid artery calcium score, 4) bilateral carotid (neck) Doppler studies, and 5) echo cardiography of the heart.

Bilateral iliac, common femoral, popliteal arteries showed diffuse wall thickening, calcification with mild narrowing of lumen. Despite these lesions, blood flow studies showed normal velocity waveforms. Left femoral artery showed wall irregularity and calcified plaques causing 20-30% luminal stenosis. Bilateral anterior tibial and dorsalis pedis arteries showed biphasic waveform, diffused wall thickening, calcification with mild narrowing of the lumen. In the motor nerve, bilateral common peroneal nerve studies showed mildly prolonged latency with mildly reduced compound muscle action potential (CMAP) amplitude and reduced motor conduction velocity. Bilateral posterior tibial nerve studies showed mildly prolonged latency with reduced motor conduction velocity and normal CMAP amplitude. These studies indicate electrophysiological evidence of bilateral lower limb mild sensorimotor axonal with secondary demyelinating neuropathy. Risk assessment of coronary artery calcium (CAC) score showed significant calcification of the coronary arteries. Number of calcifications in right coronary artery was 3 [Agatston Score (AS) 1007], left main coronary artery 0, Left anterior descending artery 2 (AS 54), left circumflex artery 2 (AS 1748). In April of 2024 the blood chemistry was as follows; eGFR 59L, Protein in urine (Trace), Hemoglobin 10.7, Fasting Glucose 168, HbA1c 8.1. Lipid Panel; Total Cholesterol 86, HDL- Cholesterol 42, Triglycerides 148, LDL- Cholesterol 21, Chol/HDLC ration 2.0, Non-HDL Cholesterol 44.

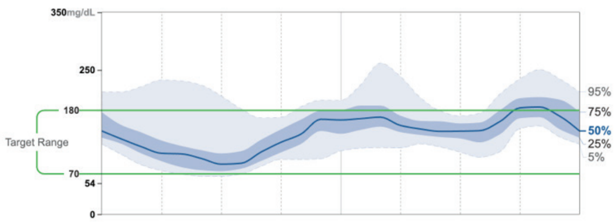

Figure 1. Daily glucose profile of patient showing well controlled glycemia. (Abbott FreeStyle Libre 3plus)

In May of 2025, his laboratory readings were, cholesterol 83, HDL Cholesterol 44, Triglycerides 76, LDL-Cholesterol 23, Hemoglobin HbA1c 7.0. According to Abbott FreeStyle Libre data the average glucose was 143, glucose variability was 29.4, Target range was 80%, Glucose Management Indicator (HbA1c equivalent) was 6.7% (Figures 1and 2). Triglycerides were reduced significantly from the previous report (148 to 76 and HbA1c from 8.1 to 6.7).

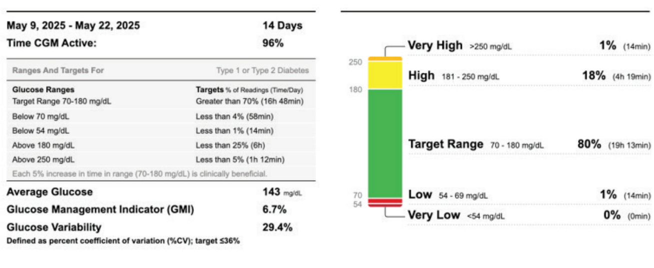

Figure 2. Glucose targets and time ranges (Toujeo Max SoloStar, 42 units/day)

In our earlier reports we have covered the various diagnostic tests that the patient has explored for detecting early cardiometabolic risks.[29,30] In this study we will report the detection of ST-segment depression during a routine testing of a newly developed Padma

Cardiac Rhythm Device (PCRD) by Cardiac Design Laboratories (184/2, Whitefield Main Road, Bengaluru, India. 560066). The patient is an international adviser for this company. The wearable device (Figure 3) is developed for long term continuous monitoring (five days) of heart for complete diagnostics and post-operative procedures. Patient evaluated the device in February of this year and found it extremely useful. As summarized in Figure 4 the average heart rate was 72 bpm. However, ST-segment depression was noted on 9 separate occasions during this five day period.

Figure 3. Patient wearing Abbott FreeStyle Libre-3Plus and Padma Cardiac Rhythm Device.

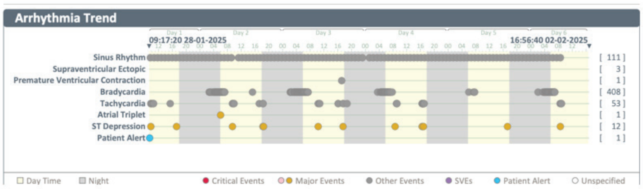

Figure 4. Summary report of PCRD for five days.

The patient was monitored continuously using Padma cardiac rhythm device for a total of 5 days 7 hours and 39 minutes (Figure4). Average heart rate was 72 bpm. Minimum heart rate was 53 and maximum was 120 bpm. One atrial triplet episode was noted. No ventricular tachycardia, atrial fibrillation or long pauses were observed (Tachycardia burden 2.4%. Bradycardia burden 5.9%). ST-segment depression episodes were detected on 9 separate occasions, across multiple days. Depression ranged up to -0.295mV, with durations ranging from 8 to 30 minutes. Associated heart rates were in the 90-112 bpm rage during these episodes. Interpretation: Mild to moderate ST-segment depression episodes with elevated HRs may suggest myocardial ischemia or could be related ST-changes especially in elderly patients. Bradycardia episodes are consistent but nor prolonged, they also may reflect age-related sinus node changes. No life-threatening arrythmias were detected. A typical EKG obtained during the highest heart rate is presented in Figure 5.

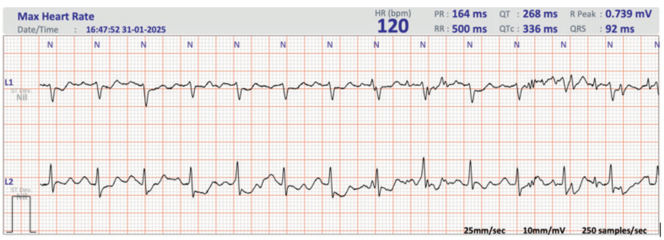

Figure 5. Typical ECG graph of patient on PCRD

ST segment depressions on an electrocardiogram (ECG) are significant findings that generally indicate myocardial ischemia, which means that part of the heart muscle is not getting enough oxygen. In a normal ECG, the ST segment is isoelectric, suggesting that normal electric activity and adequate oxygenation of the heart muscle. A one mm ST-segment depression (1 mm below the base line) can be non-specific finding or indicate early or mild ischemia. It may occur during exercise testing or under stress and can be transient. A two mm ST-segment depression is more significant and usually indicates moderate or severe myocardial ischemia, likely associated with coronary artery disease. Persistent or worsening ST-segment depression may require stress echocardiography or nuclear stress imaging. A schematic graph showing significant ST-segment depression is presented in Figure 6 and a linear plot showing heart rate dependent St-segment depression is presented in Figure 7.

Figure 6. Schematic representation of ST-segment depression.

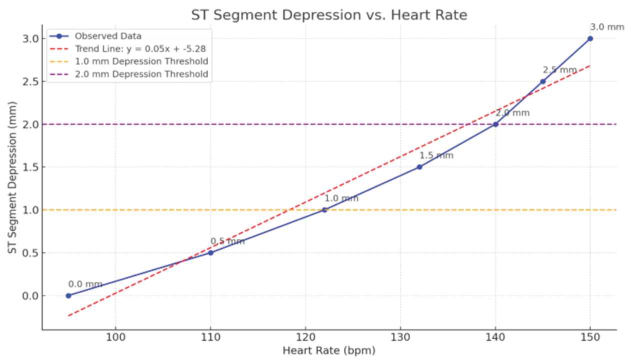

Figure 7. A plot showing correlation between heart rate increase and ST-segment depression

In healthy individuals, mild ST-segment changes (including slight depression) can occur with increased heart rate during exercise or stress, but these are typically not significant and resolve with rest. These changes are often due to increased myocardial demand and are not necessarily indicative of ischemia unless meet specific criteria (depth, duration, location). In coronary artery disease patients ST-segment depression is often rate-dependent. It appears or worsens as heart rate increases, especially during exercise or stress stressing. The relationship is nonlinear and may exhibit a threshold effect in ST-segment depression may not occur until a certain rate is reached (ischemic threshold) and after that it can increase further with heart rate elevation. In the graph above the blue line indicates the observed ST-segment depression plotted as mm change from the base line. At heart rate 120 which was the maximum achieved the ST-depression is just about close to 1.0 mm. However, in the Bruce stress test, which is described below, at a maximum heart rate of 134 the ST-segment depression was 1.38mm, which is close to the linear graph generated using the

5-day data obtained using Padma Cardica Rhythm Device.

Phase Name	Stage Name	Time in Stage	Speed (mph)	Grade (%)	HR (bpm)	BP (mmHg)
PRETEST	SUPINE	02:32	0.00	0.00	71	160/80
	STANDING	00:01	0.00	0.00	70	
	HYPERV.	00:02	0.00	0.00	68	
EXERCISE	STAGE 1	03:00	1.70	10.00	92	162/70
	STAGE 2	03:00	2.50	12.00	112	170/62
	STAGE 3	01:00	3.40	14.00	133	
RECOVERY		03:02	0.00	0.00	67	

Figure 8. Bruce Stress Test data

The Bruce protocol is the most commonly used treadmill exercise stress test protocol. It was developed by American cardiologist Dr. Robert A. Bruce. The test involves the subject walking on a treadmill that gradually increases in both speed and incline over successive 3-minute stages. The test begins with a 10% incline and 1.7 mph pace. After 3 minutes, the incline increases to 12% and the speed to 2.5 mph. The test continues with further increases in incline and speed with each 3-minute stage. During the test, the patient walks on a treadmill while his heart rate and blood pressure are monitored. The test continues until specific criteria are met such as, reaching a target heart rate or experiencing symptoms like chest pain. Bruce test data are summarized in Figure 8.[31]

The patient walked on a treadmill using the Bruce protocol, for a total of 9 minutes, to a peak energy expenditure of 10.16 METS. The heart rate rose from 62 bpm to 134 bpm, which represents achievement of 101% of the maximum predicted heart rate. The blood pressure at rest was 160/80 mmHg (since the patient had not taken his usual blood pressure medications these values are relatively high), rose to 170/62 mmHg at peak exercise, and was 160/70 mmHg in recovery, which is a normal response. Exercise was discontinued due to achievement of target heart rate. The patient reported no symptoms of chest pain during exercise. At peak exercise, there was 1.85 mm ST depression. Cardiac rhythm monitoring during exercise detected no arrhythmias. Summary of the pretest ECG compared with Bruce stress test ECG are presented in Figure 9.

Stage	Speed (mph)	Heart Rate (BPM)	Blood Pressure (mmHg)	ECG Findings
Pretest	N/A	Baseline (est. ~60–70)	Not provided	Normal sinus rhythm, no ischemia or arrhythmia noted
Stage 1	1.7	86	162/70	Mild HR increase, no significant ST changes
Stage 2	2.5	109	170/62	Appropriate HR increase, minor upsloping ST changes (normal with exercise)
Stage 3	3.4	133	Not provided	Significant HR increase, possible ST depression in inferolateral leads (suggestive of ischemia)

Figure 9. Summary of Pretest ECG compared with Bruce Tread Mill Exercise Test

The Bruce exercise test shows a normal heart rate and blood pressure response to exercise. However, the possible ST-segment depression in Stage 3 exercise is suggestive of ischemia, which may indicate coronary artery disease or inadequate blood flow to parts of the heart under stress.

Hence, further evaluation using a nuclear test was suggested. Ninety seconds prior to the cessation of the exercise protocol,10.05 mCi of Tc99m Myoview was injected I.V. Rt AC. Rest SPECT tomographic myocardial imaging was performed after I.V. injection of 29.20 mCi of Tc99m Myoview was injected I.V. Rt AC, and repeat myocardial tomographic imaging was performed. Attending cardiologist concluded: No chest pain during exercise. Left ventricular ejection fraction is 68% with normal wall motion. Normal; LV function. This is a negative stress myocardial perfusion study for ischemia. (Figure 10 and 11).

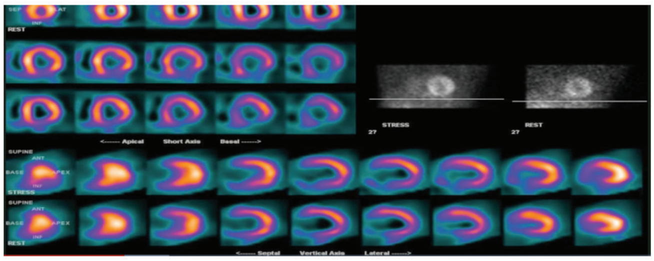

Figure 10. These images represent a **Myocardial Perfusion Imaging (MPI)** study using a **Nuclear Stress Test**, done technetium-99m to assess coronary artery disease.

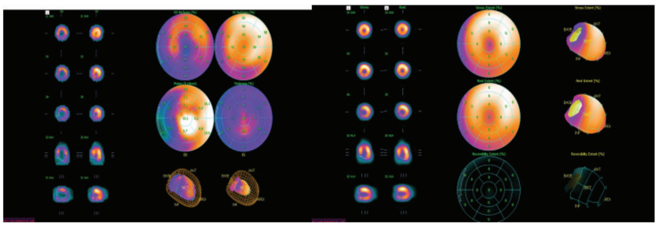

Figure 11. These images represent a **Myocardial Perfusion Imaging (MPI)** study using a **Nuclear Stress Test**, done technetium-99m to assess coronary artery disease.

We validated the advantages of using AI and deep learning app (Chat GPT, Open AI, o3 version) for the interpretation of the data presented above. According to these applications, nuclear MPI findings demonstrate a perfusion defect involving the basal septal wall of the left ventricle. This defect is present on both stress and rest images, with approximately the same extent and severity in each. All other myocardial segments (lateral, inferior, apical etc.) show normal tracer uptake at stress and rest, indicating preserved perfusion in those areas. There is no evidence of new stress-induced ischemia-in other words, no significant reversible perfusion defects. The summed stress and rest score reflect this, with an SDS-0 (negligible reversibility). As far as the Wall motion and function gated SPECT analysis the septal perfusion defect observed is hypokinetic. Other left ventricular ejection fraction appears preserved, and ejection fraction is normal. No global wall motion abnormality is seen aside from the focal septal issue. In summary, the study is abnormal due to a fixed perfusion defect in the basal septal wall consistent with myocardial scar. There is no inducible ischemia detected elsewhere. The analysis above was facilitated by specialized software that processes SPECT MPI data. In practice clinicians rely on FDA-approved quantitative analysis programs to generate polar maps, calculate scores, and create 3D heart models.

Recent advancements in technetium stress-test for myocardial perfusion imaging (MPI) include the development of high-efficiency cameras, adoption of stress-only protocols, and integration of hybrid imaging techniques. These innovations have led to quicker testing, lower radiation doses, and enhanced diagnostic precision. Ongoing technological progress is expected to further refine and expand the capabilities of nuclear cardiology. Artificial intelligence (AI), particularly through advanced algorithms and deep learning, holds the promise of transforming all aspects of nuclear diagnostic cardiology from image acquisition and reconstruction to quantification and clinical interpretation. Notably, a deep learning model designed to detect obstructive coronary artery disease (CAD) using SPECT MPI has demonstrated superior diagnostic accuracy, achieving an area under the curve (AUC) of 0.983. This performance significantly surpasses traditional methods such as total perfusion defect quantification and expert reader interpretation, with all analyses showing statistical significance ($P > 0.0001$).[32, 33]

Discussions

The patient, a South Asian male with a long-standing history of metabolic syndrome, exemplifies the challenges and opportunities in managing age-related cardiovascular decline in high-risk ethnic populations. His clinical course, characterized by hypertension, LVH, and type-2 diabetes (DM), reflects the cardiometabolic clustering that is common in South Asians. Despite multiple comorbidities, proactive diagnostic evaluations and tailored therapy enabled effective disease management into his late 80s. Key findings include early signs of cardiac dysfunction, progressively worsening atherosclerotic changes, and significant ST-segment depressions identified using the Padma Cardiac Rhythm Device (PCRD). Importantly, these ST-segment changes were both rate-dependent and suggestive of myocardial ischemia, warranting further evaluation with the Bruce treadmill stress test and technetium-99 SPECT myocardial perfusion imaging.

The stress test identified a significant 1.85 mm ST-segment depression at peak exercise, reinforcing the need for detailed perfusion assessment. Nuclear imaging, interpreted with the aid of deep learning models, demonstrated a fixed perfusion defect in the basal septal wall—consistent with a myocardial scar but no inducible ischemia. This distinction is crucial in elderly patients, where non-reversible ischemic changes must be differentiated from acute ischemic events to avoid overtreatment. In practice clinicians rely on FDA-approved quantitative analysis programs to generate polar maps, calculate scores, and create 3D heart models. Notable tools include Cedars-Sinai QPS/QGS (Quantitative Perfusion SPECT & Quantitative Gated SPECT), also known as Auto QUANT, Emory Cardiac Tool Box (ECTB), 4DM (Fourth Dimension) SPECT by INVIA, or vendor-specific integrated software (like GE's Xeleris Workstation). The utility of AI-based interpretation tools in nuclear cardiology is noteworthy. These tools not only improved diagnostic accuracy but also facilitated the detection of subtle perfusion abnormalities that may be missed during conventional reads. Such technologies are poised to enhance personalized care in cardiovascular medicine, especially in resource-limited or outpatient settings.

Conclusion

This case underscores the critical need for a comprehensive, multimodal approach in managing cardiometabolic diseases in elderly South Asian patients. The integration of advanced diagnostic tools including wearable ECG monitors, stress testing, and AI-assisted nuclear imaging allowed for detailed evaluation of cardiac function and ischemic risk. Although transient ST-segment depressions were noted, no active ischemia was detected, highlighting the value of corroborative imaging in clinical decision-making. Personalized pharmacologic management, combined with lifestyle modification and continuous monitoring, has enabled this patient to maintain stable cardiovascular health despite his advanced age and high baseline risk. This case further supports the role of AI in modern cardiology and calls for its broader integration into diagnostic workflows for high-risk populations.

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