RESEARCH ARTICLE

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Evaluation of the Relationship Between HATCH Score and SYNTAX Score in Patients Undergoing Coronary Angiography

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Abstract

Background and Aim: Originally developed to predict the progression of paroxysmal atrial fibrillation, the hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points) (HATCH) score has recently been explored as a broader prognostic tool in cardiovascular medicine. This study investigates the relationship between the HATCH score and the Synergy between PCI with Taxus and Cardiac Surgery (SYNTAX) score, a well-established measure of coronary artery disease (CAD) complexity, among patients with chronic coronary syndrome (CCS).

Materials and Methods: We retrospectively analyzed data from 235 patients who underwent coronary angiography for suspected CAD between January 2023 and May 2024. Patients were categorized into two groups based on their SYNTAX scores: low (≤22) and intermediate-high (>22). Demographic, clinical, and laboratory parameters—including the HATCH score—were compared between groups. Univariate analyses and Firth's penalized logistic regression were performed to identify independent predictors of higher SYNTAX scores. Receiver operating characteristic (ROC) analysis was used to evaluate the discriminative performance of the HATCH score.

Results: Patients with intermediate-high SYNTAX scores were significantly older, were more likely to have hypertension, heart failure, prior percutaneous coronary intervention, and renal dysfunction, and had lower left ventricular ejection fraction than those with low SYNTAX scores. Among all evaluated variables, the HATCH score emerged as the strongest independent predictor of intermediate-high coronary complexity [odds ratio: 3.815; 95% confidence interval (CI): 2.656-4.233; $P < 0.001$]. ROC analysis demonstrated good discriminative capacity, with an area under the curve of 0.805 (95% CI: 0.740-0.870; $P < 0.001$). A HATCH score cut-off of ≥2 yielded a specificity of 87% and a sensitivity of 72%.

Conclusion: The HATCH score, based on accessible clinical parameters, is independently associated with CAD complexity in CCS patients. Its simplicity and high specificity make it a useful tool for early risk stratification in clinical practice. Prospective multicenter studies are needed to validate its prognostic value and clinical utility.

Keywords: HATCH score, SYNTAX score, chronic coronary syndrome, coronary artery disease

INTRODUCTION

The term "chronic coronary syndromes (CCS)" refers to a framework introduced by the European Society of Cardiology in 2019 to replace the term "stable coronary artery disease (CAD)". This conceptual shift acknowledges the evolving and multifaceted nature of CAD, which is now understood not as a static entity but as a progressive and dynamic condition. CCS encompasses various clinical scenarios, including individuals presenting with suspected CAD who exhibit exertional angina and/or dyspnoea that remain stable over time.[1] Within the

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broader population of individuals diagnosed with coronary heart disease (CHD), approximately 30-36% are hospitalized for chronic manifestations of CHD.[2]

Invasive diagnostic strategies remain pivotal in assessing cardiovascular disease, as they provide comprehensive and irreplaceable information regarding both coronary anatomy and the physiological significance of coronary lesions. Despite advances in non-invasive imaging modalities, such approaches are not currently considered viable alternatives, because they do not match the diagnostic accuracy and therapeutic guidance provided by invasive evaluation.[1,3]

Multivessel CAD (MV-CAD) refers to the coexistence of hemodynamically significant atherosclerotic lesions in two or more major epicardial coronary arteries. This condition typically involves substantial luminal narrowing, most often defined as ≥50% stenosis, affecting epicardial coronary arteries, such as the left anterior descending artery, the right coronary artery, or the left circumflex artery. The presence of MV-CAD across various clinical presentations, including acute and CCS, is of critical importance for therapeutic decision-making and survival outcomes.[4-6] Given the paramount clinical significance of MV-CAD in cardiology practice, the Synergy between percutaneous coronary intervention (PCI) with Taxus and Cardiac Surgery (SYNTAX) score was developed to objectively quantify the anatomical complexity of CAD.[7]

de Vos et al.[8] introduced the hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points) (HATCH) score, a clinically practical and easily applied risk stratification tool developed to estimate the likelihood that atrial fibrillation will progress from paroxysmal to persistent. The score is an acronym derived from five key clinical variables: hypertension (HTN), age >75 years, transient ischemic attack or stroke, chronic obstructive pulmonary disease (COPD), and heart failure (HF).[8] In addition to its established role in forecasting the progression of atrial fibrillation, the HATCH score has emerged as a significant prognostic indicator of adverse clinical outcomes, including mortality and hospitalization, in patients with HF, regardless of the presence of atrial fibrillation.[9] Building upon the growing evidence supporting the HATCH score as a potential prognostic marker beyond its original application in atrial fibrillation, we designed our study to explore its relevance within the context of CCS. Specifically, our objective was to examine the relationship between the HATCH score and the SYNTAX score. We evaluated whether the HATCH score, composed of readily obtainable clinical parameters, could reflect the burden and severity of coronary atherosclerosis, as represented by the SYNTAX score, in patients with CCS.

METHODS

Study Population

This retrospective study included consecutive patients admitted to our tertiary care center between January 2023 and May 2024. Eligible participants were adults aged 18 years or older who underwent coronary angiography due to clinical symptoms indicative of ischemic heart disease, abnormal findings on non-invasive stress testing suggestive of underlying CAD, or both. The exclusion criteria for this study included acute coronary syndrome on presentation, a history of coronary artery bypass graft surgery, angiographic findings showing of less than 50% coronary artery stenosis or angiographically normal coronary arteries, and lack of clinical or laboratory data.

Baseline clinical, demographic, and laboratory data were collected from the hospital's electronic health system. The study population was divided into two groups based on SYNTAX score: low and intermediate-high. Comparative analyses were conducted to evaluate differences in clinical and laboratory parameters, as well as the HATCH score, between the two groups.

Ethical approval for this study was obtained from the Ethics Committee of University of Health Science Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital our tertiary care institution (approval number: 2025-15-07, date: 20.08.2025). The study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki. Informed consent was obtained from all individual participants prior to their inclusion in the study.

Definitions

CCS was defined as a clinical spectrum that includes patients with suspected CAD who have "stable" anginal symptoms and/or dyspnoea, as well as asymptomatic and symptomatic patients more than 1 year after initial diagnosis or revascularization.[1]

The SYNTAX score, a validated measure of coronary anatomical complexity, was calculated from coronary angiograms acquired during hospitalization using the official SYNTAX score online calculator. Two cardiologists, blinded to the patients' clinical information, independently performed the scoring to minimize observer bias.[10]

The HATCH score was calculated by assigning 1 point for HTN, 1 point for age >75 years, 2 points for a history of stroke or transient ischemic attack, 1 point for COPD, and 2 points for HF. The total score was calculated as the sum of these components.[9]

Left ventricular ejection fraction (LVEF) was assessed using the modified Simpson's method by transthoracic echocardiography performed prior to coronary angiography.[11]

Statistical Analysis

The normality of the distributions of all continuous variables was assessed using the Kolmogorov-Smirnov test. Variables with a normal distribution were reported as mean ± standard deviation, and comparisons between groups were performed using the independent samples t-test. Non-normally distributed variables were summarized as median [interquartile range (IQR)] and compared using the Mann-Whitney U test. Categorical variables were summarized as frequencies and percentages and compared using the chi-square test or Fisher's exact test when appropriate. Univariable logistic regression was performed to identify potential predictors of an intermediate-to-high SYNTAX score. Variables that reached statistical significance in the univariable analysis were subsequently included in Firth's penalized logistic regression to reduce small-sample bias, avoid model overfitting, and identify independent predictors. Multicollinearity was assessed using the variance inflation factor, calculated from the corresponding standard logistic regression models. The correlation between the HATCH and SYNTAX scores was further examined using Spearman's rank correlation analysis. A receiver operating characteristic (ROC) curve analysis was performed to assess the predictive value of the HATCH score for SYNTAX score categories. A post-hoc power analysis was performed to assess the ability of the study to detect differences in HATCH score and in diabetes mellitus (DM) prevalence between patients with SYNTAX scores ≤22 and those with scores >22. The HATCH score differed significantly between the SYNTAX >22 and ≤22 groups [1.00 (0.00-1.00) vs 2.00 (1.00-2.00), $P < 0.001$], with an achieved statistical power of 0.92, indicating sufficient power to detect a true difference between groups. Although the prevalence of DM was higher in the SYNTAX >22 group than in the ≤22 group (55.6% vs. 43.1%), this difference did not reach statistical significance ($P = 0.107$). The post-hoc power analysis for DM revealed a low statistical power of 0.364, suggesting that the non-significant result may reflect an inadequate sample size rather than the absence of a true association. A *P*-value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (version 25.0; IBM Corp., Armonk, NY, USA) and R software (version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 235 patients were included in the study, of whom 181 (77.0%) had a SYNTAX score ≤22 (low SYNTAX group) and 54 (23.0%) had a SYNTAX score >22 (intermediate-high SYNTAX group). The median age was significantly higher in the intermediate-high SYNTAX group compared with the low SYNTAX group (68.5 vs. 61.0 years, respectively; $P < 0.001$). There were no statistically significant differences between the groups in sex distribution or body mass index. The prevalence of HTN was significantly higher among patients in the intermediate-high SYNTAX group compared with those in the low SYNTAX group (79.6% vs. 53.6%; $P = 0.001$). In addition, HF and a history of PCI were more prevalent in the intermediate-high SYNTAX group. In contrast, no statistically significant differences were observed between groups with respect to smoking status, DM, cerebrovascular disease, COPD, or statin use. Laboratory parameters, including hemoglobin, platelet and white blood cell counts, glucose, triglycerides, LDL cholesterol, uric acid, albumin, and C-reactive protein levels, were comparable between the two groups. However, urea and creatinine levels were significantly higher in the intermediate-high SYNTAX group than in the low SYNTAX group. LVEF was significantly lower in the intermediate-high SYNTAX group (50.0% vs. 60.0%; $P < 0.001$). The median HATCH score was 1.00 (IQR: 0.00-1.00) in the low SYNTAX group and 2.00 (IQR: 1.00-2.00) in the intermediate-high SYNTAX group, with a statistically significant difference between the groups ($P < 0.001$). A significant positive correlation was observed between the SYNTAX score and the HATCH score (r=0.633, $P < 0.001$), as determined by Spearman's correlation analysis. Baseline demographic, clinical, and laboratory parameters are summarized in Table 1.

Univariate logistic regression analysis identified several clinical and laboratory variables significantly associated with advanced SYNTAX scores (>22), indicative of greater CAD complexity. Specifically, older age, HTN, HF, history of PCI, and elevated serum urea and creatinine levels were significantly associated with a higher SYNTAX score. Conversely, LVEF exhibited a statistically significant inverse relationship with SYNTAX score, such that increased LVEF was associated with a lower SYNTAX score. Notably, the HATCH score was a robust predictor of intermediate-to-high SYNTAX scores, demonstrating a statistically significant association [odds ratio (OR): 4.298; 95% confidence interval (CI): 2.676-7.543; $P < 0.001$], indicating that higher HATCH scores substantially increase the likelihood of intermediate-to-high SYNTAX scores (Table 2).

Firth's penalized logistic regression was used to identify the independent predictors of intermediate-to-high SYNTAX scores. In model A, which included serum creatinine, prior PCI, LVEF, and the HATCH score, the HATCH score emerged as a strong and statistically significant predictor. The HATCH score was the strongest predictor of an intermediate-high SYNTAX score (OR: 3.815; 95% CI: 2.656-4.233; $P < 0.001$). Serum creatinine, prior PCI and LVEF were identified as additional independent predictors of an intermediate-to-high SYNTAX score. In model B, age, HTN, HF, prior PCI, creatinine, and LVEF were identified as independent predictors of intermediate-to-high SYNTAX scores (Table 3).

ROC curve analysis demonstrated that the HATCH score exhibited good discriminative capacity for predicting intermediate-high SYNTAX scores, as evidenced by an area under the curve of 0.805 ($P < 0.001$; 95% CI: 0.740-0.870). With a cut-off of 2, the HATCH score demonstrated a high specificity of 87%, highlighting its ability to accurately identify patients without advanced CAD. Sensitivity was moderate at 72%, reflecting a conservative detection approach with limited ability to identify all patients with complex coronary lesions (Figure 1). These metrics collectively reinforce the HATCH score's potential as a pragmatic instrument for nuanced risk stratification in CAD.

DISCUSSION

In this retrospective study of patients with CCS, we assessed the severity and extent of CAD using the SYNTAX score and examined its association with the HATCH score. The principal finding was that the HATCH score demonstrated a strong, independent association with intermediate-high SYNTAX scores, suggesting its potential utility in identifying patients at greater risk for anatomically complex CAD. In addition to the HATCH score, age, HTN, LVEF, creatinine, prior PCI and HF were independent predictors of advanced SYNTAX scores in our analysis. The HATCH score, age, HTN, creatinine, prior PCI and HF were positively associated with advanced SYNTAX scores, whereas LVEF demonstrated an inverse relationship with the complexity of CAD.

Table 1: Comparison of clinical, laboratory parameters and HATCH score between low and intermediate-high SYNTAX score groups

Variable	Overall, n=235 (IQR)	Low SYNTAX group, n=181 (IQR)	Intermediate-high SYNTAX, n=54 (IQR)	*P*-value
Age (years)	69.00 (63.00-69.00)	61.00 (55.00-68.00)	68.50 (62.00-73.00)	<0.001
Female gender	67 (28.5%)	49 (27.1%)	18 (33.3%)	0.371
BMI	28.45±4.80	28.40±4.63	28.64±5.38	0.896
Smoking	153 (65.1%)	121 (66.9%)	32 (59.3%)	0.304
DM	102 (43.4%)	78 (43.1%)	24 (44.4%)	0.861
HTN	140 (59.6%)	97 (53.6%)	43 (79.6%)	0.001
Stroke or TIA	7 (3.0%)	3 (1.7%)	4 (7.4%)	0.051
COPD	22 (9.4%)	14 (7.7%)	8 (14.8%)	0.179
HF	15 (6.4)	7 (3.9)	8 (14.8)	0.004
Prior PCI	66 (28.1)	42 (23.2)	24 (44.4)	0.002
ACEI/ARB	145 (617)	109 (60.2)	36 (66.7)	0.397
Statin	216 (91.9)	164 (90.6)	52 (96.3)	0.178
SYNTAX score	14.00 (10.00–22.00)	13.00 (9.00-16.75)	26.50 (24.50-35.00)	<0.001
Hemoglobin (g/dL)	13.53±1.71	13.63±1.69	13.20±1.73	0.132
Platelet (×10³/µL)	239.00 (201.00-288.50)	240.00 (204.00-287.00)	236.00 (191.50-293.25)	0.576
Neutrophil (×10³/µL)	4.74 (3.63-6.07)	4.74 (3.57-6.07)	4.78 (3.93-6.42)	0.532
Lymphocyte (×10³/µL)	2.01 (1.59-2.58)	2.09 (1.61-2.64)	1.93 (1.40-2.48)	0.107
Glucose (mg/dL)	111.90 (97.00-147.00)	110.50 (97.15-144.00)	114.95 (96.20-165.75)	0.717
Triglyceride (mg/dL)	158.00 (116.00-223.00)	161.50 (116.00-227.75)	149.50 (115.75-213.75)	0.879
LDL (mg/dL)	97.00 (74.00-134.62)	98.00 (74.00-137.00)	96.00 (79.00-122.50)	0.546
Urea (mg/dL)	33.50 (27.60-41.80)	32.70 (26.70-40.00)	39.30 (31.95-48.70)	0.001
Creatinine (mg/dL)	0.90 (0.78-1.06)	0.88 (0.77-1.05)	0.96 (0.79-1.29)	0.024
Uric acid	5.26 (4.35-6.34)	5.20 (4.27-6.27)	5.60 (4.71-6.65)	0.062
Albumin (g/L)	45.00 (42.10-47.10)	45.15 (42.17-47.17)	44.70 (42.00-46.90)	0.138
CRP (mg/L)	3.20 (1.60-7.25)	3.00 (1.40-7.05)	4.50 (2.00-8.10)	0.195
LVEF (%)	60.00 (50.00-60.00)	60.00 (55.00-60.00)	50.00 (40.00-60.00)	<0.001
HATCH score	1.00 (0.00-1.00)	1.00 (0.00-1.00)	2.00 (1.00-2.00)	<0.001

ACEI: Angiotensin-converting enzyme inhibitors, ARB: Angiotensin II receptor blockers, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, CRP: C-reactive protein, DM: Diabetes mellitus, HATCH: Hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points), HF: Heart failure, HTN: Hypertension, LDL: Low-density lipoprotein, LVEF: Left ventricular ejection fraction, IQR: Interquartile range, PCI: Percutaneous coronary intervention, SYNTAX: Synergy between PCI with Taxus and Cardiac Surgery, TIA: Transient ischemic attack

Table 2: Univariable logistic regression analysis for intermediate-high SYNTAX score

Variable	OR	95% CI	*P*-value
Age	1.093	1.049-1.139	<0.001
HTN	3.385	1.641-6.981	0.001
HF	4.323	1.490-12.542	0.007
Prior PCI	2.455	1.294-4.658	0.006
Urea	1.032	1.010-1.055	0.004
Creatinine	1.427	1.232-2.064	0.049
LVEF	0.907	0.870-0.945	<0.001
HATCH score	4.298	2.676-7.543	<0.001

CI: Confidence interval, HATCH: Hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points), HF: Heart failure, HTN: Hypertension, LVEF: Left ventricular ejection fraction, OR: Odds ratio, PCI: Percutaneous coronary intervention

Table 3: Firth's penalized logistic regression analysis for determing of independent predictors of intermediate-high SYNTAX score

Variable	OR	95% CI	*P*-value	VIF
Model A				
Creatinine	1.332	1.010-1.966	0.044	1.02
Prior PCI	2.568	1.989-6.667	0.043	1.04
LVEF	0.880	0.854-0.996	0.001	1.50
HATCH score	3.815	2.656-4.233	<0.001	1.53
Model B				
Age	1.096	1.045-1.149	<0.001	1.06
HTN	3.421	1.437-8.147	0.005	1.06
HF	2.505	1.168-4.652	0.028	1.03
Prior PCI	2.613	1.340-4.720	0.008	1.04
Creatinine	1.537	1.012-2.334	0.044	1.02
LVEF	0.887	0.844-0.932	<0.001	1.03

CI: Confidence interval, HATCH: Hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points), HF: Heart failure, HTN: Hypertension, LVEF: Left ventricular ejection fraction, OR: Odds ratio, PCI: Percutaneous coronary intervention, VIF: Variance inflation factor

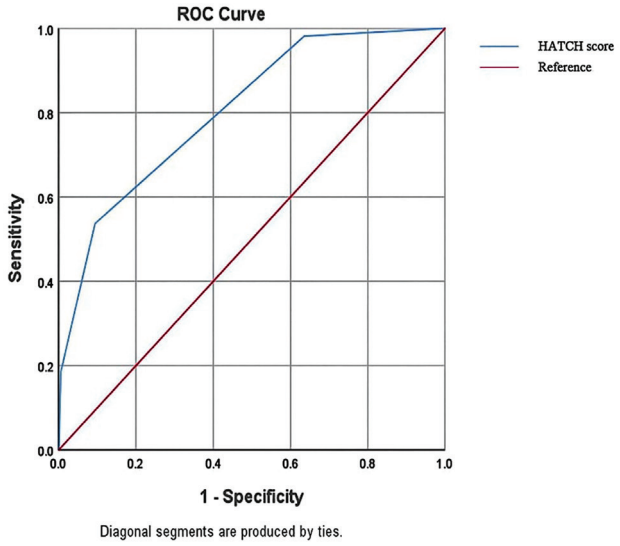

Figure 1: Receiver operating characteristic (ROC) curve analysis of HATCH score for predicting intermediate-high SYNTAX score

AUC: Area under the curve, CI: Confidence interval, HATCH: Hypertension (1 point), age >75 years (1 point), transient ischemic attack or stroke (2 points), chronic obstructive pulmonary disease (1 point), heart failure (2 points), SYNTAX: Synergy between PCI with Taxus and Cardiac Surgery

MV-CAD constitutes a significant clinical challenge requiring thorough evaluation in contemporary cardiology practice. Its presence markedly influences both procedural success in interventional cardiology and patients' long-term prognosis. Sorajja et al.[12] reported that among patients presenting with acute myocardial infarction, procedural success rates tended to decline incrementally in those with two- and three-vessel CAD compared with those with single-vessel involvement, although this trend did not reach statistical significance. In the same study, mortality rates increased incrementally in patients with two- and three-vessel disease compared with those with single-vessel disease; this difference was statistically significant.[12] The detrimental effect of MV-CAD on clinical outcomes extends beyond the setting of acute myocardial infarction. In the study conducted by Lopes et al.[13] MV-CAD was identified as an independent predictor of mortality in patients with stable CAD; its presence was associated with a 1.9- to 3.1-fold increase in long-term mortality risk.

Given the substantial clinical implications of MV-CAD, the identification of its associated risk factors has become increasingly important. Identified risk factors for the development of MV-CAD encompass a range of demographic, clinical, and metabolic variables. These include age, male sex, HTN, DM, lipid metabolism disorders, chronic kidney disease, and a history of myocardial infarction.[14] In our study, age and HTN were identified as independent predictors of more-advanced CAD, defined by an intermediate-high SYNTAX score.

Beyond the well-established traditional cardiovascular risk factors, COPD has increasingly been recognized as a meaningful contributor to the burden of CAD. COPD is no longer viewed solely as a pulmonary condition; emerging evidence points to a significant association between COPD and MV-CAD. This association may arise not only from the shared risk factor, tobacco smoking, but also from systemic inflammation and oxidative stress that characterize both conditions and critically contribute to the progression of vascular disease.

Consistent with expectations, accumulating evidence suggests a significant association between COPD and MV-CAD.[15-18]

Ischemic stroke is a clinical manifestation within the spectrum of atherosclerotic cardiovascular disease. Owing to their common atherosclerotic pathophysiology and overlapping risk factors, a bidirectional relationship between CAD and ischemic stroke has been well established in the literature. Notably, individuals with a prior history of stroke exhibit a significantly increased risk of developing CAD, while patients already diagnosed with CAD are likewise at increased risk of subsequent ischemic stroke.[19,20] Furthermore, findings from a registry study have highlighted a robust association between MV-CAD and ischemic stroke, underscoring the clinical relevance of both conditions, which share common pathophysiological mechanisms and overlapping risk factors.[20]

An additional clinical parameter that merits thorough consideration in the context of MV-CAD is left ventricular function. Accumulating evidence from multiple studies indicates that patients with a decline in left ventricular systolic performance, as quantified by reduced LVEF, are more likely to have MV-CAD.[21,22] Indeed, in our study, an inverse relationship was observed between LVEF and intermediate-high SYNTAX scores. Specifically, as LVEF decreased, the likelihood of detecting more complex CAD increased. This association may be explained by the involvement of a larger myocardial territory subjected to ischemia, which consequently leads to systolic dysfunction. The relationship between MV-CAD and left ventricular systolic function extends beyond LVEF. Indeed, Bruno et al.[23] demonstrated that complete revascularization in patients with MV-CAD significantly reduced hospitalizations for HF.

A comprehensive evaluation of the current scientific evidence reveals that several key clinical conditions—including advanced age, HTN, cerebrovascular accident, COPD, and HF—are significantly associated with the presence of MV-CAD. By integrating these five clinical variables, the HATCH score provides a comprehensive yet straightforward method for predicting the severity and anatomical complexity of MV-CAD. The HATCH score's simplicity, cost-effectiveness, and reliance on routinely available clinical parameters render it a valuable tool for broad implementation in clinical practice. By consolidating multiple high-risk comorbid conditions into a unified scoring system, it is possible to facilitate the early identification of individuals at increased risk for anatomically complex CAD. This enables clinicians to adopt a more timely, evidence-based, and individualized management approach, thereby potentially improving both short- and long-term cardiovascular outcomes.

Although the HATCH score was originally developed to estimate the likelihood of progression from paroxysmal to sustained atrial fibrillation, several of its constituent variables are also relevant to CAD. Specifically, HTN and advanced age—both well-established major risk factors for CAD—and a history of transient ischemic attacks or cerebrovascular events, which represent clinical manifestations within the broader cardiovascular disease spectrum, have been associated with the presence and severity of CAD. Moreover, these factors may contribute to vascular aging, further linking the HATCH score components to coronary complexity. This pathophysiological overlap provides a biologically plausible rationale for investigating the potential utility of the HATCH score in the assessment of coronary complexity, although rigorous validation in this context remains necessary.

Study Limitations

This study has several limitations that warrant careful consideration. Firstly, its retrospective, observational, and single-center architecture intrinsically constrains external generalizability, as the results may not extrapolate to broader, heterogeneous populations or disparate clinical milieus. Second, although the HATCH score incorporates several well-established cardiovascular risk factors, it does not account for other potentially influential contributors to coronary complexity, such as inflammatory status, genetic predisposition, or lifestyle-related variables. Third, the unequal distribution across the SYNTAX groups (low SYNTAX group: 181 patients; intermediate-high SYNTAX group: 54 patients) may have limited the statistical power to detect differences in the smaller group and may have affected the robustness of the multivariable analysis. Additionally, the study lacked an independent validation cohort, and no sensitivity analyses were conducted to assess the robustness and reproducibility of the findings. Another limitation is that internal validation techniques, including cross-validation or bootstrapping, were not employed, limiting the assessment of model stability. Moreover, potential selection bias may have influenced the findings, as the study population was derived from a single-center retrospective cohort. Lastly, the absence of long-term follow-up data precludes any assessment of the prognostic implications of the HATCH score, particularly in relation to adverse cardiovascular outcomes.

CONCLUSION

In conclusion, this investigation elucidates that the HATCH score has a strong and independent association with intermediate-high SYNTAX scores, underscoring its utility as a pragmatic and integrative tool for appraising the anatomical complexity of CAD in patients with CCS. Beyond conventional determinants such as advancing age or HTN, the HATCH score integrates multiple clinical risk factors into a single accessible metric, thereby enhancing the clinician's capacity to identify individuals at increased risk of multivessel involvement at an early stage. Its simplicity, cost-effectiveness, and reliance

on routinely procured clinical data support its incorporation into cardiovascular assessment paradigms. Nonetheless, the generalizability of these findings necessitates corroboration in large, prospective, multicenter cohorts, alongside exploration of their prognostic implications for long-term clinical trajectories.

Ethics

Ethics Committee Approval: Ethical approval for this study was obtained from the Ethics Committee of University of Health Science Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital our tertiary care institution (approval number: 2025-15-07, date: 20.08.2025). The study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki.

Informed Consent: Informed consent was obtained from all individual participants prior to their inclusion in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.A., C.Y., Concept: E.A., C.Y., Design: E.A., C.Y., Data Collection or Processing: E.A., C.Y., Analysis or Interpretation: E.A., C.Y., Literature Search: E.A., C.Y., Writing: E.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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