ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

# Usefulness of HATCH score as a predictor of atrial fibrillation after coronary artery bypass graft

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## Abstract

**Background:** Atrial fibrillation (AF) after coronary artery bypass graft (CABG) surgery is associated with increased morbidity and mortality. The HATCH score was originally devised to predict the progression of paroxysmal AF to persistent AF.

**Aim:** To determine whether the HATCH score predicts the development of AF after CABG surgery.

**Methods:** The medical records of 284 consecutive patients, who underwent CABG surgery between January 2013 and December 2014, were retrospectively reviewed for the development of AF in the postoperative (POAF) period. The HATCH score, and clinical and echocardiographic parameters were evaluated for all patients.

**Results:** Seventy (25%) patients developed POAF. The HATCH scores were higher in the POAF group (2.8 ± 1.8 vs. 1.1 ± 1.2, $p < 0.001$). The area of the HATCH score under the curve in the receiver operating characteristics analysis was 773 (95% CI 706–841, $p < 0.001$). When the HATCH score was 2 or more as a threshold, there was for POAF 72% sensitivity and 75% specificity.

**Conclusions:** The results of the present study suggest that the HATCH score can be used to predict the development of POAF.

**Key words:** atrial fibrillation, coronary artery bypass graft surgery, predictor

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## INTRODUCTION

Atrial fibrillation (AF) is the most common arrhythmia occurring after coronary artery bypass graft (CABG) surgery, developing in approximately 15–30% of patients [1–5]. The development of AF is extremely common after cardiac surgery and is associated with longer intensive care unit and hospital stays, increased morbidity and mortality, and higher utilisation of healthcare resources [6–11]. For these reasons, it is of utmost importance to identify patients who are at risk for the development of postoperative AF (POAF), and to take due precautions in the preoperative period.

Studies have identified several clinical, anatomical, and molecular risk factors that may have an effect on the development of AF after cardiac surgery [12–14]. Among these, age, heart failure (HF), rheumatic heart disease, chronic kidney disease, and chronic obstructive pulmonary disease (COPD) are the most prominent clinical risk factors [8, 15]. The predictive value of these risk factors depends on the results of various studies, and different risk factors have been emphasised in different studies. Thus, there is no simple and applicable risk classification for prediction of the development of POAF. The HATCH score was originally devised to predict the progression of paroxysmal AF to persistent AF [16]. The aim of the present study was to determine whether the HATCH score predicts the development of AF after CABG surgery.

## METHODS

The study group consisted of 284 consecutive patients who underwent on-pump CABG surgery between January 2013 and December 2014. Patient data were retrospectively

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analysed for the development of AF in the postoperative period up to discharge. The study was approved by the Local Ethics Committee.

### *Definition of postoperative AF*

Patients were monitored using a heart rhythm monitor in the intensive care unit. In addition, daily electrocardiographic (ECG) recordings were obtained during the hospital stay both in the intensive care unit and in the regular ward. Additional ECG recordings were obtained if patients reported palpitations or similar complaints. New-onset postoperative AF (as classified by the Society of Thoracic Surgeons) was defined as AF or atrial flutter occurring in the postoperative period and requiring medical treatment (beta-blocker, calcium channel blocker, amiodarone, anticoagulants, and cardioversion) [17]. Patients who developed AF in the postoperative period up to discharge were included in the POAF group.

Patient data, including age, gender, history of hypertension (HT), chronic kidney disease (glomerular filtration rate less than 60 mL/min/1.73 $m^2$ according to the Modification of Diet in Renal Disease Study Equation), diabetes mellitus (DM), HF, COPD, congenital heart disease, valvular heart disease, liver disease, stroke, thyroid disease, preoperative drug use (angiotensin converting enzyme [ACE] inhibitors, beta-blockers, and statins) and echocardiographic variables such as ejection fraction (EF), left atrial diameter (LAD), and the presence of valvular disease were retrospectively retrieved from the medical charts and included in the analysis.

### *Echocardiographic examination*

All patients underwent transthoracic echocardiography using an iE33 (Philips Medical Systems, Andover) echocardiography device and Mass S5 probe (2–4 MHz). Standard two-dimensional (2D) and colour flow Doppler views were acquired according to the guidelines of the American Society of Echocardiography and the European Society of Echocardiography [18, 19]. Ejection fraction was measured according to Simpson's method. LAD in parasternal long axis view was measured using 2D echocardiography at the end of the left ventricular systole.

Patients with paroxysmal or persistent AF, patients who were receiving antiarrhythmic medications, and those who underwent pharmacological or electrical cardioversion before CABG surgery for reasons other than AF, patients who underwent re-do CABG surgery, and other cardiac procedures in addition to CABG or who were planned to undergo emergency surgery, and patients who had significant valvular disease or prosthetic valvular disease were excluded from the study.

The HATCH score was calculated based on the presence of HT (1 point), age over 75 (1 point), transient ischaemic attack or stroke (2 points), COPD (1 point), HF (EF ≤ 40%) (2 points) and $CHA_2DS_2$-VASc score (HF [1 point], HT [1 point], age 65–75 years [1 point], DM [1 point], vascular disease [1 point], age over 75 years [2 points], and stroke [2 points]).

### *Statistical analysis*

Statistical analysis was performed using the SPSS (version 15.0, SPSS Inc., Chicago, Illinois) software package. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as percentage (%). The Kolmogorov-Smirnov test was used to evaluate the distribution of variables. Student's t-test was used to evaluate continuous variables showing normal distribution, and the Mann-Whitney U-test was used to evaluate variables that did not show normal distribution. The predictive values of $CHA_2DS_2$-VASc and HATCH score were evaluated using receiver operating characteristics (ROC) curve analysis. The cut-off value for HATCH score in predicting POAF was also calculated. A p value < 0.05 was considered statistically significant.

## RESULTS

The present study included 284 consecutive patients, 70 (25%) of whom developed POAF. The median time for POAF occurrence was 2.1 days (interquartile range 1.8–3.1 days). The mean length of hospital stay was longer in patients that developed POAF (10 ± 2 vs. 7 ± 1.9 days, $p < 0.001$).

The main characteristics of patients who developed postoperative AF and those who did not develop POAF are presented in Table 1. The patients that developed POAF were older, and the prevalence of cardiovascular risk factors such as HT, DM, and peripheral artery disease were higher and COPD was more common in these patients ($p < 0.05$). The patients who developed POAF had lower EF (≤ 40%) and larger LAD (≥ 35 mm). The two groups were comparable in terms of laboratory parameters and drug use. The HATCH and $CHA_2DS_2$-VASc scores were higher in the POAF group ($p < 0.001$).

The area of the $CHA_2DS_2$-VASc score under the curve in the ROC analysis was (AUC) 0.713 (95% confidence interval [CI] 0.642–0.784, $p < 0.001$), and the area of the HATCH score was AUC 773 (95% CI 706–841, $p < 0.001$). When the HATCH score was 2 or more as a threshold, there was for POAF 72% sensitivity, 75% specificity (Fig. 1).

## DISCUSSION

Atrial fibrillation is the most common complication occurring after POAF [1]. Despite advances in cardioplegic arrest and surgical techniques, AF incidence has paradoxically increased in recent years as a result of surgical patients being older and sicker, and due to advances in continuous ECG monitoring technology. POAF is frequently not well tolerated, and patients may have symptoms that include haemodynamic instability, thromboembolic events, and dyspnoea or chest discomfort [8]. This has also been shown to increase hospital costs and to lengthen the hospital stay [12, 13]. Therefore, preoperative risk stratification of surgical patients for the occurrence of POAF is very important.

The present study was the first to evaluate the predictive value of the HATCH score in the development of POAF.

Table 1. Preoperative clinical values and characteristics of patients who developed atrial fibrillation (AF) and those who did not develop AF after coronary artery bypass graft surgery

| | Patients with AF (n = 70 [25%]) | Patients without AF (n = 214 [75%]) | P |
|---|---|---|---|
| Age [years] | 70 ± 9 | 61 ± 9 | < 0.001 |
| Women | 20 (29%) | 51 (24%) | 0.427 |
| Length of hospital stay [days] | 10 ± 2 | 7 ± 1.9 | < 0.001 |
| Hypertension | 54 (77%) | 119 (56%) | 0.001 |
| Diabetes mellitus | 44 (63%) | 98 (46%) | 0.013 |
| CVE/TIA | 12 (17%) | 22 (10%) | 0.125 |
| COPD | 29 (41%) | 45 (21%) | 0.001 |
| Peripheral artery disease | 17 (24%) | 30 (14%) | 0.045 |
| Ejection fraction ≤ 40% | 34 (47%) | 26 (12%) | < 0.001 |
| Left atrial diameter ≤ 35 mm | 49 (70%) | 81 (38%) | < 0.001 |
| Chronic kidney disease | 3 (4%) | 15 (7%) | 0.408 |
| Beta-blocker | 69 (99%) | 198 (93%) | 0.064 |
| ACE-I/ARB | 23 (33%) | 56 (26%) | 0.278 |
| Statin | 49 (70%) | 123 (58%) | 0.063 |
| HATCH | 2.8 ± 1.8 | 1.2 ± 1.2 | < 0.001 |
| $CHA_2DS_2$-VASc | 4.4 ± 1.9 | 3.1 ± 1.7 | < 0.001 |

ACE-I/ARB — angiotensin converting enzyme inhibitor/angiotensin receptor blocker; $CHA_2DS_2$-VASc — Congestive heart failure, Hypertension, Age (65 years or over), Diabetes mellitus, 75 years or over (2 points), Stroke (2 points), Vascular disease; CVE/TIA — cerebrovascular event/transient ischaemic attack; COPD — chronic obstructive pulmonary disease; HATCH — Hypertension, Age (75 years or over), Transient ischaemic attack or stroke (2 points), Chronic obstructive pulmonary disease, Heart failure (2 points)

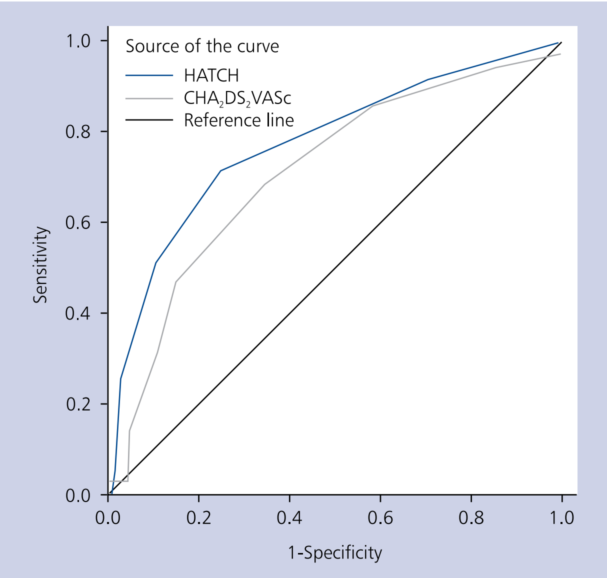


Figure 1. Predictive values of $CHA_2DS_2$VASc and HATCH score determined using receiver operating characteristics curve analysis

Previous studies have suggested several parameters for predicting the development of POAF [20, 21]. These were defined as preoperative, intraoperative, and postoperative parameters in these studies. The present study focused on preoperative parameters. In previous studies, advanced age, male gender, chronic HF, preoperative AF attacks, COPD, chronic renal disease, DM and rheumatic heart disease, metabolic syndrome, obesity, and inefficient beta-blocker or ACE inhibitor use were reported to be preoperative clinical parameters predicting the development of POAF [12–15]. In addition to these parameters, p-wave duration on ECG and elevated levels of B-type natriuretic peptide in the preoperative period also predicted the development of POAF [22–24]. However, the predictive values of these parameters vary between the studies. This discrepancy stems from the fact that different parameters have been analysed in each of these studies; there were also differences between the studies in terms of patient population, study design, and follow-up methods used.

Another variable that was evaluated in this study was the $CHA_2DS_2$-VASc score. Despite the fact that the $CHA_2DS_2$-VASc score carries common variables with the HATCH score, it is not as valuable as the HATCH score in the prediction of POAF, the reason for this being that HATCH score includes patients with more advanced age (75 years or older), patients with EF < 40%, and patients with COPD. In addition, patients with HF receive 2 points in the HATCH score, and this results in the use of a different grading scale than for the $CHA_2DS_2$-VASc score.

The HATCH scoring system is comprised of clinical parameters that can easily be calculated. Hypertension, age, COPD, HF, and ischaemic cerebrovascular events are included in the HATCH score. In this scoring system, HF and stroke receive 2 points while other parameters receive 1 point. These risk factors are associated with the distention and dilatation of the atrium and they result in chronic structural remodelling (cellular hypertrophy, proliferation of fibroblasts and tissue fibrosis) of the atrium. This remodelling process makes the atrium vulnerable to increased adrenergic stress and dynamic volume changes and increases the risk of developing POAF. Each parameter in the HATCH score is important for the development of POAF and causes left atrium dilation in the long term. For these reasons, the HATCH score is a valuable parameter for the prediction of POAF.

The HATCH score was defined for the first time by De Vos et al. [16]. They identified independent variables for the development of persistent AF after a one-year follow-up period in patients with paroxysmal AF, and they found that the HATCH score was the most important predictor. According to the results of this study, the HATCH score predicts the development of POAF with high accuracy. This scoring system utilises clinical parameters easily calculated in the clinical setting, and it does not require additional laboratory examinations. It is a very useful tool in the detection of high-risk patients for the development of AF after CABG surgery. The HATCH score can be used in the planning of preoperative drug therapy and other measures to be taken to prevent POAF.

### *Limitations of the study*

A major limitation of the present study was that AF was diagnosed by ECG monitoring in a hospital setting without performing a follow-up after discharge. Another limitation of the study was the lack of an independent cohort to validate the findings of the study. The retrospective study design and lack of follow-up after discharge are other limitations of the study. Patients who developed postoperative AF episodes in the short-term period might have been mistakenly included in the group of patients without POAF due to lack of continuous ECG monitoring.

Although this is the first study to show that the HATCH score has a predictive value in the development of POAF, further prospective studies with a larger number of patients are required due to the relatively small number of patients in the present study. Another limitation of the study is that LAD was measured from the parasternal long axis view and there was no data on left atrial volume.

## CONCLUSIONS

The present study suggest that the HATCH score can be used to predict the development of POAF. Therefore, it can be used in planning preoperative drug therapy and other measures to be taken to prevent POAF.

***Conflict of interest:*** *none declared*

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# Przydatność skali HATCH w prognozowaniu wystąpienia migotania przedsionków po zabiegu pomostowania aortalno-wieńcowego

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## Streszczenie

**Wstęp:** Migotanie przedsionków (AF) po zabiegu pomostowania aortalno-wieńcowego (CABG) wiąże się ze zwiększoną chorobowością i śmiertelnością. Skala HATCH została opracowana pierwotnie w celu prognozowania progresji napadowego AF do przetrwałego AF.

**Cel:** Celem niniejszego badania było określenie, czy skala HATCH umożliwia ocenę ryzyka rozwoju AF po zabiegu chirurgicznym (CABG).

**Metody:** Dokumentację medyczną 284 kolejnych chorych poddanych CABG w okresie od stycznia 2013 r. do grudnia 2014 r. przeanalizowano retrospektywnie pod kątem rozwoju AF w okresie pooperacyjnym (POAF, *AF in the postoperative period*). U wszystkich pacjentów oceniono wskaźnik HATCH oraz parametry kliniczne i echokardiograficzne.

**Wyniki:** Wystąpienie POAF odnotowano u 70 (25%) chorych. Wskaźnik HATCH był wyższy w grupie POAF (2,8 ± 1,8 vs. 1,1 ± 1,2; p < 0,001). Pole pod krzywą (AUC) dla wskaźnika HATCH w analizie krzywych ROC wynosiło 773 (95% CI: 706–841; p < 0,001). Dla wartości wskaźnika HATCH większych lub równych wartości granicznej wynoszącej 2 czułość i swoistość w prognozowaniu POAF określono na, odpowiednio, 72% i 75%.

**Wnioski:** Wyniki przedstawionego badania wskazują, że skala HATCH może być przydatna w prognozowaniu ryzyka rozwoju POAF.

**Słowa kluczowe:** migotanie przedsionków, pomostowanie tętnic wieńcowych, czynnik predykcyjny

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