The role of HATCH score in predicting the success rate of sinus rhythm following electrical cardioversion of atrial fibrillation

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Abstract

Background: The HATCH score predicts the development of persistent and permanent atrial fibrillation (AF) one year after spontaneous or pharmacological conversion to sinus rhythm in patients with AF. However, it remains unknown whether HATCH score predicts short-term success of the procedure at early stages for patients who have undergone electrical cardioversion (EC) for AF.

Aim: The present study evaluated whether HATCH score predicts short-term success of EC in patients with AF.

Methods: The study included patients aged 18 years and over, who had undergone EC due to AF lasting less than 12 months, between December 2011 and October 2013. HATCH score was calculated for all patients. The acronym HATCH stands for Hypertension, Age (above 75 years), Transient ischaemic attack or stroke, Chronic obstructive pulmonary disease, and Heart failure. This scoring system awards two points for heart failure and transient ischaemic attack or stroke and one point for the remaining items.

Results: The study included 227 patients and short-term EC was successful in 163 of the cases. The mean HATCH scores of the patients who had undergone successful or unsuccessful EC were 1.3 ± 1.4 and 2.9 ± 1.4, respectively (p < 0.001). The area of the HATCH score under the curve in receiver operating characteristics analysis was (AUC) 0.792 (95% CI 0.727–0.857, p < 0.001). A HATCH score of two and above yielded 77% sensitivity, 62% specificity, 56% positive predictive value, and 87% negative predictive value in predicting unsuccessful cardioversion.

Conclusions: HATCH score is useful in predicting short-term success of EC at early stages for patients with AF, for whom the use of a rhythm-control strategy is planned.

Key words: HATCH score, cardioversion, atrial fibrillation

INTRODUCTION

Atrial fibrillation (AF) is the most common type of cardiac arrhythmia encountered in clinical practice [1]. AF can result in death, stroke, heart failure (HF), a decrease in exercise capacity, left ventricular dysfunction, and a decrease in the quality of life of the patient [2, 3]. AF is therefore regarded as one of the major public health problems.

The selection of either rate or rhythm control therapies plays an important role together with the treatment of AF, as stated in the latest European Society of Cardiology guidelines...
HATCH score and cardioversion success

HATCH score predicts short-term success of EC in patients with paroxysmal and persistent AF.

**METHODS**

This retrospective consecutive study was designed for patients aged 18 and over, who had undergone EC due to paroxysmal and persistent AF between the dates of October 2011 and November 2013. Paroxysmal AF was defined as AF lasting up to 7 days. Persistent AF was defined as an AF episode lasting longer than 7 days or requiring termination by cardioversion. Patients with AF lasting more than 12 months were not evaluated. Also, patients using anti-arrhythmic drugs were not evaluated due to an important difference in the treatment process and the success of cardioversion between pharmacological and electrical cardioversion.

Transoesophageal echocardiography was performed in patients who had AF more than 48 h before the EC process. EC was not applied to patients who had thrombus in the left atrium (LA) or left atrial appendage (LAA), and these patients were excluded from the study. A total of 351 patients were assessed. Forty-one of these patients had a history of AF lasting more than 12 months, 22 had thrombus in the LA or LAA, but the AF onset of 61 patients was not clearly known. Thus, these patients were excluded from the study, and a total of 227 patients were included in the study.

**Electrical cardioversion**

After providing patients with detailed information and obtaining their written consent for the procedure, EC was performed after 6–8 h of fasting under deep sedation. Heart rhythm, oxygen saturation, and blood pressure were monitored and all equipment necessary for cardiopulmonary resuscitation was made available before the procedure. The device paddles were placed in anterolateral position to deliver a maximum of 200 joules of energy using a biphasic device. EC was not performed in patients with digitalis intoxication, electrolyte imbalance and those who had not received anticoagulant medications or appropriate sedation.

Patient data was retrieved from hospital records and the patients were then divided into two groups. After EC, the patients were followed with continuous electrocardiographic monitoring until hospital discharge. Those with regular sinus rhythm on electrocardiography at the one-week control were included in the successful cardioversion group whereas the remainder were included in the unsuccessful cardioversion group.

Patient age, gender, and past history of hypertension (HT), coronary artery disease (CAD), chronic kidney disease, diabetes, HF, pulmonary disease, valvular heart disease, liver disease, stroke, thyroid disease, and previous drug treatment were all obtained from the hospital records.

The HATCH score ([Hypertension (1 point), Age above 75 years (1 point), Transient ischaemic attack or stroke (2 points), Chronic obstructive pulmonary disease (1 point), Heart failure (2 points), CHA2DS2-VASc scores ([Heart failure (1 point), Hypertension (1 point), Age (age range 65–75 years —1 point), Diabetes (1 point), Vascular disorder (1 point), Age above 75 years (2 points), Stroke (2 points)], and age, presence of Diabetes Mellitus (DM), Hypertension (HT), Chronic Heart Failure (CHF), Ejection Fraction (EF), LA diameter, obesity, Obstructive Sleep Apnoea Syndrome (OSAS), pulmonary disease, valvular disease, congenital heart disease, hyperthyroidism, and drugs before the procedure (beta-blockers and calcium channel blockers) were all evaluated for their relationship to the short-term success of cardioversion.

**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 performed to test whether variables were normally distributed. Inter-group differences were evaluated using Student’s t-test for normally distributed continuous variables and using Mann-Whitney U-test for variables that did not show normal distribution. Chi-square tests were used for the comparison of categorical variables. The accuracy of the HATCH and CHA2DS2-VASc scores in predicting the short-term success of cardioversion and threshold values were evaluated with the receiver operating characteristics (ROC) curve. Area under curve (AUC) of HATCH and CHA2DS2-VASc were compared with the DeLong, DeLong, Clarke-Pearson method using Analyse-it 2.20 statistical software (Leeds, United Kingdom). In order to identify independent factors in predicting unsuccessful EC, multivariate analysis (logistic regression) was applied for variables in univariate analysis with p values < 0.20. Odds ratio (OR) and 95% confidence interval (CI) were calculated with standard methods. Other clinical parameters significant in the univariate analysis were not
evaluated in logistic regression analysis since these variables were included in the HATCH score. A p value < 0.05 was considered statistically significant.

**RESULTS**

In this study, a total of 227 patients were evaluated. Most of the patients had persistent AF (164, 72%). The mean age of the patients was 60 ± 14 years. 163 of the patients had a short-term successful cardioversion process, whereas 64 had an unsuccessful cardioversion process. 41 (64%) of the patients had an unsuccessful cardioversion immediately (within 5 min), 16 (25%) and 7 (11%) of those had converted the AF within 24 h and 7 days, respectively, after EC. Basic clinical characteristics of the patients can be seen in Table 1. It was observed that elderly age of the patient (p < 0.001), HT (p < 0.001), CHF (p < 0.001), OSAS (p = 0.031), valvular disease (OR 4.8, 95% CI 1.6–14.4, p = 0.005), and RAS — renin–angiotensin system

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Successful cardioversion (n = 163)</th>
<th>Unsuccessful cardioversion (n = 64)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>57 ± 14</td>
<td>68 ± 10</td>
<td>0.001</td>
</tr>
<tr>
<td>Women</td>
<td>61 (37%)</td>
<td>23 (36%)</td>
<td>0.655</td>
</tr>
<tr>
<td>Obesity (BMI ≥ 30 kg/m²)</td>
<td>40 (25%)</td>
<td>18 (28%)</td>
<td>0.577</td>
</tr>
<tr>
<td>AF duration (≤ 2 weeks)</td>
<td>49 (30%)</td>
<td>14 (22%)</td>
<td>0.215</td>
</tr>
<tr>
<td>AF duration (2 weeks – 3 months)</td>
<td>51 (31%)</td>
<td>24 (38%)</td>
<td>0.371</td>
</tr>
<tr>
<td>AF duration (3–12 months)</td>
<td>63 (39%)</td>
<td>24 (38%)</td>
<td>0.873</td>
</tr>
<tr>
<td>Paroxysmal AF</td>
<td>48 (29%)</td>
<td>15 (23%)</td>
<td>0.363</td>
</tr>
<tr>
<td>Persistent AF</td>
<td>115 (71%)</td>
<td>49 (77%)</td>
<td>0.363</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>36 (22%)</td>
<td>12 (19%)</td>
<td>0.770</td>
</tr>
<tr>
<td>Hypertension</td>
<td>68 (42%)</td>
<td>49 (77%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>46 (28%)</td>
<td>26 (41%)</td>
<td>0.071</td>
</tr>
<tr>
<td>Chronic heart failure</td>
<td>30 (18%)</td>
<td>34 (53%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>12 (7%)</td>
<td>19 (30%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Obstructive sleep apnoea syndrome</td>
<td>14 (9%)</td>
<td>12 (20%)</td>
<td>0.031</td>
</tr>
<tr>
<td>Valvular disease</td>
<td>23 (14%)</td>
<td>14 (21%)</td>
<td>0.154</td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>15 (9%)</td>
<td>4 (6%)</td>
<td>0.470</td>
</tr>
<tr>
<td>Hyperthyroidism</td>
<td>9 (6%)</td>
<td>4 (6%)</td>
<td>0.832</td>
</tr>
<tr>
<td>Stroke</td>
<td>6 (4%)</td>
<td>5 (8%)</td>
<td>0.192</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>51 ± 14</td>
<td>46 ± 13</td>
<td>0.005</td>
</tr>
<tr>
<td>Ejection fraction (&lt; 50%)</td>
<td>47 (29%)</td>
<td>40 (63%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Left atrial diameter (≥ 40 mm)</td>
<td>71 (44%)</td>
<td>44 (69%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>68 (42%)</td>
<td>34 (53%)</td>
<td>0.120</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>23 (14%)</td>
<td>12 (19%)</td>
<td>0.384</td>
</tr>
<tr>
<td>RAS blockers</td>
<td>57 (35%)</td>
<td>36 (56%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Statin</td>
<td>63 (39%)</td>
<td>33 (52%)</td>
<td>0.076</td>
</tr>
<tr>
<td>HATCH</td>
<td>1.3 ± 1.4</td>
<td>2.9 ± 1.4</td>
<td>0.001</td>
</tr>
<tr>
<td>CHA₂DS₂-VASc</td>
<td>1.7 ± 1.5</td>
<td>3.1 ± 1.1</td>
<td>0.001</td>
</tr>
</tbody>
</table>

AF — atrial fibrillation, BMI — body mass index, CHA₂DS₂-VASc — Heart failure (1 point), Hypertension (1 point), Age (age range 65–75 years — 1 point), Diabetes (1 point), Vascular disorder (1 point), Stroke (2 points), HATCH — Hypertension, Age (> 75 years), Transient ischaemic attack or stroke (2 points), Chronic obstructive pulmonary disease, Heart failure (2 points); RAS — renin–angiotensin system
HATCH score and cardioversion success

The predictive values of CHA2DS2-VASc and HATCH score determined using receiver operating characteristics (ROC) curve analysis

2.6, 95% CI 1.6–4.3, p < 0.001), LA diameter (OR 1.2, 95% CI 1.1–1.3, p = 0.005), EF (OR 1.13, 95% CI 1.07–1.20, p < 0.001) and age (OR 1.06, 95% CI 1.01–1.11, p = 0.010) remained as independent predictors of unsuccessful EC.

CHA2DS2-VASc (3.2 ± 1 vs. 1.7 ± 1.5, p < 0.001) and HATCH scores (2.9 ± 1.4 vs. 1.3 ± 1.4, p < 0.001) of patients who had unsuccessful EC were higher compared to patients who had successful EC. The area of the HATCH score AUC in the ROC analysis was 0.792 (95% CI 0.727–0.857, p < 0.001), and the AUC of the DS2-VASc score was 0.781 (95% CI 0.720–0.841, p < 0.001) (Fig. 1). The AUC of the HATCH score was not different from that of the CHA2DS2-VASc score (difference: 0.011–0.028–0.051, p = 0.57). When the HATCH score was two or greater as a threshold, it was found that the EC was unsuccessful, with 77% sensitivity, 62% specificity, 56% positive predictive value, and 87% negative predictive value. When the CHA2DS2-VASc score was three or greater as a threshold, EC was unsuccessful with 75% sensitivity, 71% specificity, 51% positive predictive value, and 88% negative predictive value.

DISCUSSION

This is the first study to evaluate HATCH score in predicting the short-term success of EC in patients with AF. According to the results of the current study, patients who underwent unsuccessful EC had significantly higher HATCH scores.

In previous studies, it has been stated that clinical parameters such as antiarrhythmic medication, valvular disease, statin, beta-blocker, and angiotensin converting enzyme/angiotensin receptor blocker (ACE/ARB) use before cardioversion, LA dilatation, pulmonary disease, cardiomyopathy, HT, body weight, duration of AF, and OSAS can be indicative for the success of cardioversion [7–18]. However, in this study only COPD, CHF, OSAS, valvular disease, HATCH score, LA diameter, EF, and age remained as independent predictors of unsuccessful EC. One of the reasons for these differences is that the use of statin, beta-blocker, and ACE/ARB was below the expectations of guidelines, which might have masked the protective effect of those drugs against AF. The other reason for these differences is that these risk factors were obtained from different studies, and also the onset time of AF, patient characteristics, evaluated clinical parameters, and criteria for EC success varied in these studies. Therefore, it is not possible to reach a firm conclusion about the actual predictive parameters and to determine a clear method for predicting the success of cardioversion. The HATCH score is an easy, simple, and practical scoring system that includes clinical variables that have been separately shown in previous studies to be risk factors for the failure of EC. Hypertension, age, pulmonary disease, HF, and ischaemic cerebrovascular diseases are the clinical parameters constituting the HATCH score. These underlying diseases might cause chronic stretch and atrial dilation, which appear to be important stimuli for chronic atrial structural remodelling (cellular hypertrophy, fibroblast proliferation, and tissue fibrosis) that causes unsuccessful cardioversion and maintenance of AF [19].

In the study by de Vos et al. [6], independent variables that could predict the development of persistent and permanent AF within a follow-up period of one year were evaluated in patients with paroxysmal AF, and they found the HATCH score to be the most significant parameter. A score of 2–4 points was considered to indicate moderate risk, and a HATCH score of five or more points was considered to indicate high risk for the development of persistent AF [6]. The HATCH score was also investigated in other studies for progression of paroxysmal to persistent AF and was found to be useful in the study carried out by Jahangir and Murarka [20] and modestly useful in studies performed by Potpara et al. [21] and Barret et al. [22]. The HATCH score was also evaluated for predicting the recurrence of AF after catheter ablation in studies carried out by Tang et al. [23], in which the score proved not to be useful. Miao et al. [24] and Schmidt et al. [25] demonstrated that with higher HATCH scores, AF recurrences after catheter ablation were more frequent. In the present study, we aimed to investigate the HATCH score in the short-term for predicting the success of cardioversion and found that when a HATCH score was two or more as a threshold, the EC was unsuccessful, with 77% sensitivity, 62% specificity, 56% positive predictive value, and 87% negative predictive value in predicting unsuccessful cardioversion. The results of this study revealed that HATCH score was not inferior to the CHA2DS2-VASc score. Despite including similar parameters, the HATCH score has
some differences from the CHA2DS2-VASc score. The HATCH score includes older patients (age > 75 years) compared to the CHA2DS2-VASc score (age > 65 years). In addition, unlike the CHA2DS2-VASc score, the HATCH score gives more importance to HF and COPD. The HATCH score includes COPD whereas the CHA2DS2-VASc score does not. Also, in the HATCH score two points are appointed to HF, whereas only one point is appointed to HF in the CHA2DS2-VASc score. Heart failure (OR 8.4, 95% CI 2–34.8, p = 0.003) and COPD (OR 14, 95% CI 3–57, p < 0.001) are the two most important variables predicting EC success in this study. Thus, we believe that these two parameters determine the success of HATCH score.

In the current retrospective study, the majority of patients in the study, who had scheduled EC directly before trying pharmacological cardioversion, had persistent AF. This may be due to the cumbersomeness and lower effectiveness of pharmacological cardioversion in patients with persistent AF. To some extent the study shows the real power of EC, without the influence of antiarrhythmic drugs. EC restored sinus rhythm in the vast majority of patients (72%), which is in accordance with earlier studies. The reason for this was that patients who were selected for EC were already expected to respond to the procedure. Despite this selection bias, the HATCH score was significantly different between patients who responded versus those who failed to respond to the cardioversion attempt.

The selection of rhythm-control versus rate-control strategies is of particular importance in patients with AF. However, there are no established rules determining which strategy would be more appropriate for each patient. Rhythm versus rate control strategies should be individualised. Therefore, antiarrhythmic therapy can be initiated before cardioversion attempt. Otherwise be redundantly exposed to unsuccessful EC at early stages. This scoring system can therefore be helpful in patients with AF before deciding on rhythm or rate control strategies.

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Conflict of interest: none declared

References
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Znaczenie wskaźnika HATCH w prognozowaniu skutecznego powrotu do rytmu zatokowego po kardiowersji elektrycznej z powodu migotania przedsiomków

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Streszczenie

Wstęp: Skala HATCH umożliwia prognozowanie rozwoju przetrwałego i utrwalonego migotania przedsiomków (AF) w ciągu roku po samoistnym lub spowodowanym leczeniem powrocie do rytmu zatokowego u chorych z AF. Nie wiadomo jednak, czy wskaźnik HATCH jest przydatny w określaniu prawdopodobieństwa powodzenia zabiegu w perspektywie krótkoterminowej we wczesnym stadium u pacjentów, których poddano kardiowersji elektrycznej (EC) z powodu AF.

Cel: Celem pracy była ocena, czy wskaźnik HATCH umożliwia prognozowanie wczesnego powodzenia EC u chorych z AF.

Metody: Do badania włączono chorych w wieku 18 i starszych, których w okresie od grudnia 2011 r. do października 2013 r. poddano EC z powodu AF występującego krócej niż 12 miesięcy. U wszystkich chorych obliczono wskaźnik HATCH. Akronim HATCH oznacza Hypertension (nadciśnienie tętnicze), Age (wiek, powyżej 75 lat), Transient ischaemic attack or stroke (przemijające niedokrwienie mózgu lub udar mózgu), Chronic obstructive pulmonary disease (przewlekła obturacyjna choroba płuc) i Heart failure (niewydolność serca). W tej skali niewydolność serca i przemijające niedokrwienie mózgu lub udar oznaczają 2 punkty, natomiast obecność każdego z pozostałych elementów — 1 punkt.

Wyniki: W badaniu uczestniczyło 227 chorych. W przypadku 163 z nich odnotowano powodzenie EC we wczesnym okresie po zabiegu. Średnie wartości w skali HATCH u chorych, u których przeprowadzono skuteczną i nieskuteczną EC, wynosiły odpowiednio 1,3 ± 1,4 i 2,9 ± 1,4 (p < 0,001). Pole pod krzywą (AUC) wskaźnika HATCH w analizie krzywych ROC wynosiło 0,792 (95% CI 0,727–0,857; p < 0,001). Wskaźnik HATCH ≥ 2 pozwalał na prognozowanie niepowodzenia kardiowersji, przy czym czułość tego parametru wynosiła 77%, swoistość — 62%, wartość predykcyjna dodatnia — 56%, a wartość predykcyjna ujemna — 87%.

Wnioski: Skala HATCH jest przydatna w prognozowaniu szans powodzenia EC we wczesnym okresie po zabiegu u chorych z AF, u których planuje się zastosowanie strategii kontroli rytmu serca.

Słowa kluczowe: skala HATCH, kardiowersja, migotanie przedsiomków

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