Association Between CHADS₂ Score and the Development of Interatrial Block

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Summary

Interatrial block (IAB) is associated with a multitude of medical conditions. The aim of this retrospective study was to investigate whether CHADS₂ (congestive heart failure, hypertension, age ≥ 75 years, diabetes mellitus, prior stroke) score is positively associated with the development of IAB. A total of 1072 patients (men, 555; women, 517; mean age, 61 ± 14 years) were included in the study. P-wave duration was measured manually using a caliper. IAB was defined as a P-wave duration of ≥ 120 ms on a 12-lead electrocardiogram. CHADS₂ scores were calculated retrospectively. Among the 1072 patients, the prevalence of IAB was 36.1% (387/1072). In multivariate analysis, increased CHADS₂ score (odds ratio [OR], 1.810; 95% confidence interval [CI], 1.577-2.077; \( P < 0.001 \)), coronary artery disease (OR, 1.536; 95% CI, 1.065-2.216; \( P = 0.022 \)), and increased left atrial diameter (OR, 1.039; 95% CI, 1.008-1.071; \( P = 0.013 \)) were independently associated with IAB. The percentages of patients with IAB among those with a CHADS₂ score of 0, 1, 2, 3, 4, 5, and 6 were 20.6%, 33.0%, 45.0%, 55.9%, 61.9%, 77.8%, and 100%, respectively (\( P < 0.001 \)). There was a greater percentage of patients with a CHADS₂ score of ≥ 2 with IAB compared with a CHADS₂ score of < 2 (26.5% vs 52.0%; \( P < 0.001 \)). In receiver operating curve (ROC) analysis, CHADS₂ score (area under the curve, 0.670; 95% CI, 0.636-0.704; \( P < 0.001 \)) was predictive of IAB. In conclusion, CHADS₂ score was significantly associated with the development of IAB in this study population.

Key words: P-wave duration

Interatrial block (IAB), a conduction delay between the right and left atria, is characterized by the presence of a prolonged P-wave that equals or exceeds 120 ms on a 12-lead electrocardiogram (ECG).¹ A recent review of the prevalence of IAB described this condition as being an under-appreciated clinical pandemic, particularly in the aging population.² IAB can be associated with a multitude of medical conditions, including atrial fibrillation (AF),³ left atrial electromechanical dysfunction,⁴ thromboembolic ischemic stroke,⁵ and increased cardiovascular and all-cause mortalities.⁶ Therefore, it is crucial that patients who are at an increased risk for developing IAB are identified.

The CHADS₂ (congestive heart failure, hypertension, age ≥ 75 years, diabetes mellitus, prior stroke) score is currently the recommended clinical risk prediction tool used to evaluate the risk for thromboembolism in patients with non-valvular AF.⁷ Recently, the CHADS₂ score has been reported to have a predictive role for outcomes in patients without known AF.⁸⁻¹¹ Because congestive heart failure, hypertension, old age, and diabetes mellitus are risk factors for developing IAB,¹²⁻¹⁵ and prior stroke might indicate the existence of IAB,¹² it is reasonable to hypothesize that the CHADS₂ score has a strong correlation with the development of IAB. However, there is little information available on the association between the CHADS₂ score and IAB.

Methods

Study participants: Our prospectively established database of ECG recordings of patients who were hospitalized at Henan Provincial People’s Hospital for diagnosis and treatment between 1 March and 10 March 2010 was retrospectively reviewed. If patients underwent more than one ECG during the index hospitalization, only the first ECG recording was analyzed. Clinical records of all patients were reviewed. The main exclusion criteria were known AF and previous cardiac surgery, congenital heart disease, missing data for calculation of the CHADS₂ score, and...
use of anti-arrhythmic drugs (including class I drugs, amiodarone, and sotalol). The study protocol was approved by the local institutional review board. The requirement for informed consent was waived because of the anonymous nature of the data.

**ECG analysis:** For all patients, interatrial conduction was assessed from a resting 12-lead ECG in sinus rhythm (high-pass filter, 0.05 Hz; low-pass filter, 150 Hz, 25 mm/second, 10 mm/mv), which has been described previously. Briefly, P-waves were measured manually using a caliper to identify the greatest P-wave duration in all 12 ECG leads. Each P-wave was measured once by one observer. At least three beats on each ECG lead were measured, and the average P-wave duration was calculated on each ECG lead. The onset of the P-wave was the point of initial upward or downward deflection from ECG baseline, and the P-wave endpoint was determined as the point where the waveform returned to baseline. IAB was defined as a P-wave duration of ≥120 ms on the 12-lead ECG. ECG analysis was performed independently by two observers who were blind to patient details, and any differences between observers were resolved by consensus.

**Calculation of CHADS2 scores:** The CHADS2 score was calculated by assigning 1 point each for age ≥75 years, hypertension, diabetes mellitus, and congestive heart failure, and 2 points for a previous stroke or transient ischemic attack. Hypertension was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or treatment with antihypertensive drugs. Congestive heart failure was considered present for patients with a history of heart failure or a measured left ventricular ejection fraction of <0.35. Diabetes was defined as a fasting blood glucose level of >126 mg/dL or treatment with hypoglycemic agents.

**Statistical analysis:** Data analysis was performed with SPSS software (ver. 17.0) (SPSS Inc., Chicago, IL, USA). Data are expressed as percentages or mean ± standard deviation, as appropriate. Continuous and categorical variables were compared between groups using independent-samples t-tests and χ² tests, respectively. Univariate analysis was performed along with logistic regression analysis. For each variable, the odds ratio (OR), 95% confidence interval (CI), and P values are provided. Variables found to significantly correlate in the univariate analysis were further analyzed using a forward stepwise multiple logistic regression analysis to identify factors associated with IAB. All probability values were two-sided. A P value of <0.05 was considered statistically significant.

**Results**

A total of 1072 patients (men, 555; women, 517; mean age, 61 ± 14 years) were included in the study. IAB was detected in 387 (36.1%). The clinical characteristics of patients with and without IAB are listed in Table I. Compared with patients without IAB, patients with IAB were older and had higher CHADS2 scores, larger left atrial diameters, and higher rates of use of calcium channel blockers, ACEI/ARB, statins, anticoagulants, and antiplatelet agents. Prevalence of coronary artery disease, diabetes mellitus, hypertension, and prior stroke or transient ischemic attack was significantly higher in patients with IAB than in those without IAB.

Determinants for the development of IAB in all study participants are shown in Table II. In the univariate analysis, IAB was significantly associated with increased age, history of coronary artery disease, diabetes, hypertension, or prior stroke, a high CHADS2 score, and a high rate of use of calcium channel blockers, ACEI/ARB, statins, anticoagulants, and antiplatelet agents. In the forward multivariate logistic analysis, high CHADS2 score (OR, 1.810;
Table II. Determinants of IAB in the Study Population

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Univariate</th>
<th>Multivariate (Forward)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>1.058 (1.049-1.067) &lt; 0.001</td>
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<tr>
<td>Male, n (%)</td>
<td>1.416 (1.149-1.745) &lt; 0.001</td>
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<tr>
<td>Valvular heart disease, n (%)</td>
<td>1.694 (1.176-2.442) 0.004</td>
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<tr>
<td>Coronary artery disease, n (%)</td>
<td>2.537 (2.024-3.179) &lt; 0.001</td>
<td>1.536 (1.065-2.126) 0.022</td>
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<tr>
<td>Diabetes mellitus, n (%)</td>
<td>3.084 (2.459-3.870) &lt; 0.001</td>
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<tr>
<td>Hypertension, n (%)</td>
<td>3.865 (3.104-4.813) &lt; 0.001</td>
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<tr>
<td>Heart failure, n (%)</td>
<td>1.115 (0.759-1.637) 0.579</td>
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<tr>
<td>Smoker, n (%)</td>
<td>1.126 (0.895-1.417) 0.312</td>
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<tr>
<td>Prior stroke or TIA, n (%)</td>
<td>4.337 (3.084-6.099) &lt; 0.001</td>
<td></td>
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<tr>
<td>CHADS2 score</td>
<td>1.951 (1.779-2.138) &lt; 0.001</td>
<td>1.810 (1.577-2.077) &lt; 0.001</td>
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<td>Left atrial diameter (mm)</td>
<td>1.078 (1.052-1.104) &lt; 0.001</td>
<td>1.039 (1.008-1.071) 0.013</td>
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<td>LVEF, %</td>
<td>0.983 (0.971-0.996) 0.008</td>
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<td>Calcium channel blockers, n (%)</td>
<td>1.639 (1.286-2.089) &lt; 0.001</td>
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<tr>
<td>β-blockers, n (%)</td>
<td>1.344 (0.977-1.848) 0.068</td>
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<tr>
<td>ACEI/ARB, n (%)</td>
<td>2.290 (1.702-3.081) &lt; 0.001</td>
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<tr>
<td>Statins, n (%)</td>
<td>2.570 (2.035-3.246) &lt; 0.001</td>
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<tr>
<td>Anticoagulants, n (%)</td>
<td>2.589 (1.181-5.677) 0.014</td>
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<tr>
<td>Antiplatelet, n (%)</td>
<td>1.657 (1.337-2.054) &lt; 0.001</td>
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OR indicates odds ratio; and CI, confidence interval. For other abbreviations, see Table I.

Figure 1. Percentage of patients with IAB among those with different CHADS2 scores (A) and those with a CHADS2 score of < 2 and ≥ 2 (B).

95% CI, 1.577-2.077; P < 0.001), coronary artery disease (OR, 1.536; 95% CI, 1.065-2.126; P = 0.022), and left atrial diameter (OR, 1.039; 95% CI, 1.008-1.071; P = 0.013) were associated with IAB.

The percentage of patients with IAB with respect to CHADS2 scores are shown in Figure 1A. The percentages of patients with IAB among those with a CHADS2 score of 0, 1, 2, 3, 4, 5, and 6 were 20.6% (72/350), 33.0% (105/318), 45.0% (100/222), 55.9% (66/118), 61.9% (26/42), 77.8% (14/18), and 100% (4/4), respectively (P < 0.001). There was a greater percentage of patients with a CHADS2 score of ≥ 2 with IAB compared with a CHADS2 score of < 2 (26.5% versus 52.0%; P < 0.001) (Figure 1B).

The predictive value of the CHADS2 score for predicting the risk for IAB was modest (Figure 2). The area under the ROC was 0.670 (95% CI, 0.636-0.704; P < 0.001).

Discussion

We evaluated the association between CHADS2 score and the development of IAB and found that CHADS2 score was independently associated with IAB. Coronary artery disease and left atrial diameter also significantly correlated with IAB.

Several studies have investigated the risk factors for IAB. Hypertension and diabetes mellitus were identified as risk factors for developing IAB in a study by Ariyarahjah et al.23 The prevalence of IAB is associated with increased age.25-28 In healthy young men, IAB was present in only 9% of those younger than 35 years and 5% of those younger than 20 years.25 However, in patients older than 50 years, IAB was detected in 40%-60%.26-28 Congestive heart failure can result in an overstretch of the atrium, which is reported to cause IAB based on the reversal of IAB with diuretic therapy.29 A prior stroke may
The CHADS2 score is a validated clinical prediction tool commonly used to estimate the risk for stroke in patients with AF. Because all the five components of the CHADS2 score individually correlate with IAB, the score itself should have a strong correlation with IAB. In the current study, we found that four components of the CHADS2 score (age, hypertension, diabetes mellitus, and prior stroke or transient ischemic attack), and the CHADS2 score itself were associated with IAB in the univariate analysis. In the multivariate analysis, the CHADS2 score remained a major determinant for IAB. It is suggested that the CHADS2 score may help identify patients who are at an increased risk for developing IAB.

Because coronary artery disease may contribute to atherosclerotic plaque formation and endothelial injury, leading to ischemia-mediated interatrial conduction delay, coronary artery disease has been identified as a risk factor for developing IAB in previous studies. In support, another study that revealed a significant reduction in P-wave duration after angioplasty in patients with acute myocardial infarction. There was a significant correlation between coronary artery disease and the development of IAB in the current study.

The relationship between IAB and left atrial enlargement has been studied extensively. Although IAB is a separate entity from atrial enlargement, it is frequently associated with left atrial enlargement. IAB is an insensitive but specific (90%) marker of left atrial enlargement. We found that left atrial diameter was independently associated with IAB in the current study.

We suggest that the predictive value of the CHADS2 score is moderate at best. With an area under the curve of around 0.670 in the ROC analysis, the score cannot be used as a stand-alone prognosticator in this context. Support is provided by the finding that CHADS2 score, coronary artery disease, and left atrial diameter significantly correlated with IAB. The score should be considered alongside other correlates of IAB, such as coronary artery disease and left atrial diameter.

This study has some limitations. First, because the study had a cross-sectional design, we could only confirm the presence of a significant association between CHADS2 score and IAB and were unable to determine a true cause-effect relationship between these two variables. Second, P-wave duration was measured manually and not with semi-automatic calipers, which is considered a more sophisticated way to determine P-wave duration. Third, because a higher CHADS2 score is associated with a higher risk of AF, more patients with a higher CHADS2 score may have had AF at baseline. Thus, some patients with high CHADS2 scores were excluded from the study population because patients with known AF were excluded from this study. Finally, this was a single-center hospital-based study, and the characteristics of the study population might differ from those of the general population, meaning that any generalizations should be made with caution.

In conclusion, CHADS2 score was significantly associated with the development of IAB in this study. Calculating the CHADS2 score may help identify patients who are at high risk for developing IAB.

Disclosures

Conflicts of interest: None.

References