ABCD2 Score and Large-Artery Atherosclerosis

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Abstract

Background and Purpose: Extracranial stenosis (ECS) or intracranial stenosis (ICS) are independent risk factors for stroke after transient ischemic attack (TIA). We examined the association of the age, blood pressure, clinical features, duration of symptoms and diabetes (ABCD2) score, a validated risk prediction model for stroke after TIA, and the presence of ICS or ECS.

Methods: Vascular imaging and ABCD2 scores were obtained in a retrospective cohort of 77 consecutive patients diagnosed with TIA in a single center emergency department. The association between vascular stenosis and ABCD2 scores and how each related to clinical outcome was examined.

Results: In all, 30 (39.2%) TIA patients had 37 stenotic lesions; 15 (40.5%) stenotic lesions were ICS and 22 (59.5%) stenotic lesions were ECS. A total of 7 patients (9.5%) had both ECS and ICS lesions. Patients with ABCD2 > 3 were more likely to have ICS (odds ratio [OR] = 6.25, confidence interval [CI] 1.39-32.44, $P = .009$) and ECS (OR = 5.25, CI = 1.56-17.66, $P = .005$). Of the 37 stenotic lesions, 21 (56.7%) were symptomatic; 4 (19.2%) of these had an ABCD2 ≤ 3. At 7 days, there were 4 ischemic strokes, 3 had previously demonstrated symptomatic stenotic lesions, and all had ABCD2 scores > 3.

Conclusions: Compared to patients in the low-risk ABCD2 scores, the patients with medium- to high-risk ABCD2 scores are more likely to have symptomatic and asymptomatic vascular stenotic lesions. However, 1 in 5 patients with low-risk ABCD2 score has symptomatic stenotic lesions, indicating ABCD2 score does not identify all patients with symptomatic stenotic lesions.

Keywords

TIA, ABCD2, stenosis, intracranial stenosis, extracranial stenosis

Introduction

Over the years, 2 posttransient ischemic attack (TIA) clinical risk stratification scales, the California Rule and the ABCD scores, have been developed.^{1,2} Both scales were combined to create a new risk stratification score, now well known as the ABCD2 score.³ The score (0-7) is calculated by the following clinical factors: age ≥ 60 (1 point); blood pressure ≥ 140/90 mm Hg (1 point); clinical features—unilateral weakness (2 points) and speech impairment without weakness (1 point); duration ≥ 60 minutes, (2 points) 10 to 59 minutes (1 point); and diabetes (1 point). This score was subsequently validated, and it indicated that the ABCD2 score was predictive of short-term stroke risk. Patients who had a score of 6 or 7 had a high 2-day risk (8%) of subsequent stroke, whereas patients with a score of 4 or 5 had a lower 2-day stroke risk of 4.1%. In patients with low scores (0-3), the risk of subsequent stroke

was 2%. ABCD2 scores were also found to be predictive of a true TIA,⁴ and the presence of hyperintense diffusion-weighted imaging (DWI) lesions are independent risk factors for post-TIA stroke risk.⁵ However, the score is a clinical scale that does not incorporate vascular imaging data. This is critical, as extracranial stenosis (ECS)⁶ and intracranial stenosis (ICS)⁷ are independent predictors of stroke, and early surgery in extracranial stenosis may be vital to prevent further

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strokes.⁸ Therefore, using only ABCD2 score may not be sufficient for triaging patients. Data available have found variable association of ABCD2 scores with symptomatic ECS^{10,11}, few studies have examined the association of ABCD and ABCD2 scores with symptomatic ICS. Early screening of intracranial and extracranial vasculature may be necessary. We sought to determine the frequency of clinically significant ECS or ICS lesions, defined as 50% or greater stenosis, in patient with low-risk scores (ABCD2 $\leq$ 3) versus medium- to high-risk scores (ABCD2 $>$ 3).

Methods

Seventy-seven consecutive TIA patients presenting to the emergency department (ED) were identified in a stroke registry at Sparrow hospital, Lansing, and Michigan State University, East Lansing, using *International Classification of Diseases, Ninth Revision (ICD-9)* codes (435.9). Three patients were excluded as they did not have any vascular imaging and were discharged from the ED. Of the 77 patients, 10 patients including the 3 patients excluded were diagnosed by ED physicians and 67 patients were diagnosed by a stroke neurologist. Fifty patients were admitted to the hospital and 27 patients were discharged home from the ED. The ABCD2 scores were collected and documented in all patients at the time of ED admission. The score was further dichotomized into low-risk ($\leq$ 3) and medium- to high-risk ($>$ 3) categories. We combined medium- and high-risk groups due to a small number of patients in the high-risk category ($n = 8$). Demographic information including known risk factors was collected. We also retrospectively extracted data for 7-day stroke risk.

Imaging Data

Imaging data were abstracted by a blinded reviewer (A.B.) pertaining to ECS or ICS lesions of 50% or greater. The data were retrospectively abstracted from the actual readings of the neuroradiologists interpretations. The readings were based on the existing standardized methods for ECS¹² and ICS.¹³

Symptomatic and Asymptomatic Lesions

Lesions were further classified into symptomatic and asymptomatic based on the clinical findings. Anterior circulation (carotid, middle cerebral artery [MCA], and anterior cerebral artery) TIAs were defined as the presence of at least one of the following symptoms: unilateral weakness, unilateral numbness, dysarthria, aphasia, or unilateral transient vision loss. Posterior circulation (vertebrobasilar and posterior cerebral artery) TIAs were defined as the presence of at least one of the following symptoms: dizziness, vertigo, double vision, drop attacks, unsteadiness or incoordination, confusion, headache, hearing loss, abnormal noise in the ears, with or without the presence of unilateral weakness, numbness, or dysarthria.

Symptom data were abstracted in a blinded fashion by a neurologist (A.R.). Lesions were categorized as symptomatic or asymptomatic with complete agreement by 2 neurologists (A.B. and A.R.). In case of a disagreement, a third neurologist (A.S.) independently determined the classification.

Statistical Analysis

Data were analyzed using SPSS version 11.1 (SPSS Inc, Chicago). Univariate analysis was conducted to determine factors associated with ECS or ICS; also to determine whether the stenosis was symptomatic or asymptomatic. Categorical data analysis was conducted by chi-square methods and 95% confidence intervals (CIs) were calculated. A multivariate binary logistic regression model was created to determine predictors of symptomatic ECS or ICS. In the multivariate model, age, sex, pretreatment with statins, pretreatment with antiplatelets, first admission blood pressure, diabetes, low-density lipoprotein (LDL) levels, and history of smoking tobacco were not associated with the presence of symptomatic ECS or ICS. We also examined individual components of the ABCD2 score such as dysarthria, unilateral weakness, and duration of symptoms greater than 60 minutes in the multivariate model.

Results

Of 74 patients (50 admitted and 24 discharged from ED) who presented to the ED with TIA and had imaging from October 2007 to August 2008, 50 had computed tomography angiogram (CTA of the neck and brain), 18 had magnetic resonance angiogram (MRA of the neck and brain), and 6 underwent cerebral angiography within 24 to 48 hours. There were 41 (55.4%) females and the mean age was 69 ± 14 years. The three patients of age 42, 51, and 49 that were excluded had ABCD2 scores 1, 2, and 2, respectively. No follow-up imaging data were available on them. Initial noncontrast CT scan was unremarkable in all 3 patients. Four (5.4%) patients were readmitted within 7 days with ischemic strokes. All 4 patients had ABCD2 scores more than 3 (4, 6, 6, 5) and three had symptomatic vascular stenosis. These 4 patients had left MCA stenosis of 80%, left extracranial internal carotid artery (ICA) stenosis of 75%, right extracranial ICA stenosis of 72%, and new onset atrial fibrillation, respectively. All 3 patients with vascular stenosis had CTA as an initial imaging modality.

Of the 74 patients, 30 (40%) patients had ECS or ICS lesions. A total of the 37 lesions (Tables 1 and 2) were identified in these 30 patients (Figure 1). Seven patients had both ECS and ICS lesions, 15 patients had only ECS lesions and 8 patients had only ICS lesions. Of the 37 lesions, 21 (28.4%) were symptomatic (13 ECS and 8 ICS) and 16 were asymptomatic.

The mean $\pm$ standard deviation (SD) ABCD2 score was 3.78 ± 1.25 . There were 32 (43.2%) patients in the low-risk category and 42 (56.8%) patients in the medium- to high-risk

Table 1. Distributions of Stenotic Lesions

ECS (N)	22
Carotid	17
Vertebral	5
ICS (N)	15
Carotid	8
Vertebral	2
Middle cerebral	3
Basilar	1
Other	1
Total	37

Abbreviations: ECS, extracranial stenosis; ICS, intracranial stenosis.

Table 2. Classification of ECS and ICS Lesions Versus ABCD2 Score

Score	ECS (Stenotic Lesions)	ICS (Stenotic Lesions)
ABCD2 $\leq$ 3	4 (2 symptomatic)	2 (both symptomatic)
ABCD2 $>$ 3	18 (10 symptomatic)	13 (7 symptomatic)

Abbreviations: ECS, extracranial stenosis; ICS, intracranial stenosis.

category (34 in medium and 8 in high risk). Patient characteristics were not significantly different in patients with ABCD2 $\leq$ 3 and ABCD2 $>$ 3 (Table 3).

On univariate analysis (Table 4), there were 6 patients (19%) with stenotic lesions (ECS or ICS) in the low-risk group, whereas (57%) patients had stenotic lesions belonged to the medium- to high risk group (OR = 5.60, CI = 1.2-10.2, P = .002). Similarly, patients in the medium- to high-risk category (ABCD2 $>$ 3) were more likely to have ICS (OR = 6.25, CI = 1.39-32.44, P = .009) and ECS (OR = 5.25, CI = 1.56-17.66, P = .005).

Of the 21 symptomatic ECS or ICS lesions, 17 (77.3%) were in the medium- to high-risk group (4 high risk and 13 medium risk) and 4 (22.7%) were in the low-risk group. Patients classified in medium to high ABCD2 score $>$ 3 were more likely to have symptomatic lesions (OR = 5.2, CI = 1.6-16.7, P = .008).

On multivariate analysis (Table 5), age, sex, pretreatment with statins, pretreatment with antiplatelets, first admission blood pressure, hypertension (HTN), diabetes, LDL levels, history of smoking tobacco, and presence of dysarthria were not associated with the presence of symptomatic ECS or ICS. ABCD2 score $>$ 3 was independently associated with symptomatic ECS or ICS (adjusted OR = 3.32, 95% CI = 1.1-9.2, P = .031). However, 19% of patients with a low ABCD2 score had ECS or ICS. In addition, presence of unilateral weakness (adjusted OR = 5.61, 95% CI = 1.9-16.5, P = .003) and duration of symptoms for more than 60 minutes (adjusted OR = 9.03, 95% CI = 2.9-27.9, P = .001) were independently associated with symptomatic stenotic lesions.

Discussion

Large-artery atherosclerosis (LAA), mainly carotid stenocclusive disease, is an independent predictor of subsequent stroke

in patients with TIA.^{6,7} A 90-day stroke risk with ipsilateral carotid disease can be as high as 20.1%.⁶ Early carotid endarterectomy of extracranial carotid disease within 1 to 2 weeks is prudent in patients with TIA.⁸ Patients with symptomatic intracranial atherosclerosis need early aggressive medical therapy. Our study identifies an association between ABCD2 score and ICS and ECS.

Despite the increasing use of ABCD2 score for stratifying TIA patients, few studies have examined the relationship of the ABCD2 score and the presence of clinically significant ECS and ICS lesions on vascular imaging. Among them, 2 studies^{6,7} have evaluated a direct relationship of ABCD2 scores and carotid disease. Both studies showed that patients with higher ABCD2 score had higher likelihood of having carotid stenosis.

In our study, we also found that ABCD2 score $>$ 3 was associated not only with symptomatic ECS but also with symptomatic ICS. Furthermore, there were 4 strokes within 7 days of index TIA events. One had symptomatic ICS and 2 had symptomatic ECS.

In a study of 388 patients, the single biggest predictor of stroke within 3 months after TIA was LAA.¹⁴ Although ABCD2 is a good clinical score to predict the risk of subsequent stroke, it does not take into account imaging data. Our study shows that patients with medium- to high-risk ABCD2 scores were more likely to have ICS as well as ECS lesions on imaging. In addition, presence of unilateral weakness and presence of TIA duration more than 60 minutes was associated with symptomatic stenotic lesions. This association between the ABCD2 score and presence of symptomatic stenotic lesions may be important as 3 strokes of 4 within 7 days were caused by symptomatic ICS (n = 1) and ECS (n = 2) with all patients having ABCD2 scores $>$ 3. However, still 19% (4 of 21) of patients with low ABCD2 score had symptomatic stenotic lesions. None of these patients had strokes within 7 days.

Our data indicate that intracranial stenotic disease and ABCD2 score may be associated. This is important as patients with intracranial stenotic disease can be treated with aggressive noninterventional treatments to reduce subsequent stroke risk.¹⁵ An earlier study found that although the prevalence of coexisting asymptomatic intracranial stenotic lesions (50% to 99%) in patients with symptomatic stenosis is high, the risk of stroke from these asymptomatic stenoses is low.¹⁶

Our findings need to be interpreted with some caution because outcome data (4 strokes) were not prospectively collected and of a relatively small sample from a single center. Also, different imaging modalities (eg, CTA, MRA, and digital subtraction angiography [DSA]) were used in patients, which may lead to unintentional bias.

Even though we found an association between the ABCD2 score and the presence of symptomatic stenotic lesions, the use of ABCD2 score alone in identifying stenotic vascular lesions may not be prudent as 1 in 5 patients with

Figure 1. Consecutive Patients With Transient Ischemic Attack ([TIA] n = 74).

Table 3. Demographic Characteristics

Factors ^a	All Patients, n = 74	ABCD2 ≤ 3, n = 32	ABCD2 > 3, n = 42
Mean age, years, ^b mean ± SD	69.2 ± 14.2	68.4 ± 14.2	71.2 ± 14.2
Female, %	55%	56%	55%
DM, %	15%	16%	14%
HTN, %	60%	57%	61%
Dyslipidemia, %	44%	46%	43%
Atrial fibrillation	7%	3%	9%
CAD, %	16%	19%	14%
Mean ABCD2 score, mean ± SD	3.8 ± 1.3	NA	NA
Mean systolic blood pressure (first reading, ^b mm Hg), mean ± SD	148 ± 35	141 ± 29	152 ± 39
LDL, ^b mg/dL, mean ± SD	101 ± 23.2	102 ± 16.1	97 ± 27.7
Statin on admission	37%	39%	36%
Antiplatelets on admission	67%	69%	64%
Smoking	41%	41%	40%

Abbreviations: SD, standard deviation; DM, diabetes mellitus; HTN, hypertension; CAD, coronary artery disease; LDL, low-density lipoprotein; NA, not available.

^aAll chi-square *P* values >.05 are not significant.

^bDifference in mean age (*t* test) and LDL levels, mean systolic blood pressures between the 2 groups (ABCD2 ≤ 3 and ABCD2 > 3) are not significant (all *P* values >.05).

lower ABCD2 scores had symptomatic lesions in our study. However, regardless of the ABCD2 score, knowing that patient has LAA in a time sensitive manner is vital because 3 patients were readmitted with strokes within 7 days had clinically significant ICS and ECS. A larger epidemiological study with short-term and long-term outcome data is

necessary, especially for patients with intracranial stenotic disease.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Table 4. Univariate Analysis

Characteristics	Presence of Symptomatic, ECS or ICS Lesions			Presence of Both Symptomatic and Asymptomatic, ECS or ICS Lesions		
	OR	95% CI	P	OR	95% CI	P
Age	1.14	0.84-1.2	.11	0.94	0.72-1.25	.23
Female	1.08	0.71-1.23	.22	1.18	0.94-1.39	.14
Caucasian (n = 54)	0.92	0.71-1.21	.23	1.23	0.91-1.54	.10
ABCD2 score >3	5.2	1.6-16.7	.008	5.6	1.2-10.2	.002
HTN	1.1	0.91-1.21	.12	1.2	0.8-1.3	.15
First systolic blood pressure	1.12	0.73-1.54	.13	1.09	0.33-1.42	.32
Statin on admission	0.81	0.61-1.05	.07	0.89	0.51-1.09	.08
Antiplatelet on admission	0.87	0.68-1.14	.14	0.91	0.78-1.42	.27
LDL, mg/dL	1.14	0.92-1.32	.14	1.29	0.84-1.91	.08
DM	1.10	0.89-1.41	.12	1.09	0.54-1.67	.12
Smoker	1.21	0.78-1.62	.43	1.32	0.84-2.21	.29

Abbreviations: ECS, extracranial stenosis; OR, odds ratio; CI, confidence interval; ICS, intracranial stenosis; LDL, low-density lipoprotein; DM, diabetes mellitus; HTN, hypertension.

Table 5. Association of Symptomatic Stenotic Disease (Multivariate Model)

Variable	Adjusted Odds Ratio (95% CI)	P Value
ABCD2 >3	3.32 (1.1-9.2)	.031
Unilateral weakness	5.61 (1.9-16.5)	.003
Duration of symptoms ≥ 60 minutes	9.03 (2.9-27.9)	.001
Dysarthria		.24

Abbreviation: CI, confidence interval.

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