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Misdiagnosis of Cervicocephalic Artery Dissection in the Emergency Department

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Abstract

Background and Purpose—Cervicocephalic artery dissection is an important cause of stroke. The clinical presentation of dissection can resemble that of benign neurological conditions leading to delayed or missed diagnosis.

Methods—We performed a retrospective cohort study using state-wide administrative claims data from all Emergency Department (ED) visits and admissions at nonfederal hospitals in Florida from 2005–2015 and New York from 2006–2015. Using validated *ICD-9-CM* codes, we identified adult patients hospitalized for cervicocephalic artery dissection. We defined probable misdiagnosis of dissection as having an ED treat-and-release visit for symptoms or signs of dissection including headache, neck pain, and focal neurological deficits in the 14 days before dissection diagnosis. Multivariable logistic regression was used to compare adverse clinical outcomes in patients with and without probable misdiagnosis.

Results—Among 7,090 patients diagnosed with a dissection (mean age 52.7 years, 44.9% women), 218 (3.1%; 95% CI, 2.7–3.5%) had a preceding probable ED misdiagnosis. After adjustment for demographics and vascular risk factors, there were no differences in rates of stroke (OR 0.82; 95% CI, 0.62–1.09) or in-hospital death (OR 0.26; 95% CI, 0.07–1.08) between dissection patients with and without a probable misdiagnosis at index hospitalization.

Conclusion—We found that approximately 1 in 30 dissection patients were probably misdiagnosed in the 2 weeks before their diagnosis.

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Disclosures

BBN and AEM have received personal fees for medicolegal consulting on stroke. HK is a co-PI for the NIH-funded ARCADIA trial which receives in-kind study drug from the BMS-Pfizer Alliance and in-kind study assays from Roche Diagnostics, serving as Deputy Editor for *JAMA Neurology*, serving as a steering committee member of Medtronic's Stroke AF trial (uncompensated), serving on an endpoint adjudication committee for a trial of empagliflozin for Boehringer-Ingelheim, and having served on an advisory board for Roivant Sciences related to Factor XI inhibition.

Keywords

Cervicocephalic Dissection; Diagnostic Error

Subject terms:

Ischemic stroke; Carotid Artery Dissection; Vertebral Artery Dissection

Cervicocephalic artery dissection is uncommon in the general population but a frequent cause of stroke in the young.¹⁻³ While many patients with cervicocephalic artery dissection present with cerebral ischemia, symptoms can be non-specific including isolated headache and cervical pain.⁴⁻⁶

Rates of cervicocephalic artery dissection misdiagnosis in the ED have not been systematically evaluated despite the fact that early identification of dissection represents an important opportunity for stroke prevention.⁷ We therefore sought to measure the rate of cervicocephalic artery dissection misdiagnosis in the ED using a large, heterogeneous cohort. We also evaluate the effect of probable ED misdiagnosis on the clinical outcomes of dissection patients.

Methods

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Design

We conducted a retrospective cohort study using statewide administrative claims data collected by the Florida Agency for Health Care Administration and the New York Statewide Planning and Research Cooperative System (Supplemental Methods). The Weill Cornell Medicine institutional review board approved this study and granted a waiver of informed consent.

Subjects

We identified all patients >18 years of age with an index hospitalization for cervicocephalic artery dissection using previously validated *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes (Supplemental Methods).

Measurements

We defined a probable ED misdiagnosis as having had an ED treat-and-release visit for signs and symptoms related to dissection in the 14 days before dissection hospitalization. ED visits for these signs and symptoms were identified using the primary *ICD-9-CM* discharge diagnosis codes detailed in Supplemental Table I.

We evaluated whether demographics, concomitant head or neck trauma, and stroke risk factors were predictors of probable dissection misdiagnosis. To assess whether probable ED

misdiagnosis of cervicocephalic artery dissection was associated with adverse clinical outcomes, we evaluated rates of stroke (ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage) as well as death during hospitalization for dissection using previously validated *ICD-9-CM* codes (Supplemental Methods).

Statistical Analysis

We calculated proportions with 95% confidence intervals using the exact method. We compared characteristics between groups using the *t* test for continuous variables and χ^2 test for categorical variables. We used multivariable logistic regression to evaluate characteristics associated with increased odds of having a probable ED misdiagnosis and to compare rates of adverse clinical outcomes at the time of dissection hospitalization. Analyses were performed using Stata/MP, version 15 (StataCorp, TX). We used an alpha error of 0.05.

Results

We identified 7,090 patients with a diagnosis of cervicocephalic artery dissection. Mean age was 52.7 years (SD, 16.3) and 3,181 (44.9%) were women. There were 218 (3.1%; 95% CI, 2.7–3.5%) patients with a probable misdiagnosis as evidenced by having an ED treat-and-release visit for symptoms or signs of dissection in the 14 days before dissection diagnosis. Among patients with a probable misdiagnosis, most had an ED visit for headache (n=194/218; 89.0%).

Patients with a probable ED misdiagnosis were younger (43.4 years [SD, 11.0] versus 53.0 years [SD, 16.4]; $P<0.001$) and more often women (61.9% versus 44.3%; $P<0.001$; Table 1). In multivariable logistic regression analysis, age (OR: 0.97; 95% CI, 0.96–0.98) was associated with decreased odds of probable dissection misdiagnosis, while female sex (OR 1.76; 95% CI, 1.33–2.34) was associated with higher odds of probable misdiagnosis (Supplemental Table II).

Rates of ED treat-and-release visits steadily increased from 2 weeks before cervicocephalic artery dissection hospitalization to 1 day before dissection hospitalization (0.07% versus 0.54%; $P<0.001$; Figure 1).

Stroke was diagnosed in 83 (38.1%; 95% CI, 31.6–44.9%) patients with a probable dissection misdiagnosis versus 3,150 (45.8%; 95% CI, 44.7–47.0%; $P=0.02$) without misdiagnosis. After adjustment for demographics and vascular comorbidities, there was no difference in rates of stroke (OR 0.82; 95% CI, 0.62–1.09) or in-hospital death (OR 0.26; 95% CI, 0.07–1.08) between the two groups.

Discussion

In a large heterogeneous cohort, we found that approximately 1 in 30 cervicocephalic artery dissection patients had a probable preceding ED misdiagnosis. This rate of misdiagnosis is within the range of prior measurements of cerebrovascular disease misdiagnosis in the ED. In a study of patients admitted for stroke or transient ischemic attack using HCUP data from 9 states, the rate of probable misdiagnosis at index ED visit was 1.2%.⁸ In a Canadian study

of 1,507 hospitalized patients with subarachnoid hemorrhage, ED misdiagnosis occurred in 5.4%.⁹ In our recent study of 5,966 patients with cerebral venous thrombosis, 3.6% had a probable ED misdiagnosis.¹⁰ Though these rates of diagnostic error are similar, whether or not there are similar reasons for ED misdiagnosis for these different cerebrovascular diseases requires further study.

We did not find differences in the risk of stroke or in-hospital death among patients with a probable ED misdiagnosis as compared to other dissection patients. However, we were unable to evaluate the impact that diagnosing dissection in the ED may have had on patients who were initially misdiagnosed. It remains plausible that a timely diagnosis of dissection can positively impact patient outcomes by preventing subsequent ischemic events. The short-term risk of incident stroke after isolated cervical artery dissection is non-trivial.⁷ In the CADISS study, although the frequency of ischemic stroke within one year of dissection was only ~2.5% regardless of treatment allocation, 7% of patients had a minor stroke or TIA an average of 3 days before study enrollment.^{4, 11} When dissections are diagnosed early, stroke prevention strategies can be initiated to mitigate subsequent stroke risk when this risk is at its highest.^{4, 7, 11} Improved access to neurological consultation in the ED may help reduce rates of ED stroke misdiagnosis, but further research is needed.¹²

Our study has important limitations. First, our study is prone to ascertainment error because cases of cervicocephalic artery dissection were identified through diagnostic code claims rather than prospective adjudication. Second, we were unable to account for hospital-level (e.g., teaching status) or provider-level (e.g., years in practice) factors which might affect the accuracy of dissection diagnoses. Third, using data from only two East Coast states as well as excluding patients with a history of cerebrovascular disease may limit the generalizability of our findings. Finally, given the limitations of the HCUP dataset, we were unable to assess stroke severity and functional outcomes.

Conclusions

We found that approximately 1 in 30 patients with cervicocephalic artery dissection had a probable ED misdiagnosis in the 14 days before their hospitalization for dissection. After adjustment for demographics and vascular comorbidities, probable ED misdiagnosis of dissection was not associated with increased odds of stroke or death at index hospitalization.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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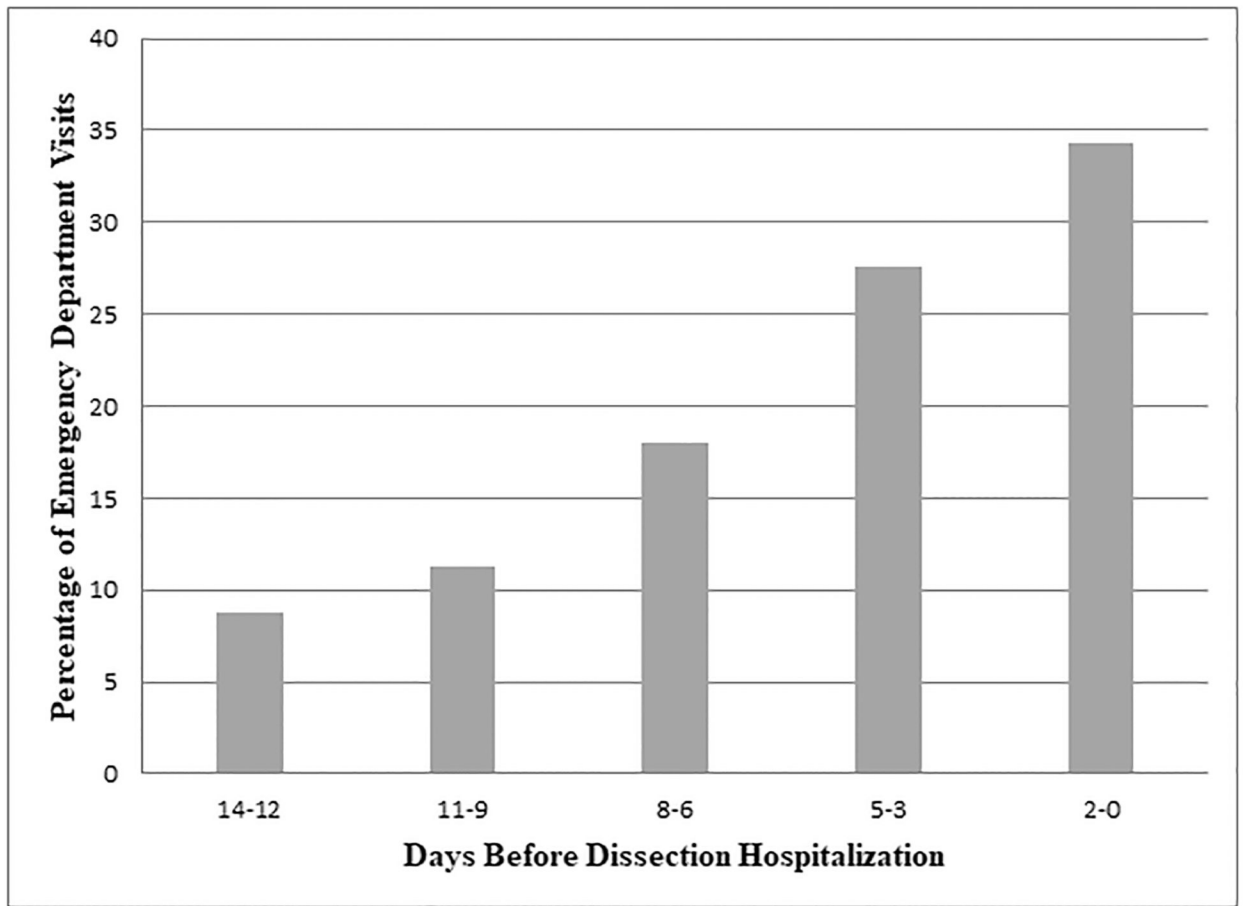


Figure 1. Histogram of Emergency Department Visits before Dissection Diagnosis
 Time (days) from Emergency Department (ED) treat-and-release visit for symptoms or signs of cervicocephalic artery dissection before hospital admission among patients with a probable ED misdiagnosis. ED encounters on the same day of hospital admission (day zero) that resulted in discharge to home are included.

Table 1.

Patient Characteristics, Stratified by Probable Emergency Department Misdiagnosis of Cervicocephalic Artery Dissection

Demographics*	No Misdiagnosis (N = 6872)	Probable Misdiagnosis (N = 218)
Age, mean (SD), y	53.0 (16.4)	43.3 (11.0)
Female	3046 (44.3)	135 (61.9)
Race		
White	4651 (67.7)	148 (67.9)
Black	797 (11.6)	22 (10.1)
Other	1424 (20.7)	48 (22.0)
Clinical Features		
Hypertension	3655 (53.2)	86 (39.5)
Tobacco Use	632 (9.2)	17 (7.8)
Alcohol Abuse	1352 (19.7)	32 (14.7)
Payment source		
Medicaid	900 (13.1)	23 (10.6)
Private Insurance	3523 (51.3)	165 (75.7)
Self-pay	377(5.5)	11 (5.1)
Other	2072 (30.1)	19 (8.6)

* Data are presented as number (%) unless otherwise specified.