Disparities in Stroke Type and Vascular Risk Factors Between 2 Hispanic Populations in Miami and Mexico City

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Background: The heterogeneous nature and determinants of stroke among different Hispanic groups was examined by comparing hospitalized Hispanic stroke patients in Miami, where the Hispanic population is largely of Caribbean origin, to a Mestizo population in Mexico City. *Methods:* Consecutive Hispanic patients who were admitted with stroke or transient ischemic attack (TIA) and included in the prospective stroke registries of 2 tertiary care teaching hospitals were studied. Demographic factors, stroke subtypes, vascular risk factors, stroke severity, and outcomes were compared. Vascular risk factor definitions were standardized. *Results:* A total of 928 patients (520 Mexicans and 408 Miami Hispanics) were analyzed. Mexicans were younger, with a greater proportion of women. More cerebral venous thromboses (CVTs) were admitted in Mexico, while TIA and stroke mimics were more commonly admitted in Miami; cardioembolic strokes were more commonly ascertained in Miami, and more cryptogenic strokes in Mexico. Stroke severity was similar for intracerebral hemorrhages, but more severe ischemic strokes and CVTs were included in the Mexican registry. Outcome at 1 and 3 months was similar in both registries after adjusting for age and baseline stroke severity. After adjusting for age and sex, hypertension, dyslipidemia, and atrial fibrillation were more frequent, and diabetes mellitus was less frequent, among Miami Hispanics compared to Mexicans. *Conclusions:* We found significant differences in the frequency of hypertension, diabetes, dyslipidemia, and atrial fibrillation in Miami Hispanics and Mexican stroke patients, highlighting the heterogeneity of the Hispanic ethnic group. Future studies are needed to clarify the relative contribution of genetic and environmental disparities amongst Mexican and Caribbean Hispanic stroke patients. **Key Words:** Hispanics—risk factors—stroke—stroke subtypes.

Stroke is the second global cause of mortality,[1] the third cause of death in Mexico,[2] and the fourth cause of death in the United States.[3] Despite recent decreases in stroke mortality[4] and incidence[5,6] in the United States, the aging population[7] and alarming increases in both obesity and diabetes[8] suggest that stroke prevalence will significantly grow in the coming decades. In addition, population-based studies in the United States have found a greater incidence of stroke in Hispanics, the fastest growing segment of the population.[9,10] In Corpus Christi, Mexican Americans had a greater stroke incidence than non-Hispanic whites (NHWs), and this difference was more pronounced at younger ages.[9] Similarly, Caribbean Hispanics had a 2-fold risk of stroke compared to NHWs in northern Manhattan.[10]

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Received April 10, 2012; accepted May 29, 2012.

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2012.05.016

According to the Office of Minority Health, US Department of Health and Human Services, in the United States the terms "Hispanic" or "Latino" are used to describe a heterogeneous group that includes individuals of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. It includes Amerindians, Mestizos, whites, and individuals of African and Asian origin. As the largest minority in the United States, Hispanics account for 16.3% of the population.[11] Mexican origin accounts for two-thirds of the Hispanic group, but a significant proportion (>20%) are of Caribbean and Central American origin. Nevertheless, Hispanics are often thought of as a homogeneous group, and stroke epidemiologic studies in the United States usually compare Hispanics as a uniform group to whites and blacks. Variations in the stroke characteristics and stroke risk factors across Hispanics of diverse origins have not been well explored, which contributes to the ongoing perception of Hispanics as a uniform group. This perception, and the design and interpretation of studies that have not adjusted for variations within the Hispanic population, contributes to lack of understanding of specific characteristics and risk factors within Hispanic subgroups, which may contribute to the growing stroke disparities in minorities.[12]

The objective of this study was to examine the heterogeneous nature and determinants of stroke among different Hispanic groups. In order to achieve this goal, we compared hospitalized Hispanic stroke patients in Miami, where the Hispanic population is largely of Caribbean origin, to a Mestizo population in Mexico City.

Methods

We examined stroke etiology and vascular risk factors in consecutive Hispanic patients admitted with a diagnosis of stroke or transient ischemic attack (TIA) between October 2008 and July 2010 and who were included in the prospective stroke registries of 2 tertiary care teaching hospitals: the National Institute of Neurology and Neurosurgery (NINN) in Mexico City and Jackson Memorial Hospital/University of Miami School of Medicine, in Miami, Florida. Both stroke registries were approved by their overseeing institutional review board.

Mexico City is a large metropolitan area with 20 million citizens, most of them Mestizos of mixed European Spanish and Native American heritage. The NINN is a tertiary care public academic center in Mexico City with approximately 300 annual admissions for stroke and TIA. All patients admitted to the NINN are entered into a prospective stroke registry; the institutional review board does not require written informed consent for deidentified data analysis of observational data.

The metropolitan area for Miami, Florida, is encompassed by Miami-Dade County. It has an ethnically diverse population of 2.5 million; Hispanics account for 62.5% of the population.[13] Contrary to the rest of the United States, where those of Mexican ancestry predominate, the Hispanic population in Miami is truly diverse; the top countries of origin for the Hispanic population in Miami are Cuba (35%), Colombia (4.9%), Nicaragua (4.3%), and Puerto Rico (4%).[14] Jackson Memorial Hospital is a 1550-bed tax-supported county hospital affiliated with the University of Miami with 990 annual stroke and TIA admissions. Patients admitted for cerebrovascular disease are approached and provide written informed consent (directly or through proxy) for participation in the prospective Cerebrovascular Registry and Biorepository at the University of Miami/Jackson Memorial Hospital.

We compared the demographics, vascular risk factors, stroke etiology, and severity of Hispanic patients with stroke or TIA between the 2 registries. We included all patients with: (1) ischemic stroke, as indicated by brain imaging (computed tomography or magnetic resonance imaging); (2) TIA, defined as sudden onset focal neurologic deficit attributed to cerebral ischemia lasting <24 hours, without infarction on brain imaging, and diagnosed by a neurologist; (3) primary intracerebral hemorrhage confirmed by imaging; and (4) cerebral venous thrombosis (CVT) confirmed by imaging. Stroke etiology was determined with the modified Trial of Org 10,172 in Acute Stroke Treatment (TOAST) classification, and ascertained by a vascular neurologist.[15,16] The algorithm and availability of diagnostic testing for evaluation of cryptogenic strokes was similar at both institutions: cortical or large subcortical strokes with unrevealing transthoracic echocardiogram and cervical and intracranial vascular imaging underwent transesophageal echocardiography and extended cardiac rhythm monitoring.

We selected common and relevant variables from each registry and standardized vascular risk factor definitions across both sites. Hypertension was defined as a history of hypertension reported by the patient or reported in the chart, the prehospital use of antihypertensives, or at least 2 blood pressure measurements ≥140/90 mm Hg after 72 hours of admission. Diabetes mellitus was defined as a previous diagnosis, treatment with insulin or oral hypoglycemic medications, or a fasting plasma glucose level ≥126 mg/dL or glycosylated hemoglobin (HbAIc) ≥6.5. Dyslipidemia was defined as the prehospital use of antilipidemic medication or low density lipoprotein (LDL) ≥100 mg/dL. Smoking was defined by either the current or former practice of smoking, and smoking cessation for at least 2 years preceding admission. Coronary artery disease was determined by patient report or chart documentation of myocardial infarction, angina, or abnormal stress test. Atrial fibrillation (AF) was defined by patient report or chart documentation of the presence of chronic or paroxysmal AF. We also analyzed data on previous stroke or TIA and the presence of other drugs of abuse on urine

Table 1. *Stroke subtypes*

Stroke type	Mexico (n = 520)	Miami (n = 408)
Ischemic stroke	75.0%	68.9%
Transient ischemic attack	3.1%	8.1%
Intracerebral hemorrhage	15.6%	13.7%
Cerebral venous thrombosis	6.4%	1.5%
Other, mimics	0%	7.8%

Chi-square 66; degrees of freedom 4; $P < .0001$.

toxicology test. Baseline stroke severity on admission was determined with the National Institutes of Health Stroke Scale (NIHSS)[17] and was performed by a certified evaluator, usually the neurology resident.

Statistical Analysis

Data are summarized as mean and standard deviation for continuous variables and percentage for categorical variables. For univariate analyses, the Student *t* test was used to examine the differences in age and baseline NIHSS score. The Chi-square test was used to compare the frequencies of sex, stroke type, ischemic stroke TOAST classification, vascular risk factors (previous TIA or stroke, hypertension, diabetes, dyslipidemia, tobacco use, drug use, AF, or coronary artery disease) between Mexican and Miami Hispanic stroke patients. Multiple logistic regression models were used to compare the presence of hypertension, diabetes, dyslipidemia, AF, and other risk factors between the groups after adjustment for age and sex. The results were expressed as multivariable-adjusted odds ratios (ORs) and 95% confidence intervals (CIs). A 2-sided $P < .05$ was considered statistically significant. All data analyses were performed with SAS statistical software (version 9.2; SAS Institute Inc, Cary, NC).

Results

A total of 928 Hispanic patients were included in the analysis, including 520 Mexicans from Mexico City and 408 predominantly Caribbean patients residing in Miami. In Miami, 71.9% were Caribbean, 14.5% were Central American, 9.8% were South American, and 3.8% were from Mexico, Spain, or the United States. Of the 21 countries of origin, 5 accounted for 85% of Miami Hispanics: Cuba (n = 239), Nicaragua (n = 27), Puerto Rico (n = 25), Honduras (n = 21), Dominican Republic (n = 20), and Colombia (n = 14). Overall, Mexicans were younger (55.7 ± 18.1 *v* 65.4 ± 14.8 years [mean ± SD]; $P < .0001$), with a greater proportion of women (51.2% *v* 38.7%; $P = .0002$).

Stroke subtypes admitted to each institution are described in Table 1. More cerebral venous thromboses were admitted in Mexico, while TIA and stroke mimics were more commonly admitted in Miami. Amongst ischemic strokes, differences in TOAST-defined stroke mechanisms were noted (Table 2), with more cardioembolic strokes ascertained in Miami and more cryptogenic strokes in Mexico.

Vascular risk factors were different in this hospitalized cohort. As noted in Table 3, hypertension, dyslipidemia, previous stroke and TIA, AF, coronary artery disease, and drug use in young patients were more common in hospitalized Hispanics in Miami, while in Mexicans diabetes mellitus was more common, particularly in older patients. Although the differences in the proportion of hypertensive patients attenuated in those ≥50 years of age, it remained statistically significant. Age impacted the frequency of risk factors: at >50 years of age, diabetes was more frequent in Mexicans and dyslipidemia more frequent in Miami Hispanics. After adjusting for age and sex, comparing the Miami and Mexico groups, differences were noted for the following stroke risk factors: hypertension (OR 2.2; 95% CI 1.6-3.0; $P < .0001$); diabetes mellitus (OR 0.6; 95% CI 0.5-0.9; $P = .0092$); dyslipidemia (OR 1.5; 95% CI 1.2-2.0; $P = .0020$); and AF (OR 2.5; 95% CI 1.4-4.3; $P = .0012$).

Stroke severity, determined by the admission NIHSS score, was similar for intracerebral hemorrhages (11.6 ± 7.6 in Mexico, 11.3 ± 8.4 in Miami; $P = .8408$), but more severe ischemic strokes (9.3 ± 6.8 in Mexico, 7.5 ± 7.1 in Miami; $P = .0008$) and CVT (6.2 ± 7.2 in Mexico, 1.8 ± 2.8 in Miami; $P = .0176$) were included in the Mexican registry.

Discussion

We found significant differences in the frequency of hypertension, diabetes, dyslipidemia, and AF between Caribbean Hispanics and Mexican hospitalized stroke patients. Although the prevalence in diabetes in Mexicans has been described before, the greater frequency of hypertension and dyslipidemia in Miami Hispanics compared to Mexicans is intriguing.

In the Brain Attack Surveillance in Corpus Christi (BASIC) project, Hispanics of Mexican origin with stroke had significantly more diabetes than NHWs.[18] In the Northern

Table 2. *Ischemic stroke according to the TOAST classification*

Category	Mexico (n = 390)	Miami (n = 281)
Large vessel	24.1%	21.3%
Small vessel	16.7%	15.7%
Cardioembolism	23.3%	34.9%
Cryptogenic	20.5%	11.4%
Indeterminate and conflicting	15.4%	16.7%

Chi-square 17; degrees of freedom 4; $P = .0022$.

Table 3. *Vascular risk factors*

	All ages			Age ≥50 years			Age <50 years		
Risk factor	Mexico (n = 520)	Miami (n = 408)	*P* value	Mexico (n = 335)	Miami (n = 350)	*P* value	Mexico (n = 185)	Miami (n = 58)	*P* value
Hypertension	53.1%	78.9%	<.0001	70.5%	84%	<.0001	21.6%	48.3%	<.0001
Diabetes mellitus	24.4%	21.1%	.2291	33.1%	22.3%	.0015	8.7%	13.8%	.2519
Dyslipidemia	43.7%	58.3%	<.0001	51.3%	61.1%	.0097	29.7%	41.4%	.0984
Tobacco, former use/current use	12.5%/29.2%	14.7%/29.7%	.5720	15.5%/31.1%	16.3%/28.9%	.8185	7%/26%	5.2%/34.5%	.4313
Drug use	2.1%	4.7%	.0298	1.8%	3.7%	.1255	2.7%	10.3%	.0246
Previous stroke or TIA	5%	19.1%	<.0001	7.2%	19.4%	<.0001	1.1%	17.2%	<.0001
Atrial fibrillation	4%	12.6%	<.0001	6%	14.7%	.0002	0.5%	0	1
Coronary heart disease	7.3%	14.6%	.0003	11.3%	15.3%	.1314	0	10.3%	.0002

Abbreviation: TIA, transient ischemic attack.

Manhattan Stroke Study (NOMASS), Caribbean Hispanics with stroke were more likely to have hypertension, hypercholesterolemia, and diabetes compared to NHWs.[19] In a Mexican registry of more than 1000 patients enrolled with a first stroke in 59 hospitals throughout the country, a high prevalence of hypertension (66%) and diabetes (35%) was noted.[20] However, there are limited data on the direct comparison of vascular risk factors among different Hispanic subgroups. The Multiethnic Study of Atherosclerosis (MESA)[21] analyzed vascular risk factors among Hispanics 45 to 84 years of age who were free of clinical disease, of which 56% were Mexican Americans, 12% Dominicans, 14% Puerto Rican, and 18% from other Latin American countries. While blood pressure, glucose, and LDL levels were similar across all groups, Mexican Americans had higher triglyceride levels and a greater frequency of metabolic syndrome, as well as higher levels of subclinical atherosclerotic disease (coronary and thoracic calcium and carotid intima media thickness).

The greater prevalence of diabetes in Mexicans in our study is not surprising and has been described before, both in Mexico[22] and the United States.[23] The age-adjusted ratio of diabetes in Mexican Americans is 1.9 compared to NHWs.[24] Supporting our findings of different rates of diabetes across different Hispanic populations, the Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study, a cross-sectional population-based study conducted in 7 Latin American cities, found that diabetes and the metabolic syndrome were more prevalent in Mexico City compared to other South American cities.[25] Acculturation has been associated with a greater risk of diabetes; interestingly, this has affected Hispanics of non-Mexican origin to a larger extent than those of Mexican origin living in the United States.[26] It should be noted that most Caribbean Hispanics in our study are foreign born and therefore exhibit less acculturation than in other reports.

The greater prevalence of dyslipidemia in our study is also intriguing. Additional analysis is required to compare other lipid fractions across both groups. There are few comparative data on lipid profiles within diverse Hispanic groups. In the CARMELA study, wide variations of lipid profiles were noted across Latin America.[27] Similarly, in MESA, Mexican Americans had similar LDL levels compared to Dominicans and Puerto Ricans, but higher triglyceride levels.[21]

Similar blood pressures[21] and frequency of hypertension[28] have been reported across different stroke-free Hispanic groups in the United States. However, low-renin essential hypertension and low responsiveness to angiotensin-converting enzyme inhibitors (ACE-Is) as monotherapy has been reported in Caribbean Hispanics,[29] while an excellent response to ACE-Is has been noted in Mexicans.[30] Whether African admixture in Caribbean Hispanics[31] contributes to a differential response to antihypertensive therapy in the presence of a United States–based diet needs to be examined.

The causes of the differences in vascular risk factors are complex and beyond the scope of this discussion. Obesity, an unhealthy diet and physical inactivity, greater gestational diabetes and prenatal exposure to hyperglycemia, genetic predisposition,[32] socioeconomic differences,[33] and acculturation[26] have been invoked as contributing factors. However, it is clear that certain vascular risk factors have a greater impact on vascular disease in diverse populations,[21] such as diabetes and intracranial atherosclerotic disease in Hispanics[34]—although the differential impact of these factors on end-organ injury may be difficult to discern across Hispanic populations.[35] The genetic determinants of risk by Hispanic subgroup need to be further elucidated.

Stroke subtype differences were observed in our study. Such differences may be a result of referral patterns at each institution. However, given the greater prevalence

of hypertension in Miami, it is interesting that the proportion of intracerebral hemorrhages was similar for both groups. Other hospital-based series in South America have reported that intracerebral hemorrhages account for 25.9% to 46% of all stroke admissions,[36] greater than the proportion reported in our series. Whether this is related to a greater incidence of hemorrhagic stroke or a difference in hospitalization rates for milder ischemic strokes in Latin America cannot be discerned from these data. CVT is the least common form of acute cerebrovascular disease. However, in Mexico, hospital-based series have reported that the prevalence of CVT ranges from 0.43% to 8%. The first Mexican multicenter registry found that the relative frequency of CVT in hospitalized Mexican stroke patients, compared to other international registries, is higher than previously thought.[37] Most of the cases were associated with puerperium, followed by oral contraceptive use and pregnancy. Although speculative, many cases in Mexico may be explained by poor care during pregnancy and childbirth. The differences noted in cardioembolic and cryptogenic proportions, despite similar algorithms for evaluation of stroke patients, is probably related to a greater frequency of AF in Miami. In the United States, minorities, and in particular African Americans, have less awareness of the diagnosis of AF than NHWs.[38] Whether this is the explanation for the differences noted in our data is unknown. It is also possible that differences in ascertainment criteria by investigators at each institution result in the differences in cryptogenic and cardioembolic strokes in both cohorts. Finally, we found similar stroke severity in both groups. This should be considered in light of the consent process in Miami that may have excluded more severely affected cases.

Our study has certain limitations. First, we have included discrete data from single large institutions in each city. That the NINN in Mexico City does not reflect the preponderance of stroke care in Mexico is evident by reviewing a hospitalized stroke surveillance study in the northern Mexican state of Durango, where in spite of similar admission NIHSS scores (median 11), hospital mortality was 39%.[39] Second, the referral patterns and differences in the inclusion process in the registry at each institution may contribute to the differences in the stroke subtypes and other demographic factors. Moreover, not all admitted stroke patients were included in the Miami registry, because it required signed consent; this resulted in the inclusion of about two-thirds of ischemic strokes, three quarters of TIAs, and half of ICHs in Hispanic patients, and it is likely that more severe patients were excluded in Miami. Lastly, subarachnoid hemorrhage was not included in either registry.

In conclusion, this study contributes to the understanding of stroke in Hispanics by exploring some of the differences in the frequency of stroke risk factors and subtypes among 2 thoroughly evaluated Hispanic groups. Our results indicate significant differences in vascular risk factors across different Hispanic stroke populations, with greater hypertension and dyslipidemia in a predominantly Caribbean Hispanic group and more diabetes in a Mexican Mestizo population. These findings underlie the heterogeneity of the Hispanic ethnic group. Our data may be useful for researchers planning cross-national studies of acute stroke. Future studies are needed to clarify the relative contribution of genetic and environmental disparities among Mexican and Caribbean Hispanics in relation to stroke risk and stroke etiology. Further understanding of these differences will help design tailored education and prevention programs in specific communities with the goal of improving stroke disparities in minorities.[12]

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