Type 2 Diabetes and Hemorrhagic Stroke: A Population-Based Study in Spain from 2003 to 2012

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Aim: The objective of this study is to compare trends in outcomes for intracerebral hemorrhagic stroke in people with or without type 2 diabetes in Spain between 2003 and 2012. *Methods:* We selected all patients hospitalized for hemorrhagic stroke using national hospital discharge data. We evaluated annual incident rates stratified by diabetes status. We analyzed trends in the use of diagnostic and therapeutic procedures, patient comorbidities, in-hospital mortality (IHM), length of hospital stay, and readmission rate in 1 month. *Results:* We identified a total of 173,979 discharges of patients admitted with hemorrhagic stroke (19.1% with diabetes). Incidences were higher among those with than those without diabetes in all the years studied. Diabetes was positively associated with stroke (incidence rate ratio [IRR] = 1.38, 95% confidence interval [CI] 1.35-1.40 for men; IRR = 1.31, 95% CI 1.29-1.34 for women). Length of stay decreased significantly and readmission rate remained stable for both groups (around 5%). We observed a significant increase in the use of decompressive craniectomy from 2002 to 2013. Mortality was positively associated with older age, with higher comorbidity and atrial fibrillation as risk factors. We found a negative association with the use of decompressive craniectomy. Mortality did not change over time among diabetic men and women. In those without diabetes, mortality decreased significantly over time. Suffering diabetes was not associated with higher mortality. *Conclusions:* Type 2 diabetes is associated with higher incidence of hemorrhagic stroke but not with IHM. Incidence among diabetic people remained stable over time. In both groups, the use of decompressive craniectomy has increased and is associated with a decreased mortality. **Key Words:** Type 2 diabetes mellitus—hemorrhagic stroke—incidence—hospitalization—length of stay—in-hospital mortality.

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Received November 25, 2015; revision received January 16, 2016; accepted February 24, 2016.

Grant support: This study forms part of a research funded by the Fondo de Investigaciones Sanitarias (FIS—Health Research Fund, grant no. PI13/00118, Instituto de Salud Carlos III).

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2016.02.031

Introduction

Stroke or cerebrovascular accident (CVA) represents one of the most important public health problems particularly in industrialized countries.[1] Nonfatal stroke is also one of the most disabling health conditions worldwide, resulting in a heavy social impact.[2] Hemorrhagic strokes represent around 13%-20% of all CVAs. Around 80% of these hemorrhagic strokes are intracerebral with the remaining 20% being subarachnoid.[3] In Spain, CVAs are the second leading cause of mortality in the general population and the first among women.[4,5] Stroke incidence has been evaluated in several studies conducted in our country finding different results and with most studies including all stroke subtypes.[6] Incidence rates fluctuate between 120 and 350 cases per 100,000 people/year.[7,8] The Stroke Project of the Spanish Cerebrovascular Diseases Study Group (IBERICTUS), which included transient ischemic attack and ischemic and hemorrhagic strokes, estimated 187 new cases per 100,000 people, 30% of them hemorrhagic, with the greatest incidence among people aged over 85 years.[9]

A recent review showed a 42% decrease in stroke incidence rates in high-income countries over the past 4 decades.[10] However, limited information is available regarding the trend in hemorrhagic stroke incidence in Spain.

Cardiovascular risk factors also have a different impact on stroke subtypes. Hypertension and age are well-recognized risk factors for both ischemic and hemorrhagic strokes. Type 2 diabetes mellitus (T2DM) is a significant risk factor for stroke, increasing 2-3 times the relative risk, and is also associated with an increased risk of mortality. However, the effect of T2DM on the incidence of hemorrhage stroke is not yet well established.[11-13] A meta-analysis published in 2010 showed that the presence of diabetes doubles the risk of both ischemic and hemorrhagic strokes. A recent cohort study, following nearly 2 million people, found a positive and strong association between T2DM and ischemic stroke, whereas the association between T2DM and hemorrhagic stroke was less consistent.[14,15] The prevalence of diabetes is constantly increasing and elderly people account for around 40% of the diabetic population.[16] Nearly 20% of diabetic people die from CVA.[17] At this point, it is important to investigate the effect of T2DM and other risk factors on hemorrhagic stroke. This epidemiological information is needed to implement appropriate health strategies.

The main objective of the present study was to compare trends in the incidence rates and outcomes of hemorrhagic stroke among hospitalized men and women with and without T2DM between 2003 and 2012 in Spain. In particular, we analyzed trends in the use of diagnostic and therapeutic procedures, patient comorbidities, and in-hospital outcomes such as length of hospital stay (LOHS), readmissions rates, and in-hospital mortality (IHM). Specific objectives included (1) analysis of the existence of an interaction between the presence of diabetes and gender in terms of risk or outcome; (2) description and analysis of the national trends in incidence, outcome, and management of intracerebral hemorrhage (ICH) over the last decade; (3) assessment of whether diabetes increases the adjusted risk of ICH in the population; and finally, (4) assessment of whether diabetes worsens the outcome of patients with ICH when considering other risk factors.

Materials and Methods

This retrospective, observational study was conducted using the Spanish National Hospital Database (*Conjunto Mínimo Básico de Datos* [CMBD]). This database is managed by the Spanish Ministry of Health, Social Services and Equality and compiles all public and private hospital data, hence covering more than 95% of hospital discharges.[18] The CMBD includes patient variables (gender and date of birth), admission date, discharge date, up to 14 discharge diagnoses, and up to 20 procedures performed during the hospital stay. The Spanish Ministry of Health, Social Services and Equality sets standards for record-keeping and performs periodic audits.[18]

Disease and procedure criteria were defined according to the International Classification of Diseases—Ninth Revision, Clinical Modification (ICD-9-CM), which is used in the Spanish CMBD.

We selected all patients hospitalized for hemorrhagic stroke (ICD-9-CM codes: 430, 431, 432.1) as the primary diagnosis between January 1, 2003, and December 31, 2012.

Discharges were grouped by diabetes status as follows: T2DM (ICD-9-CM codes: 250.x0 and 250.x2) and no diabetes. Patients with type 1 diabetes (ICD-9-MC codes: 250.x1 and 250.x3) were excluded.

We calculated the incidence of discharge rates after hemorrhagic stroke for men and women with and without T2DM per 100,000 inhabitants. We calculated yearly diabetes-specific incidence rates by dividing the number of cases per year, gender, and age group by the corresponding number of people in that population group, using age- and gender-adjusted estimated prevalence of diabetes obtained from National Health Surveys conducted in April 2003, July 2006, October 2009, and December 2011 and data from the Di@bet.es Study.[19,20] We also calculated the yearly age- and gender-specific incidence rates for nondiabetic patients by dividing the number of cases per year, gender, and age group by the corresponding number of people in that population group (excluding those with T2DM), according to data from the Spanish National Institute of Statistics, as reported on December 31 of each year.[21]

Clinical characteristics included information on overall comorbidity at the time of diagnosis, which was assessed by calculating the Charlson Comorbidity Index (CCI). The index applies to 17 disease categories, the scores of which are added to obtain an overall score for each