Cerebrovascular Dissemination in Time and Space as a Predictor of Cardioembolism

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Background: Cardioembolism has tendency to recur and cause lesions in distinct cerebrovascular territories. Using the imaging characteristics of cerebral lesions to determine dissemination in time and space (DTS) is a concept already used in other neurologic conditions; however, it has never been applied as a diagnostic tool in ischemic stroke etiology. *Aim:* This study aimed to assess DTS as a diagnostic marker of cardioembolism. *Methods:* We enrolled consecutive patients with acute ischemic stroke of various etiologies admitted in a cerebrovascular disease nursery from a university hospital in a retrospective cohort study. We excluded patients with coexisting etiologies, incomplete study, or without an acute vascular lesion on computed tomography scan. Lacunar infarctions were not considered. Cerebrovascular territory was divided into right anterior, left anterior, and posterior. Localization of the acute vascular lesion(s), existence of previous vascular lesions, and their respective areas were analyzed. The presence of dissemination in time, space, or DTS was determined. *Results:* We included 661 patients (mean age: 74.05 years (SD: 13.01)). Cardioembolism was the etiology with most DTS (30.47% of cardioembolic strokes); DT occurred more frequently within the atherosclerotic subtype (9.88%); DS was more prevalent within the arterial dissection group (3.33%). There was a statistically significant difference in stroke etiology between patients with DTS and patients without dissemination ($P < .001$). DTS had 81.67% specificity, 30.47% sensitivity, 66.67% positive predictive value, and 49.40% negative predictive value for the identification of cardioembolism. *Conclusion:* DTS is a specific diagnostic predictor of cardioembolic stroke and may be helpful in guiding etiologic investigation. **Key Words:** Ischemic stroke—stroke subtypes—cardiac emboli—CT scan—diagnostic method—atrial fibrillation.

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Introduction

Cardioembolism is responsible for 15%-35% of ischemic strokes,[1-7] and typically, the prognosis is poor not only in terms of mortality, but also in short- and long-term recurrence.[2,5,8,9]

The diagnosis of cardioembolic stroke requires the identification of at least 1 cardiac emboligenic condition and exclusion of other potential large-artery sources of thrombosis or embolism.[10,11]

A stroke occurring simultaneously or sequentially in more than 1 vascular territory is particularly suggestive of a cardioembolic origin,[8,9,12,13] alerting for high recurrence risk and the need to institute specific secondary prevention strategies. This is especially the case when there are ischemic embolic lesions with different ages and involving distinct vascular territories. In other neurologic conditions (such as multiple sclerosis), the concept of dissemination in time and space is already in practice based on using the imaging characteristics of lesions to infer a pathologic substrate. However, to the best of our knowledge, the concept of cerebrovascular dissemination in time and space has never been used as a predictor of cardioembolic strokes.

Aims

The aim of this study is to compare cardioembolic with noncardioembolic strokes concerning the existence of ischemic embolic lesions in multiple cerebrovascular territories (dissemination in space), the occurrence of such infarcts within the same territory (dissemination in time), and both phenomena simultaneously (dissemination in time and space), assessing the diagnostic validity of these concepts for stroke etiology.

Methods

Study Population

We included consecutive patients with ischemic stroke admitted at our University Hospital's Stroke Unit and Cerebrovascular Ward from January 2014 to December 2015.

Exclusion criteria were absence of an acute lesion on computed tomography (CT) scan; undetermined cause of stroke without a thorough clinical evaluation (12-lead electrocardiography, transthoracic or transesophageal echocardiography, transcranial and cervical Doppler ultrasonography, and 24-hour Holter monitoring); stroke of coexisting causes; and rarely determined etiologies (except for arterial dissection due to its frequency among young and middle-aged patients).[12,14] Figure 1 presents the algorithm for patient inclusion.

All patients were informed of data collection for clinical studies and were free to withdraw consent. Written informed consent was not obtained due to the observational and retrospective nature of the study, which was approved by the local ethics committee.

Demographic Data and Risk Factors

We collected data on patients' vascular risk factors from a prospectively defined clinical registry: age, sex, alcoholism, smoking, arterial hypertension, diabetes mellitus, dyslipidemia, coronary artery disease, peripheral artery disease, atrial fibrillation (AF), heart failure, obesity, history of previous strokes, and migraine.

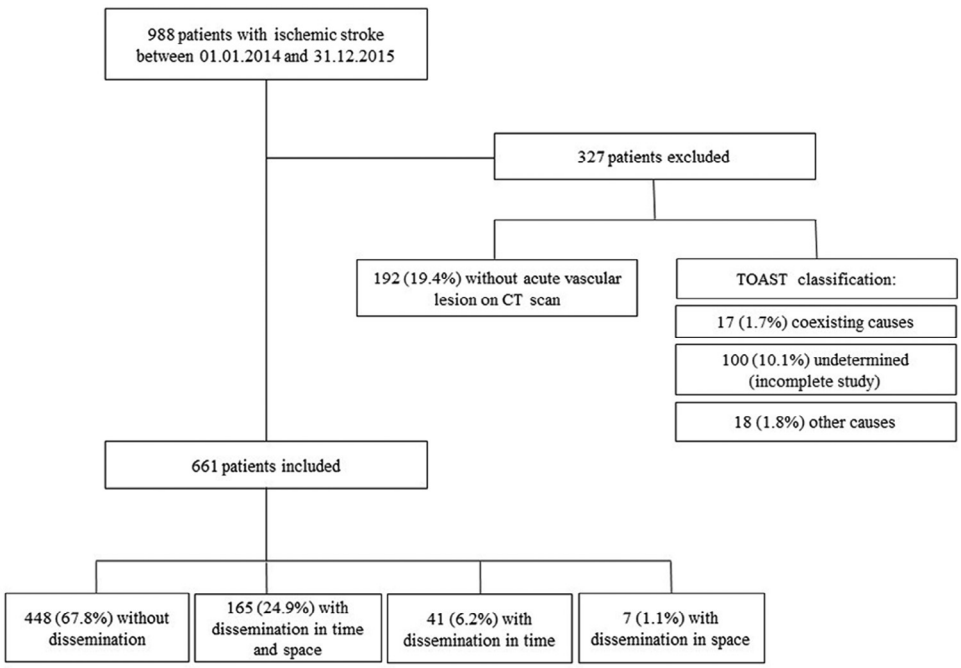

Figure 1. *Algorithm for patient inclusion. All exclusion criteria and the respective number of patients are listed.*