Short Report: The Importance of Neurocysticercosis in Stroke in Rural Areas of a Developing Latin American Country

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Abstract. There is limited information on the prevalence of neurocysticercosis (NCC) among stroke patients, and no community-based survey has addressed this issue. We performed a 3-Phase, population-based study, to assess the prevalence and pathogenesis of stroke in a rural village of coastal Ecuador, where cysticercosis is highly endemic. Twenty stroke patients were found among 642 individuals ≥ 40 years of age. Eighteen of these patients underwent neuroimaging studies and no patient had evidence of NCC or angiitis of intracranial vessels. The serum immunoblot test for the detection of anticysticercal antibodies, performed in 15 of these 20 patients during a previous survey, were negative in 13 cases and the remaining two had a normal computed tomography of the head. This study suggests that NCC is not responsible for the increasing burden of stroke in rural areas of developing countries.

Ischemic stroke is a well-known complication of neurocysticercosis (NCC) and almost always occurs in patients with the subarachnoid form of the disease.¹ In such cases, the inflammatory reaction surrounding subarachnoid cysticerci induces occlusion or segmental narrowing of medium-size or small perforating arteries arising from the circle of Willis or its major branches.² Hospital-based registries in endemic areas have shown that 4–6% of NCC patients have a stroke.^{3,4} The opposite, i.e., the prevalence of NCC among stroke patients, has been less-well investigated. Some older studies revealed NCC in 2.5–7.3% of stroke patients.^{5,6} However, these reports came from specialized NCC centers where the prevalence of NCC among stroke patients may have been overestimated. No population-based stroke registry performed in cysticercosis-endemic communities has reported the occurrence of this parasitic disease, suggesting that its actual prevalence among stroke patients is low or nonexistent. We conducted this study in Atahualpa, a previously known highly endemic village for cysticercosis with a seroprevalence of 8.6% in the general population⁷ to confirm the suggested absence of NCC among stroke patients diagnosed at the rural level.

As described elsewhere, the Atahualpa Project is a 3-Phase, population-based survey primarily designed to evaluate the cardiovascular health and the prevalence of stroke in a village representative of rural coastal Ecuador.⁸ During *Phase I*, trained field personnel screened all Atahualpa residents ≥ 40 years of age with a validated questionnaire to identify persons with suspected stroke.⁹ We used the capture-recapture method to enhance the detection of all possible stroke cases. Therefore, besides the door-to-door survey, we reviewed the medical records from the only one health center of Atahualpa, and the original files of our stroke survey performed in 2003 at the same village.¹⁰ In *Phase II*, certified neurologists examined all individuals who screened as suspected cases, and two randomly selected persons who were considered negative during the screening phase (matched by age and gender to the suspected cases). Neurologists were blinded as to whether the individual was a suspected positive case or a negative control, and stroke

was defined in patients who had experienced a rapidly developing event characterized by clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours, with no apparent cause other than vascular. In *Phase III*, stroke patients were invited to undergo further examination, including brain magnetic resonance imaging (MRI), magnetic resonance angiography (MRA) of intracranial vessels, 12-lead electrocardiogram (ECG), transthoracic echocardiogram, and Doppler examination of extracranial arteries.

The questionnaire revealed 28 suspected stroke cases among 642 Atahualpa residents ≥ 40 years of age. Neurological evaluation showed that 19 of these subjects had experienced a completed stroke. Examination of 56 non-suspected individuals disclosed one further patient, yielding a total of 20 stroke patients (mean age, 69.8 ± 11 years; 60% men). A crude prevalence rate of stroke was 31.15‰ in subjects aged ≥ 40 years (27.78‰ when adjusted to the United States population). The 20 stroke patients had a mean age of 69.8 ± 11 years, and 60% were men. They had a mean age of 63.4 ± 8.5 at the time of first-ever stroke occurrence.

Eighteen of the 20 stroke patients accepted the practice of complementary exams. The MRI and MRA were performed in all but one patient who had a history of a coiled intracranial aneurysm; this patient was only studied with computed tomography (CT). The MRI showed corresponding vascular lesions consistent with stroke in all but two cases. Twelve patients had single or multiple small subcortical infarctions, which were most often associated with leukoaraiosis and basal ganglia microbleeds, and the remaining patients had cortical infarcts or old intracranial bleeds. Overall, 55% of patients had hypertensive arteriopathy as the most likely pathogenic mechanism underlying the stroke, one had a ruptured intracranial aneurysm, and the remaining cases had stroke of undetermined etiology (more than one cause or no identifiable cause).¹¹

An expert neuroradiologist (J.L.) evaluated all imaging studies with special attention to findings suggestive of subarachnoid NCC or intracranial vascular lesions consistent with angiitis. There were no lesions consistent with NCC in 17 patients undergoing MRI or in the single patient that was evaluated with CT, and no patient had evidence of intracranial angiitis on MRA.

In addition, we reviewed the files of our previous stroke survey in Atahualpa¹⁰; at that time, eight out of 10 stroke

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patients were evaluated with CT, and intracranial calcifications not related to the stroke were found in two of them. The neuroradiologist (J.L.) reviewed again those CTs and found no evidence of subarachnoid cysts or any other active form of NCC. One of the two patients with stroke and incidental calcifications found in the 2003 survey died before the current study, and the other was one of the 20 stroke patients detected at the current survey, but he was now 91 years old and did not accept the practice of MRI. By the time of the 2003 survey, we performed a serum immunoblot for the detection of cysticercal antibodies in all consented Atahualpa residents,¹² and we found a seroprevalence of 8.6% in the general population.⁷ All of the currently detected stroke patients were living at Atahualpa by 2003 (four already had a stroke at that time), 15 of them had the immunoblot, and all but two (with normal CTs at that time) were negative.

This study has potential weaknesses, including the small size of the sample, which may not allow drawing definitive conclusions, and the fact that the two patients with stroke detected at the 2003 survey were only evaluated with CT at that time, and repeated neuroimaging (MRI) could not be performed. The major strength of this analysis, however, is that it is based on a community survey including all persons ≥ 40 years of age living in a village that is highly endemic for cysticercosis.

Another potentially perceived limitation of this study is that stroke patients were identified some years after the acute event, and it could be argued that they actually had subarachnoid NCC causing the stroke that spontaneously resolved by the time MRIs were performed. However, this form of NCC is most often relentlessly progressive, causing entrapment of intracranial arteries at the base of the brain or obstructive hydrocephalus as a result of occlusion of Luschka and Magendie's foramina, and it is not expected to resolve spontaneously.¹³

In conclusion, we did not detect a significant association between NCC and stroke in this rural population where cysticercosis is highly endemic, suggesting that NCC is not a major cause of the increasing burden of stroke in rural areas of developing countries. This is not surprising because it is well known that the clinical manifestations and forms of presentation of NCC are different in infected persons detected in community-based studies performed in rural villages than in patients attending specialized centers in urban areas. In the former, most persons with NCC are either asymptomatic or develop seizures as the sole manifestation of the disease.^{7,14,15}

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