Stroke accounts for 2% of all medical emergencies during commercial flights with an estimated incidence of 1 stroke every 163,420 flights. On-board stroke has been reported in several scientific studies, although most were retrospective case series focusing on economy class stroke syndrome (ECSS). This subtype of stroke results from paradoxical embolism through a patent foramen ovale. Every subject with suspected acute stroke in the airport is assessed by a neurologist on arrival. A prospective registry was designed to include all consecutive patients referred from an international airport (40 million passengers a year) to our hospital with a diagnosis of ischemic stroke or transient ischemic attack and onset of symptoms during a flight or immediately after landing.

**Methods**—A prospective registry was designed to include all consecutive patients referred from an international airport (40 million passengers a year) to our hospital with a diagnosis of ischemic stroke or transient ischemic attack and onset of symptoms during a flight or immediately after landing. Patients with symptom onset during the flight prompted a flight diversion. From the Ethics Committee of our center.

**Results**—Forty-four patients (32 ischemic strokes and 12 transient ischemic attacks) were included over a 76-month period (January 2008 to April 2014). The estimated incidence of stroke was 1 stroke in 35,000 flights. Pathogeneses of stroke or transient ischemic attack were atherothrombotic in 16 (36%), economy class stroke syndrome in 8 (18%), cardioembolic in 7 (16%), arterial dissection in 4 (9%), lacunar stroke in 4 (9%), and undetermined in 5 (12%) patients. Carotid stenosis >70% was found in 12 (27%) of the patients. Overall prognosis was good, and thrombolysis was applied in 44% of the cases. The most common reason for not treating patients who had experienced stroke onset midflight was the delay in reaching the hospital. Only 1 patient with symptom onset during the flight prompted a flight diversion.

**Conclusions**—We found a low incidence of stroke in the setting of air travel. Economy class stroke syndrome and arterial dissection were well represented in our sample. However, the main pathogenesis was atherothrombosis with a high proportion of patients with high carotid stenosis. (Stroke. 2016;47:1117-1119. DOI: 10.1161/STROKEAHA.115.012637.)

**Key Words:** air travel, dissection, embolism, paradoxical, foramen ovale, patent ischemic attack, transient stroke
The Table shows the demographic variables, history of the flight, cerebrovascular risk factors, clinical variables, as well as the stroke management and outcome.

Pathogeneses of stroke or transient ischemic attack were atherothrombotic in 16 (36%), cardioembolic in 7 (16%), ECSS in 8 (18%), arterial dissection in 4 (9%), and lacunar stroke in 4 (9%) of the cases. In 5 (12%) of the patients, the pathogenesis of stroke was undetermined, with 2 of these cases being because of the coexistence of cardioembolic and atherothrombotic stroke criteria. Regarding atherothrombotic stroke, stenosis >70% was found in 12 patients (27%), including 5 carotid occlusions (11%). Patients with arterial dissection reported no previous cervical trauma.

None of our patients with ECSS had deep vein thrombosis, although 2 patients had concomitant pulmonary thromboembolism and only 1 of them had a risk factor for thrombosis (protein C deficiency). ECSS and arterial dissection were the most frequent pathogenesis among patients with uncommon causes of stroke. Sixteen patients were treated with reperfusion therapies (44% of ischemic stroke patients): all received intravenous thrombolysis, and in 1 case, endovascular thrombectomy was also performed after intravenous thrombolysis. Only 1 flight was diverted because of stroke suspicion upon consultation with a physician on the same flight who volunteered his services. Ten of 21 patients with stroke onset during the flight could not receive reperfusion therapies because of the delay in arriving at the hospital. All patients with stroke onset after landing arrived within the time window for thrombolysis.

**Discussion**

This study is the largest clinical series (44 patients) of stroke in this clinical setting to date. In our prospective cohort, the estimated incidence of stroke was 1/35,000 flights, which is higher than that estimated in a previous study (1/163,000) but still indicates a low incidence of stroke during commercial flights. The younger mean age (62.8), high proportion of male patients (68%), and frequency of patients with uncommon causes of stroke and without common stroke risk factors (30%) in our series together suggest a different risk profile for stroke linked to commercial flights when compared with stroke in the general population.

A high frequency of high-grade carotid stenosis and occlusion was found (12 patients, 27%). Reynolds et al analyzed stroke incidence during airplane travel in 77 patients with a previous diagnosis of carotid stenosis or occlusion. They did not find any clinical episode in none of the 174 flights. However, all the flights were of short duration (mean 107±4.1 minutes), although in our series 8 of 12 strokes linked to high-grade carotid stenosis or occlusion occurred in longer flights (>4 hours). The risk of stroke in established chronic carotid occlusions, which lead to compensatory changes in brain hemodynamics to preserve global perfusion, is known to be lower than that of high-grade carotid stenosis. The drop in ambient oxygen concentration with the lowering pressure in the cabin decreases blood oxygen saturation to <94%. This effect—together with the dehydration in long flights—might further compromise brain perfusion in individuals with a poor hemodynamic reserve, although no patient presented signs of dehydration and only 1 had a history of chronic pulmonary disease. Further evidence is required to establish the safety of air travel in patients with carotid disease.

In previous studies, ECSS emerged as the most frequently reported pathogenesis of stroke in commercial flights. Although well represented (8 patients, 18%), ECSS was the second most common pathogenesis in our series. Another point of interest is the relatively high proportion of stroke caused by artery dissections in our series (9%). In a literature search, we found 3 case reports of stroke in air travelers caused by this pathogenesis. Maintained unnatural cervical postures and microtrauma caused by turbulence during the flight might contribute to cervical artery dissection in predisposed individuals. Cervical artery dissections and economy class stroke syndrome were the main pathogenesis of stroke in younger air travelers without conventional stroke risk factors. This finding may help focus diagnostic work-up and management of this condition by clinicians. The limitations of this
study include the lack of a control group, no information on adherence to usual treatments during the flight, and the lack of follow-up after hospital discharge.

**Disclosures**

None.

**References**

Stroke in Commercial Flights
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