There is another argument suggesting that abuse of sympathomimetic drugs like khat is associated with cardiovascular events: the circadian rhythm of people suffering thrombotic events is different from that of normal controls.

Studies such as ISIS-2 have consistently shown a morning peak in the incidence of acute myocardial infarction, which is related to an increased sympathetic outflow and circulating catecholamines at this time of the day [10]. Alkadi et al. [5] studied the occurrence of myocardial infarctions in khat users and found that 59% of myocardial infarctions developed between late afternoon and midnight. They found that the myocardial infarction incidence was increased three-fold [5]. Pharmacokinetic studies have shown a peak plasma concentration of cathinone 2.1–2.3 h after chewing [1, 11].

Present Case. Our patient developed recurrent large vessel cerebral disease. Both strokes occurred in the evening, after khat chewing. Alternative causes for stroke in young adults were carefully excluded. Apart from khat chewing, this young patient had no major risk factors for stroke, although he reported a familial history of severe arterial hypertension and neurological deficit in family members who also regularly chewed khat. A genetic background that renders people vulnerable to khat-induced vascular changes, as suggested by Alkadi [5], cannot be ruled out. After stopping khat chewing and taking aspirin regularly, no further cerebrovascular events occurred. We therefore conclude that our observation is highly suggestive of khat use being causally associated with ischaemic stroke. As we live in a multicultural society, we want to highlight this possible neurological manifestation of a social habit amongst immigrants.

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Brain Stem Infarction Caused by Proximal Internal Carotid Artery Stenosis in a Patient with a Persisting Primitive Trigeminal Artery

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Introduction

The primitive trigeminal artery (PTA) is the most common of the persistent embryonal carotid-basilar anastomoses with a prevalence of 0.2–0.6% in adult angiographic series [1, 2]. Together with the otic, hypoglossal and proatlantic arteries, the PTA evolves in the 3- to 5-mm embryo connecting the dorsal aorta (the future distal internal carotid artery, ICA) to the bilateral longitudinal neural arteries, which later develop into the vertebrobasilar artery system [3, 4]. This case report describes a patient with a PTA suffering a brain stem infarction most likely caused by artery-to-artery embolism from a proximal ICA stenosis.

Case Report

A 62-year-old Caucasian woman with a history of arterial hypertension reported a transient episode of ill-defined visual disturbance and a mild right-sided hemiparesis. She noticed the symptoms immediately after a visit to her dentist, where a procedure was performed with her head extended backwards and turned to the left. A few days after symptom onset, an MRI of the brain revealed two small diffusion-weighted imaging-positive and T₂-hyperintense midbrain lesions suggestive of subacute midbrain infarction (fig. 1a). Doppler sonography identified a moderate proximal ICA stenosis on the right side, which was not felt to be related to the midbrain lesions. The patient was put on antiplatelet drugs. Within weeks, the neurological deficit resolved completely.

Approximately 14 months later, carotid ultrasound was repeated, and progression of ICA stenosis was suspected. The patient was then referred to our outpatient cerebrovascular clinic as a potential candidate for interventional therapy. Meanwhile, symptoms suggestive of new cerebrovascular events had not occurred, and the neurological examination was completely normal. Doppler sonography now showed high-grade ICA stenosis on the right side (80%). A critical reevaluation of the initial MRI revealed a persisting PTA on the right side (initially misinterpreted as the right posterior communicating artery) associated with hypoplastic vertebral arteries (fig. 1b). The patient was then admitted to our stroke unit for further diagnostic workup. There was no evidence of concomitant heart disease, atrial fibrillation or coagulation disorders. We concluded that the mesencephalic and peduncular infarctions were due to embolism from the right ICA stenosis and transmitted through the PTA into the posterior circulation. We discussed possible therapeutic options regarding the formerly symptomatic ICA stenosis with the patient who decided in favor of transluminal angioplasty and stent implantation.

Diagnostic angiography of the right common carotid artery, performed in the same session with the carotid stent procedure,

Fig. 1. T₂-weighted MRI of the patient performed a few days after the onset of an ill-defined vision disturbance and a mild right-sided hemiparesis. a The T₂-hyperintense (and diffusion-weighted imaging-positive) lesion refers to a small subacute mesencephalic infarct (arrow). b Flow-void phenomena (arrow) indicating carotido-basilar anastomosis (trigeminal artery).

Fig. 2. DSA images performed 15 months after symptom onset. Sonographically, progression of the ICA stenosis to a degree of 80% was documented. a High-grade right-sided ICA stenosis before carotid angioplasty. b Filling defect in the cavernous carotid artery due to inflow phenomena of the trigeminal artery indicating retrograde flow and contribution to the collateral supply of the right hemisphere. c Recanalization of the ICA lumen after carotid stenting. d Orthograde filling of trigeminal artery is visible after restoration of normal ICA flow.

showed a high-grade stenosis of the ICA with a luminal narrowing of 90% according to NASCET criteria [5] (fig. 2a). The cavernous portion of the right ICA showed a filling defect, no anastomosis to the posterior circulation was visible (fig. 2b). Intracranially, we found a slightly delayed filling of the right anterior and middle cerebral arteries. Diagnostic angiography was followed by endovascular treatment of the carotid artery stenosis. Under protection of a filter device placed in the high cervical ICA, a self-expanding

carotid stent was positioned across the stenosis and dilated to a diameter of 5 mm. Control angiograms after carotid stenting showed restoration of the ICA lumen at the former site of stenosis (fig. 2c). In contrast to the initial angiogram, filling of the carotid-basilar anastomosis from the cavernous segment of the ICA to the midportion of the basilar artery was visible after recanalization, indicating a reversal of flow in the PTA (fig. 2d). Two days after the intervention, the patient was discharged. She was put on com-

bined antiplatelet therapy (ASS and clopidogrel) for the next 3 months.

Discussion

In the literature, associations of the PTA with intracranial aneurysms, cavernous sinus fistulas and trigeminal neuralgia were described [6–8]. Consistent with a previously published case report [9], our study emphasizes that the PTA may also play a role in cerebral ischemia while transmitting an embolus from the carotid artery distribution into the posterior circulation. In most instances, angiograms of patients with the PTA show a flow direction of the anastomosis from the carotid to the basilar artery [1]. This explains why patients with carotid stenoses proximal to the PTA may develop embolic infarcts in the territory of the posterior circulation. In our patient, a moderate stenosis of the right ICA progressed to a high-grade, hemodynamically relevant stenosis, and our hypothesis is that a former orthograde perfusion of the anastomosis turned to a retrograde flow contributing to the collateral supply of the right anterior circulation. After successful endovascular recanalization of the ICA stenosis, the orthograde flow of the PTA was reestablished and visible on the carotid angiogram.

Conclusions

In patients with otherwise unexplained upper brain stem ischemia and 'coincidental' stenosis of the ICA, further diagnostic efforts, preferably MRI and MR angiography [10], are justified to search for a persisting PTA. This may help to avoid potentially harmful delays in initiating specific treatment.

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Neuroimaging and Pathology of the Progression of Unilateral to Bilateral Medial Medullary Stroke

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Medial medullary stroke (MMS) accounts for less than 0.5% of all cerebral infarcts [1]. Spiller in 1908 [2] and Déjerine in 1914 [3] described the association of ipsilateral tongue paralysis and contralateral hemiparesis with loss of deep sensation, but without pathologic support.

This triad is rare and partial syndromes are more common [4]. Some autopsies have revealed bilateral involvement [4]. Ocular bobbing and upbeat nystagmus have also been reported [4].

We present the first case of a patient with initial presentation of right anteromedial medullary stroke and progression to bilateral anteromedial medullary ischemia documented by brain magnetic resonance imaging (MRI) as well as autopsy.

Case Presentation

A 64-year-old African-American woman presented with left hemiparesis sparing the face and dysphonia. She had a history of hypertension, hepatitis C, and chronic renal insufficiency. On examination she had upbeat nystagmus, labile blood pressure, tachycardia and right tongue deviation. Her deep tendon reflexes were brisk on the left side, tone was decreased but extensor plantar response was not present until few days later.

Initial head CT was normal but diagnosis of medullary infarct was entertained and confirmed by brain MRI. Diffusion-weighted imaging (DWI) revealed right medial medullary infarct (fig. 1a). Magnetic resonance angiography showed absent right vertebral artery flow and tortuous basilar artery (fig. 1b). She was started on intravenous heparin since presentation. One day later, she developed right hemiparesis and respiratory distress requiring intubation. Repeated DWI revealed bilateral MMS (fig. 2). Transesophageal echocardiogram, carotid and transcranial Doppler were negative. Hepatitis C screening and ANA were positive (1:80, mixed speckled and homogeneous pattern) and ESR was 74. Rheumatoid factor and antiphospholipid panel were negative. Patient had no history of drug abuse and initial drug screen was negative.

She remained in a locked-in state with marked fluctuation of the nystagmus and dysautonomia. Although initially she was able to communicate by blinking, few days later she became unable to move her tongue or facial muscles. She developed medical complications with worsening renal failure requiring dialysis. Two months later she developed unexplained fever. She had a gastric perforation caused by a PEG tube. She was treated for peritonitis but died a few days later. Autopsy revealed cystic bilateral medial medullary infarct with right vertebral artery stenosis and 50% basilar artery stenosis (fig. 3). Both vertebral arteries were patent but no flow was observed in the right posterior inferior cerebellar artery.

Discussion

This is the first documented brain MRI series showing the progression of unilateral anteromedial to bilateral anteromedial med-