

all levels of the CNS and cranial nerves and spinal nerve roots. Drainage of DAVFs may be into venous sinuses or cerebral or perimedullary veins. DAVFs with medullary venous drainage as opposed to sinus drainage are believed to pose a high risk of future ischemia and hemorrhage.<sup>1</sup> Although usually spontaneous, it may be that a congenital anomaly and proper hemodynamic circumstances are required for development of DAVFs. Most commonly, intracranial DAVFs are believed to occur after trauma or sinus thrombosis or some other cause of venous sinus hypertension.<sup>1,3</sup>

One detrimental effect of DAVF is through venous hypertension and resultant ischemia. Passive congestion occurs because of retrograde increased venous pressure toward the venous drainage routes of normal brain and spinal cord.<sup>2-5</sup> Because of their lack of valves, the intramedullary veins are even more directly affected by pressure increases in the perimedullary veins.<sup>5</sup>

Intracranial DAVFs can lead to myelopathy with increased MRI T2-weighted signal in the spinal cord.<sup>6</sup> This is thought to occur because the coronal venous plexus of the spinal cord is connected with the veins of the posterior fossa.

Reports of intracranial DAVF causing isolated brainstem abnormalities are rare.<sup>7</sup> An important feature is that the site of T2-weighted signal change is not necessarily indicative of the site of the DAVF, a point that is useful to remember because full neuraxis imaging is warranted when the diagnosis of DAVF is considered. Expanded imaging in our patient was helpful because a biopsy of the medulla would have likely been nondiagnostic and possibly morbid. The diagnosis was not readily apparent in our patient from the brain MRI, although in retrospect the flow void off the lateral surface of the medulla may have been a clue. Only after the abnormal vascularity was seen on the spine MRI was the diagnosis of a DAVF strongly considered. Formal angiography, including selective injections of the external carotid arteries, may be necessary to definitely make the diagnosis and evaluate the venous drainage of the lesion.

The goal of management of this type of DAVF is to disconnect the draining vein, thereby eliminating the fistula.<sup>2</sup> A direct surgical approach is straightforward with low rates of failure (<3%) and morbidity or mortality and was the treatment of choice for this patient. Additionally, endovascular approaches, usually from the venous side of the fistula, and stereotactic radiosurgery have also been successful in managing DAVFs.

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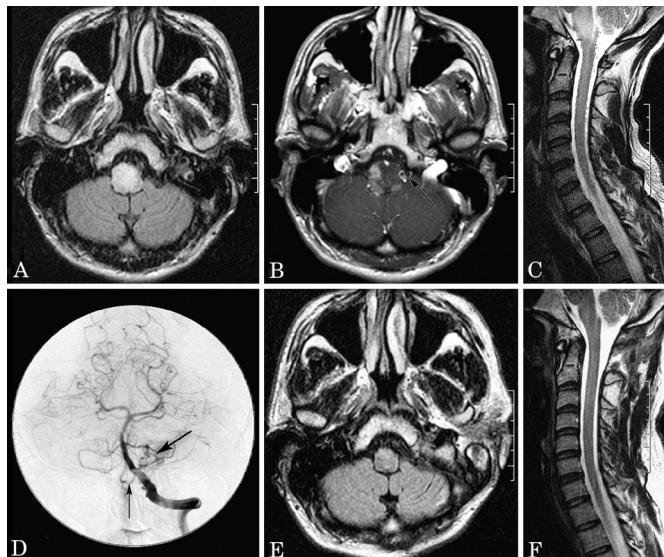
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## Recurrent hemiplegia, normal MRI, and NOTCH3 mutation in a 14-year-old: Is this early CADASIL?

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Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) is a rare, progressive, familial vasculopathy associated with mutations in the *NOTCH3* gene, a transmembrane protein expressed in vascular smooth muscle cells.<sup>1</sup> Although clinical symptoms are primarily neurologic, abnormalities are found in the systemic and cerebral vasculature.<sup>2</sup> Migraines in people with CADASIL may begin as early as age 10 years,<sup>3</sup> but TIAs and strokes are rare before age 20 years.<sup>3,4</sup> We describe a girl aged 14 years with migraines, hemiplegia, hypertension, and *NOTCH3* mutation but unremarkable cerebral MRI and no family history of CADASIL.



**Figure.** (A) Initial axial fluid-attenuated inversion recovery MRI revealing increased signal and expansion in the medulla. (B) Patchy enhancement after gadolinium administration with suspicious flow void (arrow). (C) Sagittal cervical spine T2-weighted MRI shows serpiginous vessels on the surface of the spinal cord. (D) The dural arteriovenous fistula (larger arrow) and draining vein (smaller arrow) were seen with angiography. (E and F) Postoperative MRI shows resolution of the hyperintensity in the medulla and of the abnormal vascular flow voids in the cervical spine.

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**Case report.** A right-handed girl aged 14 years came to our clinic with a 3-year history of severe headaches, three episodes of right hemiparesis (at ages 11, 12, and 14 years), persistent hypertension, and a 4.5-kg weight loss. Each episode began with sleepiness, weakness, and headache with photophobia, progressing to tingling of the right face and right arm followed by right facial droop and right arm and leg weakness. She had residual hemiparesis after the second event. Hypertension, diagnosed at the time of the first event, with systolic blood pressure of ~150 to 159 mm Hg and diastolic blood pressure of ~90 to 99 mm Hg, was treated with atenolol, 25 mg once a day. Medical history was unremarkable. Family history was negative for headaches, early strokes, hypertension, and dementia. A maternal great-grandfather had multiple strokes in his 70s that were attributed to cardiac disease.

At our clinic her weight was 47.4 kg and her height was 153.4 cm. She read a grade-level paragraph with good comprehension. She had mild right hemiparesis with slight facial droop and decreased strength (4/5) in the arm and leg, mild right sensory loss, and slight right hyperreflexia. Two previous cranial MRI studies

at other hospitals were unremarkable, as was 3-T MRI at our institution, which included diffusion-weighted imaging, spectroscopy, and MR angiography with and without contrast. EEG, echocardiogram, renal ultrasound, and renal dimercaptosuccinic acid scan were unremarkable. CSF demonstrated no cells; unremarkable glucose, protein, and lactate; and no elevation of myelin basic protein or oligoclonal bands. Borderline elevations of anticardiolipin and antiphosphatidylcholine immunoglobulin M were not present on repeat testing. Serum studies of blood urea nitrogen, creatinine, glucose, lactate, prothrombin time, partial thromboplastin time, erythrocyte sedimentation rate, angiotensin-converting enzyme, thyroid function, aldosterone, and renin were unremarkable. Analyses by Athena Diagnostics (Worcester, MA) for *MELAS* mutations 3243, 3271, 3252, 3256, 3291, and 13513 were negative but revealed an A-to-T transversion at nucleotide 973 of codon 299 in the *NOTCH3* gene, changing serine to cysteine and predicted to be a CADASIL-associated mutation.

The patient became depressed. After genetic counseling, her asymptomatic mother declined testing; her father did not come to clinic. Treatment with counseling, aspirin, 325 mg once a day; paroxetine hydrochloride, 20 mg once a day; naproxen, 250 mg every 12 hours; promethazine hydrochloride, 25 mg before bedtime; and propanolol, 20 mg once a day resulted in mild improvement of headaches and depression; after a fourth episode of hemiparesis, propanolol was changed to nifedipine, 30 mg XL once a day.

**Discussion.** CADASIL usually is diagnosed in children only after another older family member has been diagnosed. Our patient developed symptoms at age 11 years and had no family history suggesting CADASIL.

We considered the diagnoses of migraine-associated stroke and familial hemiplegic migraine, but her history did not fit the International Headache Society criteria for either diagnosis: she had no history of migraines with aura before her first stroke, had persistent motor and sensory symptoms, and had no family history of hemiplegic migraine.<sup>5</sup> We did not evaluate the *CACNA1A* gene, also on chromosome 19, for this reason. Although her specific *NOTCH3* mutation has not, to our knowledge, been previously described, similar mutations in exon 6, which also lead to the gain of cysteine, have been associated with CADASIL.<sup>6</sup>

Our patient's hypertension may be caused by microvascular renal involvement. We do not have a renal biopsy to confirm this; however, all other studies for renal causes of hypertension were negative. Her clinical course does not suggest a general systemic

vasculitis. There are rare reports of hypertension associated with CADASIL.<sup>3</sup>

Our patient may develop abnormalities on her cranial MRI as she grows older. MRI abnormalities in CADASIL develop over time and may be subtle in CADASIL patients in their early 20s.<sup>7</sup> Our patient may currently have lesion(s) so small that even 3-T MRI cannot detect them.

We suggest that clinicians consider screening for the *NOTCH3* gene in children with chronic headaches and repeated episodes of hemiplegia, even in the absence of MRI abnormalities or a family history suggestive of CADASIL.

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## Acute cerebellar ataxia due to Sjögren syndrome

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Acute cerebellar ataxia is more common in pediatric patients than in adults and is usually caused by a postinfectious process or drug ingestion. Although a myriad of other causes have been described, acute cerebellar ataxia has not been reported as the presenting symptom of Sjögren syndrome. We report a previously healthy adolescent girl who was examined for acute cerebellar ataxia and MRI findings of parotitis and who was diagnosed with primary Sjögren syndrome (PSS).

**Case report.** A girl aged 16 years developed a headache; evaluation at a local emergency department with head CT revealed sinusitis, and she was treated with antibiotics. A few days later, she developed leg numbness, dysarthria, and ataxia. An MRI at another hospital demonstrated "cerebellar inflammation," and a lumbar puncture revealed a protein of 110 and leukocyte count of 210 with a lymphocytic pleocytosis. Treatment with cefotaxime and acyclovir was stopped after CSF cultures, herpes simplex virus PCR, and blood cultures were negative. After discharge, her primary doctor referred the patient to our institution for persistent ataxia 1.5 weeks after symptom onset.

Her medical history was unremarkable. She took no medications. Her mother had hyperthyroidism, and her grandmother and aunt had rheumatoid arthritis. She denied substance abuse.

Review of systems was unremarkable aside from the current symptoms. She specifically denied xerostomia, xerophthalmia, photosensitivity, rash, arthritis, oral ulcers, recent illness, vaccinations, or toxic ingestions.

Physical examination revealed dental caries and full, non-tender parotid glands. Neurologic examination revealed ocular dysmetria, cerebellar dysarthria, and symmetric appendicular dysmetria and end tremor. Left plantar response was extensor. There was no nystagmus, meningismus, or objective sensory changes.

MRI at our institution (figure) showed T2-weighted and fluid-attenuated inversion recovery hyperintensity of the superior cerebellar vermis and inferior cerebellar hemispheres with mild contrast enhancement. There were multiple areas of mixed signal and T2-weighted hyperintensity within the parotid glands. Review of the previous CT scan revealed diffuse tiny areas of parotid mineralization bilaterally.

Normal laboratory tests included serum electrolytes, serum creatinine, urinalysis, blood counts, liver enzymes, thyroid panel, intermediate normalized ratio, activated partial thromboplastin time, G6PD screen,  $\beta_2$ -glycoprotein, dilute Russell viper venom time, anticardiolipin antibodies, complement levels, double-stranded DNA, anti-Smith, anti-SCL-70, anti-JO1, rheumatoid factor, anti-Hu and anti-Ri antibodies, RPR, Lyme titer, *Bartonella henselae* titer, serum cryptococcal antigen, serum enterovirus PCR, PPD, and HIV testing. Mumps titers were consistent with previous immunization.

Salivary amylase was 102 U/L, lipase, 267 U/L; erythrocyte sedimentation rate, 32 mm/h; C-reactive protein, 1.7 mg/dL; and anti-SSA/Ro, 35.9 U—all elevated. Antinuclear antibody (ANA) was markedly elevated at  $\geq 1:1,280$  in a speckled pattern. Anti-SS-B/La was markedly elevated at  $> 733.4$  U.

A diagnosis of acute cerebellar ataxia caused by PSS was made. Surgical consultants deferred a salivary gland biopsy. The biopsy yield was low after she received pulse-dose methylpred-

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