Pseudotumor Cerebri in Children With Sickle Cell Disease: A Case Series

Michael Henry, MD*; M. Catherine Driscoll, MD*; Marijean Miller, MD‡; Taeun Chang, MD§; and Caterina P. Minniti, MD*

ABSTRACT. Headache is a frequent symptom in sickle cell disease (SCD) that usually is attributable to anemia or cerebrovascular disease. We report 3 pediatric patients with SCD (1 patient with SCD-SC and 2 patients with SCD-SS) who presented with headache and were diagnosed with pseudotumor cerebri (PC). All 3 patients had elevated opening pressures during a lumbar puncture with normal cerebrospinal fluid studies. Magnetic resonance imaging revealed no evidence of hydrocephalus or arteriopathy in all 3 cases. Magnetic resonance venograms performed in 2 of the patients at diagnosis revealed no evidence of cerebral sinus thrombosis. Each patient received a thorough ophthalmologic examination. A diagnostic funduscopic examination revealed bilateral papilledema without signs of retinopathy in all 3 patients. There were no clinically significant changes in visual acuity or abnormalities of color vision in any patient. Goldmann or Humphrey visual-field assessment was abnormal only in patient 1, who demonstrated bilaterally enlarged blind spots at diagnosis and later developed reduced sensitivity in the inferomedial quadrant of the left eye in an arcuate pattern (which later resolved). The diagnosis of PC was made in all 3 patients, and acetazolamide treatment was started. Two of the patients’ symptoms resolved completely with medical treatment, whereas the third patient’s symptoms improved. None of these patients had permanent visual-field deficits as a result of their syndrome. PC has been reported in several other types of anemia including SCD-SC, but these cases are the first reported in conjunction with pediatric SCD. Early recognition of the signs and symptoms of PC in patients with SCD who present with headache can expedite proper diagnosis and treatment and prevent long-term complications of SCD.

ABSTRACT. Headache is a frequent symptom in sickle cell disease (SCD) that usually is attributable to anemia or cerebrovascular disease. We report 3 pediatric patients with SCD (1 patient with SCD-SC and 2 patients with SCD-SS) who presented with headache and were diagnosed with pseudotumor cerebri (PC). All 3 patients had elevated opening pressures during a lumbar puncture with normal cerebrospinal fluid studies. Magnetic resonance imaging revealed no evidence of hydrocephalus or arteriopathy in all 3 cases. Magnetic resonance venograms performed in 2 of the patients at diagnosis revealed no evidence of cerebral sinus thrombosis. Each patient received a thorough ophthalmologic examination. A diagnostic funduscopic examination revealed bilateral papilledema without signs of retinopathy in all 3 patients. There were no clinically significant changes in visual acuity or abnormalities of color vision in any patient. Goldmann or Humphrey visual-field assessment was abnormal only in patient 1, who demonstrated bilaterally enlarged blind spots at diagnosis and later developed reduced sensitivity in the inferomedial quadrant of the left eye in an arcuate pattern (which later resolved). The diagnosis of PC was made in all 3 patients, and acetazolamide treatment was started. Two of the patients’ symptoms resolved completely with medical treatment, whereas the third patient’s symptoms improved. None of these patients had permanent visual-field deficits as a result of their syndrome. PC has been reported in several other types of anemia including SCD-SC, but these cases are the first reported in conjunction with pediatric SCD. Early recognition of the signs and symptoms of PC in patients with SCD who present with headache can expedite proper diagnosis and treatment and prevent long-term complications of SCD.

From the Departments of *Hematology/Oncology, ‡Ophthalmology, and §Neurology, Children’s National Medical Center, Washington, DC.

Received for publication Sep 8, 2003; accepted Nov 20, 2003.

Address correspondence Caterina P. Minniti, MD, Department of Hematology/Oncology, Children’s National Medical Center, 111 Michigan Ave, NW, Washington, DC 20010. E-mail: cminniti@cnmc.org.

PEDIATRICS (ISSN 0031-4005). Copyright © 2004 by the American Academy of Pediatrics.

http://www.pediatrics.org/cgi/content/full/113/3/265
bilateral papilledema. Pupils were sluggish without an afferent pupil defect with a best-corrected vision of 20/30 (right) and 20/25 (left). Goldmann visual-field tests showed bilateral blind-spot enlargement. Computed tomographic head imaging, MRI, and MRA did not reveal hydrocephalus, stroke, or venous thrombosis. A lumbar puncture was performed. The CSF protein, glucose, and cell count were normal, but the opening pressure was 44.5 cm H2O (normal: ≤20 cm H2O). Her hemoglobin was 9.3 g/dL (baseline: 9–10 g/dL). A diagnosis of PC was made, and she was prescribed oral acetazolamide at a dose of 8 mg/kg per day. A few weeks later, her acetazolamide dose was increased to 10 mg/kg per day due to persistent complaints of headache. Once her eye examination returned to normal, the acetazolamide was discontinued on a taper schedule. Within a few weeks of discontinuation, the patient redeveloped headaches and papilledema. At this point, a Humphrey visual-field test showed bilateral enlarged blind spots with decreased central sensitivity of the right eye (Fig 1) and an inferior arcuate defect of the left eye (Fig 2). Visual acuity and pupils were normal. Her acetazolamide dose was titrated up to 20 mg/kg per day. She continues on a weaning dose of acetazolamide, and, at the time of this review, she has been treated for a total of 10 months (current dose: 8 mg/kg per day). Follow-up MRI, MRA, and noncontrast magnetic resonance venography (MRV) did not reveal any structural abnormality, arteriopathy, or venous thrombosis. Her hydroxyurea was discontinued recently after she presented with complaints of severe headache, and she was found to have papilledema on funduscopic examination. Follow-up lumbar puncture revealed a significantly elevated opening pressure (45 cm H2O).

**Patient 2**

An 8½-year-old girl with SCD-SS disease presented with blurred vision and difficulty reading small print of 1 day’s duration. Her SCD history involved multiple hospitalizations for vasoocclusive pain crises, pneumonia, and acute chest syndrome. She also had a history of focal segmental glomerulonephropathy, presumably secondary to her underlying sickling syndrome. On funduscopic examination she had bilateral papilledema. Ophthalmologic examination confirmed papilledema, with normal retinal periphery and without features of sickle retinopathy. Visual acuity was best corrected to 20/20 in each eye with intact color vision and normal pupillary responses. Her hemoglobin was 8.4 g/dL (baseline: 8–9 g/dL). Computed tomographic imaging and MRI of her brain (including MRA and noncontrast MRV) were normal, with no signs of cavernous sinus thrombosis. A lumbar puncture was performed with an opening pressure of 29 cm H2O. Her hemoglobin was 6.6 g/dL (baseline: ≤10 g/dL). Follow-up lumbar puncture revealed a significantly elevated opening pressure (45 cm H2O).

**Patient 3**

An 8½-year-old girl with SCD-SS disease presented with blurred vision and difficulty reading small print of 1 day’s duration. Her SCD history involved multiple hospitalizations for vasoocclusive pain crises, pneumonia, and acute chest syndrome. She also had a history of focal segmental glomerulonephropathy, presumably secondary to her underlying sickling syndrome. On funduscopic examination she had bilateral papilledema. Ophthalmologic examination confirmed papilledema, with normal retinal periphery and without features of sickle retinopathy. Visual acuity was best corrected to 20/20 in each eye with intact color vision and normal pupillary responses. Her hemoglobin was 8.4 g/dL (baseline: 8–9 g/dL). Computed tomographic imaging and MRI of her brain (including MRA and noncontrast MRV) were normal, with no signs of cavernous sinus thrombosis. A lumbar puncture was performed with an opening pressure of 29 cm H2O. Her hemoglobin was 6.6 g/dL (baseline: ≤10 g/dL). Follow-up lumbar puncture revealed a significantly elevated opening pressure (45 cm H2O).

A 16-year-old girl with SCD-SS disease was admitted for extremity pain and severe headache. Her previous SCD history included numerous hospitalizations for vasoocclusive pain crises. For an abnormal TCD at the age of 9 years, she was enrolled in the stroke-prevention trial in SCD (STOP trial) with a randomization to the red blood cell transfusion arm. She was transfused monthly to maintain her hemoglobin S percentage <30% for 4½ years, and she required iron chelation therapy with deferoxamine. The transfusions were discontinued on the STOP II trial after normal TCD, MRI, and MRA examinations. Previous ophthalmologic examinations had been normal. At the time of her hospitalization, she had been having sporadic headaches over a period of several months. Her hemoglobin was 6.6 g/dL (baseline: 7–8 g/dL). Papilledema was noted bilaterally on funduscopic examination (Fig 3). Vision was 20/20 in each eye with intact color vision for 12/12 Ishihara color plates and intact pupillary responses. Subsequent MRI, MRA, and noncontrast MRV of her head were normal except for a small Arnold-Chiari I malformation, and there was no evidence of cavernous sinus thrombosis. The patient underwent lumbar puncture with an opening pressure elevated at 36 cm H2O. A diagnosis of PC was made. Acetazolamide treatment was initiated.
at a dose of 15 mg/kg per day, and the patient had rapid symp-
tomatic relief from her headaches. After a few weeks of acetazol-
amide treatment, her dose was increased to 19 mg/kg per day. After ~9 months of medical treatment, she is maintained on her lower, original dose of 15 mg/kg per day.

**DISCUSSION**

PC is a rare condition characterized by increased intracranial pressure and normal CSF examination in the absence of a space-occupying lesion or obstruction to the CSF pathway.14-16 The most common presenting symptom is papilledema, but other frequent manifestations include headache, diplopia (from cranial nerve VI palsy), nausea and/or vomiting, altered light perception, and decreased visual acuity.15 Potential peripheral visual-field deficits or vision loss give significance to the early diagnosis of PC. Medical management with acetazolamide or furosemide is successful in most cases of PC. Symptoms occasionally can resolve spontaneously.15 Other medical treatments used with anecdotal success include corticosteroids and glycerol. Serial lumbar punctures are therapeutic but not a long-term option. With progressive visual changes, surgery is considered.

PC has been reported in several medical conditions17-25 and in various forms of anemia including acquired aplastic anemia,26 iron-deficiency anemia,27,28 paroxysmal nocturnal hemoglobinuria,29 megaloblastic anemia,30 pernicious anemia,31 SCD-SC,32 and now in SCD-SS. The mechanism of the development of idiopathic intracranial hypertension in the face of anemia is unclear, but several theories have been posited. It has been suggested that anemia itself causes the production of CSF to be increased, but that mechanism is unclear as yet.26 Other theories suggest the possibility of anemia and tissue hypoxia causing altered cerebral hemodynamics and increased brain capillary permeability, which could lead to papilledema and increased intracranial pressure.27 Any or all of these mechanisms could increase the risks for PC in SCD. Although the symptoms of PC abated with correction of the acquired anemias (ie, iron-deficiency anemia), the symptoms and eye examinations improved or resolved in the 3 patients we report regardless of the presence of their chronic anemia.

There is a known association between obesity and the development of PC, but the etiology of this relationship remains unclear.21,33 Two recent pediatric case series of PC report obesity in 59% to 70% of patients.34,35 Patient 1 in our case series is obese, with a body mass index of 26.6 kg/m² (95th percentile for age: 22.5 kg/m²). It is interesting to note that this patient has had the most difficulties in decreasing her dose of acetazolamide and has required 2 therapeutic lumbar punctures for treatment of her symp-
toms of PC.

One factor that could be contributing to the diffic-
cult clinical course of patient 1 is her hydroxyurea regimen, which was started 1 year before the onset of PC due to her unusually clinically severe medical course. Normally, hydroxyurea is not prescribed to patients with SCD-SC because of their milder disease course relative to that of SCD-SS.36 Hydroxyurea is used widely in patients with SCD to increase the percentage of fetal hemoglobin in the erythrocyte, thereby decreasing the percentage of hemoglobin S, and thus diminishing the degree of erythrocyte sickling and resultant end-organ damage.37 Hydroxyurea also increases a patient’s red blood cell mass by increasing the intracellular hemoglobin concentration.38 This process could lead to increased blood viscosity, because patients with SCD-SC are thought to have higher baseline blood viscosities than pa-
tients with SCD-SS.39 In the face of poor cerebral vessel autoregulation in SCD patients,40 such ele-
.vated blood viscosity feasibly could lead to de-
creased cerebral oxygenation and a perpetuation of the mechanisms that give rise to headache and PC in patients with SCD. Therefore, in a patient with SCD and PC who is taking hydroxyurea and is not symp-
tomatically improving with respect to PC, decreasing or discontinuing the patient’s hydroxyurea should be considered as a possible therapeutic option, as was done in patient 1.

Acetazolamide, a carbonic anhydrase inhibitor, is the main medical modality used for the treatment of PC. The mechanism of action of carbonic anhydrase inhibitors is to block the dehydration of carbonic acid into water and carbon dioxide. As a result, H⁺ and bicarbonate ion are produced. The secretion of CSF is thought to be highly dependent on this process,41 and acetazolamide has been shown to decrease the production of CSF secondary to its inhibitory effect on the carbonic anhydrase reaction.42 Other studies have demonstrated that increased tissue partial pressure of carbon dioxide and a subsequent reduction in pH can increase retinal perfusion pressure, red cell velocity, and retinal vessel dilatation after the admin-
istration of acetazolamide.43 This process could serve to decrease papilledema and retinal artery occlusion in patients with ophthalmologic complications of various conditions including SCD.

It is worthwhile to note that carbonic anhydrase inhibitors also are used to enhance diuresis secondary to an amplified osmotic effect of increased so-
dium bicarbonate production in the renal tubules. Patients with SCD have an impaired ability to con-
centrate urine due to microvascular infarctions in the kidney and subsequent renal tubular dysfunction with increased excretion of sodium and retention of potassium.44 Therefore, carbonic anhydrase inhibi-
tors should be used with caution in patients with SCD because of the deleterious effects of dehydration on sickle erythrocytes.45 Before starting patients with SCD on acetazolamide, baseline serum electrolytes should be obtained. Once treatment has been initi-
ated, increased fluid intake is recommended, and serum electrolytes should be monitored. The 3 pa-
tients in our case series had normal baseline and follow-up serum electrolytes, and they did not incur problems with dehydration or excessive sickling cri-
es.

Vision loss can be severe and permanent in PC when patients do not respond to acetazolamide.46 Regular ophthalmology examinations need to be scheduled to follow optic-disk swelling, visual acuity, color vision, pupillary responses, and serial vi-
sual-field tests to determine response to treatment. If progressive vision or visual-field loss occurs while on maximal medical treatment, optic nerve sheath fenestration or lumbar-peritoneal shunt may be required. The aforementioned 3 cases responded to medical treatment alone. It is noteworthy that papilledema returned in patient 1 after the acetazolamide taper, and she required 2 subsequent lumbar punctures to alleviate her symptoms.

In addition to being a common symptom of PC, headache is also a common complaint of SCID patients. It is unclear as to whether the headache is anesthesia-related, stress-related, or a consequence of an as-yet-unknown factor that predisposes this population of patients to headache. One model suggests that the anesthesia of SCD causes a compensatory cerebral hyperemia and hypervolemia. In the presence of poor cerebral vessel autoregulation seen in sickle cell patients, the cerebral vessels vasodilate but do not increase blood flow. Such cerebral vasodilatation is well known to cause headaches. In addition, abnormalities in cerebral perfusion, as measured by perfusion magnetic resonance studies, have been shown to be correlated with several neurologic sequelae of SCID, including headache. The abnormalities demonstrated on such perfusion imaging studies are irrespective of the TCD, MRI, MRA, and MRV results.

These 3 cases demonstrate that complaints of severe headache in patients with SCD who have normal neuroimaging studies can be related to the development of PC. Prompt evaluation of a patient PC by an ophthalmologist and a neurologist and with appropriate, emergent, cerebral imaging (such as MRI, MRA, MRV, and/or perfusion MRI) to rule out infarction or cerebral venous thrombosis can avoid long-term ophthalmologic deficits. PC responds well to carbonic anhydrase inhibitors, but these drugs should be used with caution in patients with SCD secondary to their diuretic effects.

REFERENCES
# Pseudotumor Cerebri in Children With Sickle Cell Disease: A Case Series

Michael Henry, M. Catherine Driscoll, Marijean Miller, Taeun Chang and Caterina P. Minniti

*Pediatrics* 2004;113;e265

DOI: 10.1542/peds.113.3.e265

<table>
<thead>
<tr>
<th>Updated Information &amp; Services</th>
<th>including high resolution figures, can be found at: <a href="http://pediatrics.aappublications.org/content/113/3/e265">http://pediatrics.aappublications.org/content/113/3/e265</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>This article cites 43 articles, 5 of which you can access for free at: <a href="http://pediatrics.aappublications.org/content/113/3/e265#BIBL">http://pediatrics.aappublications.org/content/113/3/e265#BIBL</a></td>
</tr>
<tr>
<td>Subspecialty Collections</td>
<td>This article, along with others on similar topics, appears in the following collection(s):</td>
</tr>
<tr>
<td></td>
<td><strong>Hematology/Oncology</strong> <a href="http://www.aappublications.org/cgi/collection/hematology:oncology_sub">http://www.aappublications.org/cgi/collection/hematology:oncology_sub</a></td>
</tr>
<tr>
<td></td>
<td><strong>Blood Disorders</strong> <a href="http://www.aappublications.org/cgi/collection/blood_disorders_sub">http://www.aappublications.org/cgi/collection/blood_disorders_sub</a></td>
</tr>
<tr>
<td>Permissions &amp; Licensing</td>
<td>Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://www.aappublications.org/site/misc/Permissions.xhtml">http://www.aappublications.org/site/misc/Permissions.xhtml</a></td>
</tr>
<tr>
<td>Reprints</td>
<td>Information about ordering reprints can be found online: <a href="http://www.aappublications.org/site/misc/reprints.xhtml">http://www.aappublications.org/site/misc/reprints.xhtml</a></td>
</tr>
</tbody>
</table>
Pseudotumor Cerebri in Children With Sickle Cell Disease: A Case Series
Michael Henry, M. Catherine Driscoll, Marijean Miller, Taeun Chang and Caterina P. Minniti

Pediatrics 2004;113:e265
DOI: 10.1542/peds.113.3.e265

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/113/3/e265