Case Reports Spontaneous Intracerebral Hematomas in Juvenile Diabetic Ketoacidosis

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Ketoacidosis is one of the common complications of Type I insulin-dependent diabetes mellitus. Several neurologic (cerebral) deficiencies have been associated with diabetic ketoacidosis, including cerebral edema with increased intracranial pressure resulting in coma; partial and generalized seizures; and cerebrovascular occlusive disease resulting in motor and/or sensory dysfunction. Intracerebral hematomas have not been reported. A child is described who had insulindependent diabetes mellitus with hyperglycemic ketoacidosis who developed multiple spontaneous intracerebral hematomas. Possible mechanisms are discussed.

Atluru VL. Spontaneous intracerebral hematomas in juvenile diabetic ketoacidosis. Pediatr Neurol 1986; 2:167-9.

Introduction

Spontaneous intracerebral hematomas in children are uncommon. These hematomas are most likely caused by ruptured arteriovenous malformations or aneurysms, bleeding diatheses, and rarely by malignant hypertension and hemorrhages into neoplasms [1]. Metabolic disturbances, such as diabetic ketoacidosis, have not been associated with intracerebral hematomas. The patient reported here presented with behavioral disturbances, lethargy, and generalized seizures. The patient was investigated further when her mental status failed to improve after adequate treatment for diabetic ketoacidosis and seizures. Multiple intracerebral hematomas were identified initially by unenhanced computed tomography (CT). The patient was managed conservatively and the hematomas resolved after several weeks.

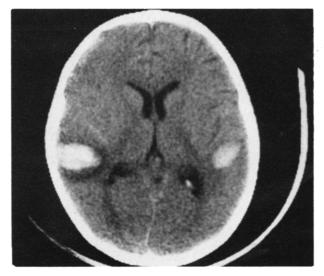


Figure 1. Unenhanced CT scan documents bilateral posterior temporal hematomas. Right-sided lesion has surrounding edema.

Case Report

An 11-year-old white girl was admitted with behavioral disturbances and lethargy. Insulin-dependent diabetes mellitus had been diagnosed at 5 years of age. She was in good health until the morning of admission when she complained of malaise. Urinalysis revealed a 5% glucose content and 4^+ acetone. She received her usual morning dose of insulin (6 units regular, 10 units NPH). She vomited after breakfast and lunch. She was incoherent, abusive, and belligerent, and later was observed to have tachypnea and increased lethargy. When seen in the emergency room, she was unresponsive and had a temperature of 37.3 °C, pulse rate 140, respiratory rate 48, and blood pressure 120/70 mm Hg. Blood glucose content determined by Dextrostix[®] was very low and she was given glucose intravenously (250 cc of 50% glucose). She had a generalized tonic-clonic seizure which was treated with diazepam (7.5 mg) and phenobarbital (150 mg). The child was admitted to the pediatric intensive care unit.

She was the product of a term gestation and a normal vaginal delivery, followed by normal developmental milestones. She had experienced several episodes of diabetic ketoacidosis. A single seizure unrelated to diabetes occurred a year prior to admission; she had been receiving phenobarbital (90 mg/day). Cranial CT was normal. The mother and paternal aunt had seizures during adolescence, and 2 siblings had speech problems.

The child's physical examination on admission revealed Kussmal type respirations at 48/min, pulse rate of 152/min, temperature of 37.3 °C, and blood pressure of 94/66. Auscultation of the chest was normal and the liver was palpable 3 cm below the right costal margin.

The child was unresponsive to noxious stimuli. Her neck was supple. The optic fundi were normal. Extraocular movements were full on oculocephalic maneuver. Pupils were dilated and nonreactive bilaterally; the corneal reflex was present. Motor examination revealed generalized hypotonia and areflexia.

On admission the blood glucose content was 1,890 mg/dl, sodium 135 meq/L, potassium 5 meq/L, chloride 105 meq/L, bicarbonate 1 meq/L, blood urea nitrogen 18 mg/dl, white blood cell count 22,900/mm³ with normal differential count, platelet count 414,000/mm³, and reticulocyte count 1.9%. Hemoglobin and hematocrit were normal. Liver function tests documented: SGOT 166 IU/L (normal = 0-45), SGPT 195 IU/L (normal = 0-45), LDH 409

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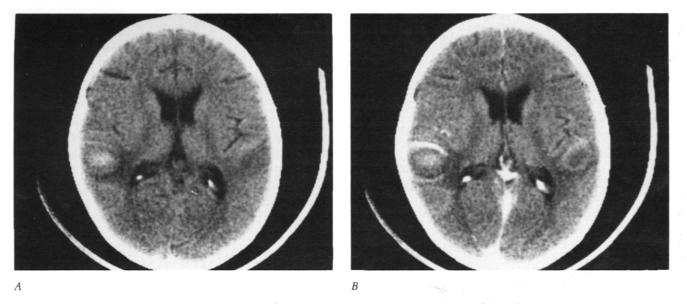


Figure 2 (A) Unenhanced scan demonstrates resolving hematomas in the posterior temporal regions bilaterally. (B) Contrast injection reveals ring-enhanced lesions.

IU/L (normal = 60-200), creatinine 2.2 mg/dl (normal = 0.7-1.4), prothrombin time 10.2/10.8 sec, partial thromboplastin time 26.7/32.0 sec, and cholesterol 266 mg/dl (normal = 120-205 mg/dl). Phenobarbital was not detectable in the serum. Urinalysis revealed pH 5, specific gravity 1.021, glucose 4+, and ketone 3+. Hemoglobin A₁c was 9.7%. Arterial blood gases were pH 6.69, bicarbonate 2 meq/L, P_{aCO2} 17 mm Hg, P_{aO2} 105 mm Hg. The calculated serum osmolality was 320 mOsm/kg. Chest x-ray documented a right pulmonary infiltrate.

The patient was treated with insulin, sodium bicarbonate, and intravenous fluids. The patient's pupils became 3 mm in size and reacted briskly to light. Withdrawal response to noxious stimuli was present in all extremities. On the following day the patient remained unresponsive and developed a temperature of 40.5 °C. Lumbar puncture revealed xanthochromic fluid; analysis revealed glucose 325 mg/dl, protein 175 mg/dl, 5,904 crenated red blood cells/mm³, and no white blood cells. The fluid was sterile. Cranial CT performed on the fourth hospital day indicated multiple intracerebral hematomas (Fig 1). Radioisotope nuclear brain scan showed normal blood brain flow and no evidence of sagittal sinus or cerebral venous thrombosis. Cerebral angiography was not performed. The patient was managed with fluid restriction. She recovered gradually, eventually attaining a normal neurologic examination.

The child also had acute renal insufficiency from which she recovered completely. CT of the abdomen showed a slightly enlarged liver with no other abnormalities. Liver function tests were normal on subsequent examination. A repeat scan performed on the sixteenth day documented resolving intracerebral hematomas (Fig 2A). Following contrast injection, ring enhancement was seen around the lesions bilaterally (Fig 2B).

She was discharged from the hospital on insulin (10 units NPH) and phenobarbital (90 mg/day). Follow-up unenhanced CT four months later demonstrated a low density lesion in the right temporal region (Fig 3).

Discussion

Neurologic complications of juvenile insulin-dependent diabetes mellitus are uncommon; they include peripheral neuropathy, myelopathy, encephalopathy, autonomic dysfunction, and central nervous system changes associated with hyperosmolality. Cerebrovascular disease and acute hemiplegic syndromes also have been reported [2]. Diabetic ketoacidosis has been known to be associated with encephalopathy, focal neurologic dysfunction, and seizures, but intracerebral hemorrhage has not been reported in children.

A variety of possible causes of the spontaneous hemorrhages in this patient can be postulated. Malignant hypertension can lead to intracerebral hemorrhage. Dolger [3] found that vascular disease was present in varying degrees of severity in every diabetes mellitus case of some years duration regardless of the age of the onset, severity of the diabetes, or type of treatment. Hyperaldosteronism has been reported with ketoacidosis, resulting in hypertension [4]. This patient, however, was normotensive 2 years prior to the ictus.

It is unlikely that a pre-existing vascular malfor-



Figure 3. Unenhanced CT scan demonstrates a low density lesion in the right posterior temporal region.

mation could have resulted in hemorrhage because of the distribution of multiple, widely-spaced lesions and the normal contrast-enhanced CT performed a year prior to admission. There was no evidence suggestive of coagulopathy or disseminated intravascular coagulation that would explain the multiple hematomas.

The role of hyperosmolality should be considered in various neurologic complications of diabetic ketoacidosis. The degree of mental obtundation correlates fairly well with the degree of hyperosmolality in diabetic ketoacidosis. Cerebral edema has been documented in some cases of treated diabetic ketoacidosis, as a consequence of the rapid lowering of the extracellular osmolality [5,9]. In ketoacidosis the circulation is impaired by the decreased blood volume and by the elevated blood viscosity typical of dehydration. With hyperosmolar coma, a similar circulation difficulty is indicated usually by renal function impairment, as was the case with this patient. Rarely, the combination of hyperosmolality with dehydration and diabetic vascular disease can lead to thrombotic occlusion of the arteries and veins [6]. Reports of adult diabetics indicated sclerosis of the cerebral arteries with areas of softening, as well as intracerebral and intraventricular hemorrhages [7]. Cerebral infarction has also been reported secondary to dural venous sinus thrombosis in diabetic ketoacidosis [8]. The primary venous drainage of the brain depends on the patency of the lateral venous sinuses and the internal jugular veins. Cerebral infarction may occur if the venous occlusion is extensive. The predisposing factors to intracranial venous sinus thrombosis include severe dehydration due to polyuria and vomiting, profound hypotension, and infection; all commonly occur in diabetes mellitus. In this patient, both the normal isotopic brain scan and the discrete nature of the hematomas argue against dural sinus thrombosis resulting in hemorrhagic infarction.

Due to the striking symmetry of these lesions, an undetected hypotensive episode resulting in watershed infarcts with softening and secondary hemorrhage should be considered. A combination of factors might be responsible for the intracerebral hematomas in this patient: hyperglycemic hyperosmolar state with dehydration, diabetic cerebrovascular disease, and regional tissue hypoxia with resultant loss of autoregulation. Intracerebral hemorrhage should be included as one of the central nervous system complications of diabetic ketoacidosis, and appropriate studies should be performed when a child fails to recover after adequate diabetic ketoacidosis therapy.

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