

# An Adult Case of Diabetic Ketoacidosis Presenting with Cerebral Edema

## *Serebral Ödem ile Başvuran Bir Erişkin Diabetik Ketoasidoz Olgusu*

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### Abstract

Cerebral edema is a life-threatening complication of diabetic ketoacidosis (DKA) which may predominantly develop in pediatric cases during the management of DKA. Symptomatic cerebral edema in children is rarely detected at admission, before initiation of the treatment. Cerebral edema associated with DKA is extremely rare in adults. Here, we report an adult patient with DKA who presented with symptomatic cerebral edema. *Turk Jem 2009; 13: 16-7*

**Key words:** Diabetes complications, cerebral edema

### Özet

Serebral ödem diyabetik ketoasidozun (DKA) daha sıklıkla pediatrik olgularda tedavi sırasında gelişen yaşamı tehdit eden bir komplikasyondur. Nadiren, serebral ödem çocuklarda tedaviye başlanmadan önce (başvuru anında) tespit edilebilir. DKA ile ilişkili serebral ödem görülmesi erişkinlerde oldukça nadirdir. Bu yazımızda semptomatik serebral ödem ile başvuran bir erişkin DKA hastası sunuyoruz. *Turk Jem 2009; 13: 16-7*

**Anahtar kelimeler:** Diyabet komplikasyonları, beyin ödemi

### Introduction

Cerebral complications of diabetic ketoacidosis (DKA) are a common cause of deaths related to DKA (1,2). Cerebral edema associated with DKA occurs predominantly in children; however, few adult cases have been described (3,4). The frequency of DKA-associated symptomatic cerebral edema has been reported to be 1% in children (5). In most cases, clinical presentation of cerebral edema occurs during the treatment of DKA, usually several hours after initiation of therapy (3). There is, however, also radiological evidence that asymptomatic or subclinical cerebral edema commonly develops before or during the management of DKA (5-7). However, it is extremely rare for a case of DKA to present with cerebral edema before treatment for DKA. Here, we report an adult case of DKA who presented with the clinical features of cerebral edema.

### Case Report

A 21-year-old male presented with nausea, vomiting, speech disability, loss of coordination, and decreased consciousness including disorientation, which started 2 days prior to admission. He experienced fatigue, polydipsia, and polyuria for the previous week, and he had lost 6 kg during the previous 2 weeks. On the examination, the patient was stuporous. Body temperature was 36.9°C, blood pressure was 100/70 mm Hg, heart rate

was 117/min, and respiratory rate was 28/min. Kussmaul respiration was noted. Height and weight were 172 cm and 64 kg, respectively. There was no stiff neck. Physical examination revealed evidence of dehydration. Laboratory evaluation revealed plasma glucose of 493 mg/dL (normal: 70-100 mg/dL), and a strongly positive urine dipstick test for glucose and ketones. Arterial blood gas analysis demonstrated severe metabolic acidosis with pH of 7.099, HCO<sub>3</sub><sup>-</sup> level of 5.7 mmol/L, and pCO<sub>2</sub> value of 18.3 mm Hg. Anion gap was 28. His HbA<sub>1c</sub> was 15.03%. Serum sodium level was 127 mmol/L, potassium was 4.8 mmol/L, blood urea nitrogen (BUN) was 32 mg/dL, and creatinine was 1.69 mg/dL. Initial brain computed tomography (CT) examination before treatment showed effacement of all subarachnoid spaces both infratentorially and supratentorially and narrowing of the ventricles, suggesting diffuse cerebral edema (Fig. 1). Density of gray and white matter structures and architecture of the brain was preserved. Fluid resuscitation was initiated with saline infusion. Dextrose water 5% was added after blood glucose fell below 250 mg/dL. Human regular insulin infusion (0.1 units/kg/h) was given intravenously. Potassium was replaced with a close follow-up. Mannitol was given at a dose of 0.5 g/kg. Diabetic ketoacidosis resolved within 36 hours; he recovered fully without neurological deficit within 72 hours. Multiple dose intensive injection therapy with insulin glargine and insulin lispro was initiated. Follow-up CT on day 15 demonstrated complete resolution of cerebral edema (Fig. 2).

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## Discussion

Cerebral edema is usually seen after initiation of treatment for DKA (3). DKA presenting with symptoms related to cerebral edema is very rare. However, it has been demonstrated that subclinical cerebral edema may be present before the treatment is started (7). This subclinical cerebral edema before initiation may improve, persist, or worsen during the management of DKA (6,8). Two mechanisms have been proposed in the pathogenesis of the development of cerebral edema in DKA. One is vasogenic edema, which occurs as a result of breakdown of the endothelial blood-brain barrier leading to interstitial brain edema; the other is cytotoxic edema caused by swelling of astrocytes as a result of altered intracellular osmotic balance or dysfunctional cellular membrane (8). Cerebral hypoxia has been proposed as the main cause of vasogenic cerebral edema in DKA (9). Hyperviscosity caused by dehydration impairs the blood flow and the ability of blood to oxygenate. Hypocapnia as a result of accelerated respiratory rate secondary to severe metabolic acidosis leads to cerebral vasoconstriction and results in hypoxia. It has been shown that the presence of acetoacetate is associated with reduced cerebral oxygenation in DKA. It has been also proposed that rapid change in serum osmolality is a causative factor for cerebral edema in DKA (7,8).

Radiological imaging has played an important role in confirmation of cerebral edema associated with DKA. In our case, CT helped us to monitor both the presence and resolution of cerebral edema. Hoffman et al. (7) obtained cranial CT scans in pediatric patients with DKA before treatment, after 6 hours of treatment, and 7 days after admission. They found that ventricular narrowing as a sign of cerebral edema was present both on pre-treatment and 6-hour scans, and edema resolved radiologically on the 7-day scans. In addition to cross-sectional image data, magnetic resonance (MR) imaging has provided functional information as well (10). Diffusion weighted imaging obtained within hours of treatment in patients with DKA showed cerebral edema (8,10). However, the edema was of vasogenic type, evidenced by increased apparent diffusion coefficients. This argues against the theory of intracellular accumulation of ions and osmolytes that would establish osmotic gradients between the intracellular and the extra-

cellular medium and results in intracellular edema during treatment with hypotonic fluids and insulin. The authors speculated that the vasogenic edema resulted from reperfusion injury to the previously hypoperfused brain tissue following intravenous rehydration. The authors also thought that blood-brain barrier could be injured by ketone bodies, which would lead to vasogenic edema. In another study which focused on metabolic changes during DKA, the authors performed both cross sectional MR imaging and MR spectroscopy on pediatric patients with diabetic ketoacidosis (11). The imaging was done 1, 4, 7, and 28 days after DKA resuscitation. The authors detected increased taurine, myoinositol, and glucose in the samples taken on day 1 and 4. It was stated that the increased taurine and myoinositol levels were possibly associated with the hyperosmolar state.

Epidemiological data have shown that pediatric cases are more likely to have experience cerebral edema on the course of DKA (3). Adults are rarely affected (3,4,12). To the best of our knowledge, our case is the only report of an adult patient who presented with symptomatic cerebral edema before the management of DKA. There has been little data focusing on DKA-associated cerebral edema in adults. Hypoxia as a result of different mechanisms such as cerebral vasoconstriction, hypocapnia, and decreased cerebral perfusion caused by dehydration seems to be the most acceptable hypothesis in the pathogenesis of cerebral edema in DKA. The fact that children's brains have higher oxygen requirement than those of adults may render children more susceptible to cerebral edema in DKA (9,13). In the study by Cameron et al. (11) increased levels of myoinositol, taurine, and glucose were detected with MR spectroscopy in pediatric cases of DKA-associated cerebral edema. The authors stated that although increased myoinositol was detected both in adults and children, increased taurine was detected only in children. They speculated that increased taurine might be one of the important differentiating factors in the response of the brain in diabetic children and their vulnerability to cerebral edema, compared with adults.

In conclusion, although rare, physicians should be aware that adult patients with DKA may develop cerebral edema during or before treatment.

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**Figure 1.** Initial transverse CT image through the level of foramen of Monro. The third ventricle is almost effaced (hollow arrow), while the lateral ventricles are severely narrowed (solid arrows). Note that no sulcus is seen between cerebral gyri



**Figure 2.** Follow-up CT through the same level shows recovery of normal width of the ventricles (thin arrows) and the sulci (thick arrows)