Hyperinsulinism in a child presenting with cardiac ischemia and bradycardia

Majid Al-Fayyadh a,⇑, Ziad Bulbul a, Waleed Al Maneea a, Bassam Bin Abbas b

a Heart Centre, King Faisal Specialist Hospital & Research Centre
b Department of Pediatrics, King Faisal Specialist Hospital & Research Centre

a,b Saudi Arabia

A 5-year-old boy referred to our service with suspected sinus node dysfunction. In addition to the arrhythmia, he had moderate mitral valve regurgitation and depressed ventricular function during a hypoglycemic episode. Cardiac abnormalities resolved with glucose infusion. We believe that hypoglycemia was responsible for the cardiac manifestations and it should be considered in unexplained rhythm disturbances or ischemia.

© 2014 Production and hosting by Elsevier B.V. on behalf of King Saud University.

Keywords: Hypoglycemia, Bradycardia, Myocardial ischemia

A five-year-old boy was referred to our cardiology service with suspected sinus node dysfunction. His symptoms started five months prior with episodic attacks of palpitation, abdominal pain, chest discomfort, nausea, cold extremities, sweating, and altered level of consciousness. During evaluation in the referring hospital, these symptoms were associated with sinus tachycardia followed by severe sinus bradycardia. There was no significant past medical history, and no history of medication ingestion, or remarkable family history of similar problems. Physical examination was unremarkable with normal growth parameters.

A 24-h ambulatory ECG recording was placed at the initial evaluation. During monitoring, the patient developed a typical episode and presented to the emergency room with an altered level of consciousness. Severe sinus bradycardia (45 beats/min) on the ambulatory ECG coincided with the episode onset followed by sinus tachycardia and 7 mm ST segment depression on the rhythm strip (Fig. 1). His blood pressure at the time was 100/70 mmHg. Blood sugar and cardiac enzyme levels were not obtained. Echocardiogram in the emergency room revealed the presence of moderate mitral valve regurgitation and depressed ventricular function with an ejection fraction of 24% (Fig. 2, panel A). Serum glucose was not measured at presentation; however, after initial management with IV fluid and glucose, the heart rate returned to normal, the patient regained consciousness, and this coincided with the ST segment having normalized on the ambulatory ECG monitoring, which was analyzed later. The patient was admitted to the intensive care unit for observation and, due to the severe ST segment changes observed in the 24-h ECG recording, coronary angiograms were performed, excluding coronary anomalies. Blood sugar and cardiac enzyme levels were both normal 12 h after
presentation. A repeat echocardiogram a few days after admission showed normal cardiac function with improved mitral regurgitation (Fig. 2, panel B). While in the hospital under monitoring, the patient developed another episode with the same ECG changes and bradycardia. Based on the symptoms and previous response to IV fluids, hypoglycemia was suspected as an etiology for the presenting symptoms. During the episode, a blood sample obtained showed hypoglycemia of 1.3 mmol/L (critically low random glucose <2.2 mmol/L) with elevated random insulin level (166 pmol/L). A dose of glucagon administered intravenously during the episode corrected the blood glucose level, alleviated the patient’s symptoms and reversed the electrocardiogram changes. This confirmed the diagnosis of hyperinsulinemia, and the patient was started on diazoxide prior to discharge. While on therapy the patient became asymptomatic. The child was followed as a case of persistent hyperinsulinemic hypoglycemia of infancy (PHHI, formerly called nesidioblastosis) based on
high insulin to glucose ratio, euglycemic response to glucagon, normal cortisol, adrenocorticotrophic hormone, growth hormone levels, normal free fatty acid, and lactate levels. During follow-up, medications were self discontinued and the patient presented two days later with another hypoglycemic episode and the same cardiac manifestations.

Discussion

The association of hypoglycemia with electrocardiographic changes has been well described [1–12]. However, most reports describe this association in patients with risk factors or ischemic heart disease, namely diabetes mellitus. In some of these reports, the cardiac manifestations of hypoglycemia are seen to induce angina pectoris and even myocardial infarction [5,6]. However, there are few reports of such findings in patients who are not at risk for ischemic heart disease, and even fewer reports describing the pediatric population [7,8].

In our patient, there was a cause and effect relationship between the hypoglycemia and the cardiac involvement in a young child with no risk factors for heart disease. The cardiac manifestation in our patient included rhythm disturbance (marked bradycardia) and ischemic changes as evidenced by the ST segment depression with resultant impaired cardiac function and significant mitral valve regurgitation, all of which normalized after treatment for hypoglycemia.

In 1930, Goldman observed electrocardiographic and rhythmic changes in schizophrenic patients treated with insulin-induced hypoglycemia. Changes in rhythm were associated with sinus bradycardia, sinus tachycardia, and atrial fibrillation [9], while ECG changes were minor alterations of P wave and QRS morphology, as well as ST segment changes [9]. Read and Doherty reported minor rhythm changes, as well as ST–T wave abnormalities in patients with induced hypoglycemia during the Hollander test to evaluate gastric acid secretion after vagotomy [10]. Markel et al. described a patient with eight years of insulin-dependent diabetes mellitus, hospitalized for hypoglycemic coma, and whose electrocardiogram at presentation revealed a junctional rhythm and major ischemia with an ST depression of 6–7 mm. Sinus rhythm and normal repolarization were recovered 15 min after administration of 50% glucose [1].

The cause of ECG changes associated with hypoglycemia is not clear and the explanations are inconclusive. One possible explanation relates to the altered balance between energy supply and demand [12]. Increased sympathoadrenal discharge increases energy requirements while hypoglycemia limits energy supply creating an imbalance with resultant ischemia.

Another suggested mechanism of the cardiac manifestations of hypoglycemia is the associated electrolytes imbalance. Electrocardiographic changes during hypoglycemia could be due to hypokalemia from the shift of potassium into the cells, secondary to the effects of hyperinsulinemia and catecholamine release [4,12]. Read and Doherty have shown that an intravenous infusion of potassium during hypoglycemia reduces electrocardiographic abnormalities [10]. However, the potassium level in our patient was normal, which may suggest that another mechanism is required for ECG changes. Moreover, while this mechanism provided an explanation for rhythm disturbances and ECG changes, it did not explain the cardiac ischemia we and others observed with hypoglycemia.

The association between hypoglycemia and ECG abnormalities is well documented, but the mechanism for this is still not clear. Regarding our patient, who had normal coronary arteries, we believe that hypoglycemia is responsible for and is solely associated with the marked ECG changes. It is important for physicians to be aware that ECG interpretation in this setting is not reliable and that caution is required. It is therefore important to consider hypoglycemia as a cause of unexplained rhythm disturbances or ischemia, even in the absence of risk factors for ischemic heart disease. Treating hypoglycemia with oral medications reversed the cardiac ischemia and prevented its recurrence in our patient.

Conflict of interest

We have no conflict of interest to declare.

References