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Digital Pupillometry for Noninvasive Neurologic Monitoring in Pediatric Severe Diabetic Ketoacidosis

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Introduction

Children with severe diabetic ketoacidosis (DKA) are at risk of neurologic deterioration due to cerebral edema which is the most common cause of mortality and long-term morbidity. This occurs during the initial few hours of treatment secondary to rapid osmotic changes. These patients are typically admitted to the PICU for management and undergo hourly neurologic checks (primarily pupil reactivity and Glasgow Coma Scale (GCS) scores) . An acute neurologic deterioration is managed with osmotherapy. Assessment of pupil reactivity with a flashlight has significant inter and intra-observer variability. Evaluation of GCS also can be challenging especially at nighttime in children. Pupillometry provides a a rapid, reliable, and accurate way of quantitatively monitoring pupil reactivity and has been shown to correlate with intracranial pressure in some studies.

Methods

We retrospectively evaluated DKA patients admitted to the PICU and underwent pupillometry as part of neurologic checks. We correlated the various pupillometry (NPi, %change in pupils' size, constriction velocity, latency) and laboratory parameters (serum sodium, bicarbonate, glucose) with GCS as well as the need for urgent rescue therapies for acute neurologic decline. A generalized mixed-effect linear regression model with Maximum Likelihood Estimation was used for longitudinal data analysis.

Results

There were 28 unique patients included in the study after excluding one who was on sedation while intubated which would affect his GCS scores. Two patients were included twice during separate admissions. New-onset IDDM made up 36%. Median age was 13 years with 57% females. Two patients had acute neurologic events requiring osmotherapy. During these events, the pupillometry parameters were abnormal (NPi 0- 1.9 (Normal >3), % change in size 0-8% (Normal > 10%)). Median NPi was 4.5 and median % change in pupil size was 36% for both eyes. A generalized linear modelling for repeated measures showed that a minimum NPi ≥ 3 was associated with a lower risk of GCS ≤ 12, OR and 95% C.I = 0.031 (0.004,0.273). Laboratory parameters were not correlated with GCS.

Conclusions

Pupillometry can be used as a non-invasive neurologic monitor for DKA patients to evaluate for clinical cerebral edema along with GCS.