Continuous Monitoring of EEG Delta Power in Hypoxic Ischemic Encephalopathy (HIE)

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Background

Hypoxic ischemic encephalopathy (HIE) can occur after fetal or perinatal insults [1, 2] and understanding the timing and evolution of injury is a key factor in establishing effective therapeutic approaches. Therapeutic hypothermia (TH) is an established protocol to treat term infants with HIE and continuous EEG can be useful to monitor ongoing encephalopathy and predict outcome [4]. However, expertise in qualitative neonatal EEG interpretation is limited to tertiary pediatric centers. Continuous quantitative EEG analysis could provide real-time assessment of the degree of encephalopathy in the newborn to identify those who would benefit from additional intervention.

Objective

The objective of this study is to evaluate the relationship between EEG delta power and brain injury by MRI in term infants with HIE during and after TH.

Methods

We enrolled newborns with HIE that met the National Institute of Child Health and Human Development criteria for TH in our neonatal intensive care unit [3]. EEG recordings (NicoletOneTM, Viasys Healthcare, San Diego, CA, USA or Nihon Kohden EEG 1100C, Nihon Kohden Corporation, CA, USA) were initiated at admission and continued through the completion of the rewarming. Using a modified International 10-20 system for EEG electrode placement, EEG was recorded from 11 scalp electrodes at a sample rate of either 256 (Nicolet) or 200 (Nihon Kohden) Hz. The artifact-free EEG (amplitude < +/-250 microVolts) recording was partitioned into 10-minute epochs. For EEG in every 10-minute epoch, the power spectrum was calculated using the Welch periodogram approach and the delta power (0.5 – 4 Hz) was calculated [4]. MRIs were scored by an experienced neuroradiologist blinded to the EEG data and clinical outcomes. Infants were classified as good outcome (BG score < 3 or WS <4) or adverse outcome (BG≥3, WS≥4, or death). EEG delta power was compared between the two groups of infants in three-hour increments, using a receiver operator characteristic (ROC) analysis. An area under the ROC curve (AUC) > 0.7 was considered a significant separation between the two groups.

Results

We studied a total of 97 infants with moderate or severe HIE. Within this population, 67 infants in good outcome group, and 30 infants in adverse outcome group. In Figure 1, the AUC values obtained for every electrode are displayed as a contour plot for every 3 hours from 3-108 hours of life (postnatal age). The delta power was higher in the good outcome group than the adverse

outcome group. The AUC values are greater than 0.7 for the majority of the electrodes until 52 hours, but C3, C4, P3 and P4 display higher AUC values consistently until 96 hours.

Conclusions

Our results indicate that continuous monitoring of EEG delta power could be used as a bedside tool to identify HIE infants with brain injury. Further work to study the relation between EEG delta power and regional brain injury is currently underway.

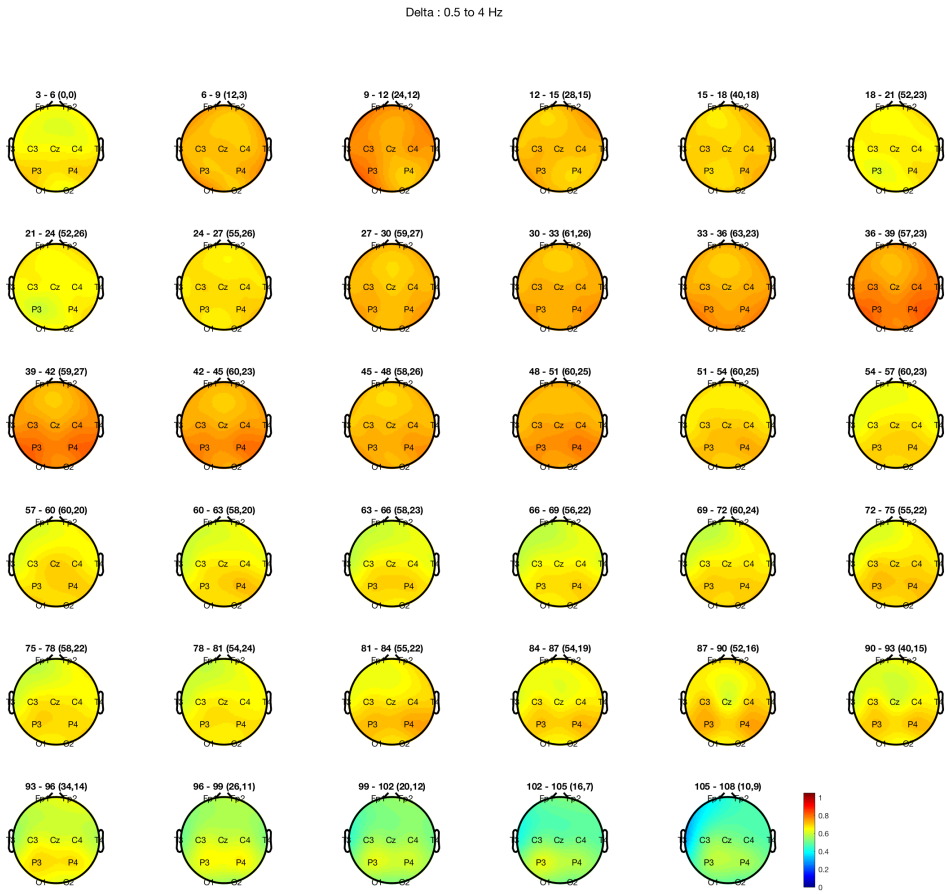

Figure 1: Contour plots of area under the receiver-operating characteristic curve for every three hours from 3-108 hours of life. The number of infants from good outcome (n1) and adverse outcome (n2) groups used in the comparison is shown in the title (n1, n2) of each graph. Also, shown in the title is postnatal age in hours.

Reference Cited

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