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Letter to the Editor

Delirium and Cortical Complexity: Divergent Changes in Alpha and Theta Bands

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We thank Dr. Kim and colleagues for their interest in our paper (1) and their thought-provoking parallel analyses of their data (2). Although it would have been interesting to see a broadband calculation of Lempel–Ziv complexity (LZC) as we had originally published, the findings of divergent changes in alpha and theta band LZC with delirium are intriguing. Therefore, we have conducted similar analyses of our published data, replicating the findings of Dr. Kim and colleagues for the theta and alpha band, but not the high alpha band.

The EEG data are derived from a perioperative cohort study of adult patients undergoing thoracic aortic aneurysm repair (IPOD-B2) and the cohort of adult patients (>65 years old) undergoing major surgery (IPOD-B3). After excluding patient data with severe artifacts, 89 patients were diagnosed for delirium status depending on the postoperative confusion assessment method (CAM+/- or CAM-ICU+/- if ventilated) and severity was assessed by the Delirium Rating Scale-98 (DRS). Using our published methods, LZC at channel Oz was calculated within different power spectral bands; theta (4–8 Hz), alpha (8–12 Hz), and high alpha (10–14 Hz).

In agreement to the analyses of Dr. Kim and colleagues, higher delirium severity was associated with lower LZC in theta and higher LZC in alpha (Figure 1A). Similarly, patients with a delirium diagnosis had lower LZC in the theta band and higher LZC in alpha band (Figure 1B). The LZC in the high alpha band, however, had no association with DRS or delirium diagnosis.

We have previously shown that delirium is associated with reduced alpha band phase lag index as a measure of cortical connectivity (3) and so we concur that the increases in LZC observed in alpha may be similarly represented as a decrease in connectivity. The loss of theta complexity is intriguing as theta power increases in delirium (3), so it is unlikely to merely represent the loss of signal-to-noise ratio. We have previously shown that caffeine reduces electroencephalogram slowing in our model of the inflammation-driven pathophysiology of delirium (4). The fact that caffeine may reduce delirium symptoms (5), while changing LZC (2), provides a tantalizing link that LZC changes may represent a causal mechanism in delirium (reduced information). Future mechanistic clinical trials should continue to evaluate the potential benefit of caffeine for prevention and/or treatment of postoperative delirium.

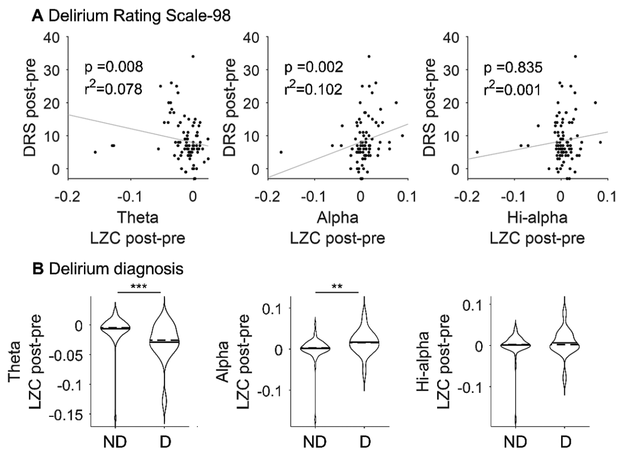

Figure 1. (**A**) Delirium Rating Scale-98 (DRS) is compared with Lempel–Ziv complexity (LZC) at different power spectral bands. For both DRS and LZC, the pre- to postoperative difference are Spearman correlated (channel Oz, $N = 88$ patients). (**B**) LZC compared by delirium diagnosis. LZC of nondelirious (ND) and delirious (D) group are compared with 2-sided Wilcoxon Rank Sum Test (channel Oz, $N_{ND} = 59$, $N_D = 30$). All *p*-values are uncorrected for false discovery rate. *$p < .05$; **$p < .01$; ***$p < .001$. Theta (4–8 Hz), alpha (8–12 Hz), and hi-alpha (10–14 Hz). Full color version is available within the online issue.

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Conflict of Interest

None declared.

Author Contributions

Further EEG analyses were completed by S.T. All authors contributed to the interpretation and writing of the article.

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