Network-Based Biomarkers Of Epilepsy Status Using Inter-Ictal EEG In High-Risk Patients

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Purpose
Epilepsy represents a major clinical burden in children with developmental disorders. Surgical interventions have demonstrated benefit in reducing seizure burden, though identification of surgical candidates remains challenging. Standard EEG measures offer limited discrimination of those at risk during the inter-ictal period. Better characterisation of cortical network function may offer insights into underlying pathology, and better identification of patients at risk.

Materials and Methods
EEG data was collected in Rett Syndrome patients (n = 42), a neurodevelopmental disorder associated with treatment-resistant epilepsy. Patients were divided by epilepsy status (no epilepsy: n = 18; epilepsy: n = 24). The epilepsy group was subdivided by treatment response (treatment responsive: n = 16; treatment resistant: n = 8).

Standard time and frequency-domain measures were derived. Network-based measures were then derived using inter-electrode coherence to calculate functional connectivity. The ability of these measures to discriminate epilepsy status and treatment responsiveness was assessed.

Results
Measures of amplitude and power in the time and frequency domains showed no discrimination between groups ($p > 0.05$).

Network measures based on power distribution successfully discriminated patients based on epilepsy status ($p < 0.05$). Measures of network architecture based on inter-electrode coherence differed significantly based on treatment responsiveness ($p < 0.05$).

Conclusion
Epilepsy status and treatment responsiveness can be accurately characterised using network-based measures. These measures offer better discrimination than standard amplitude and power-based measures. These network-based biomarkers offer improved methods of identifying patients with epilepsy and of identifying those likely to require surgical intervention following failure of medical therapy.