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Seizure Semiology of Early and Late Seizures in a Rat Model of Post-Traumatic Epilepsy

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BACKGROUND: Seizure semiology— the detailed description of behavioural manifestations during seizures—is now formally designated as a descriptor within the updated ILAE seizure classification, serving to enrich the clinical characterisation of seizures. In experimental models, however, semiology has often been reduced to simplified scales, limiting the ability to capture the complexity of seizure behaviours and their evolution over time. Developing detailed semiological frameworks in preclinical studies is crucial for enhancing the translatability of findings, refining seizure severity assessments, and supporting the development of automated detection tools and targeted therapies.

OBJECTIVE: To characterise and compare the behavioural semiology of early and late seizures in a rat model of post-traumatic epilepsy (PTE).

METHODS: Behavioural features of 244 electrographic seizures (149 early: days 0–7 post-TBI; 95 late: 7th post-injury month) were annotated using high-resolution video synchronised with EEG. A feature library comprising 59 behaviours was applied to classify pre-ictal, ictal, and post-ictal phases.

RESULTS: Early seizures were shorter (47 ± 39 s) and exhibited fewer ictal features (2.1 ± 1.6; median 2, range 1–9) compared to late seizures (106 ± 42 s; 7.2 ± 3.1; median 7, range 1–14; $p < 0.001$). Immobility dominated early seizures (81%), whereas late seizures frequently included complex motor behaviours such as rearing (64%) and falling after rearing (56%). Post-ictal behaviour was similar across groups (early: 1.3 ± 0.5 vs. late: 1.8 ± 0.7 features; $p > 0.05$). Racine scores reflected this progression: early seizures were mostly non-convulsive (median 0), while late seizures reached generalised convulsions (median 5).

CONCLUSIONS: These findings demonstrate the importance of vEEG in detecting seizures and reveal the limitations of traditional scales in capturing the complexity of semiological signs in rats with PTE.