Novel rat model of weight drop-induced closed diffuse traumatic brain injury compatible with electrophysiological recordings of vigilance states

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Traumatic brain injury (TBI) is a major cause of persistent disabilities such as sleep-wake disorders (SWD). However, rodent studies of SWD after TBI are scarce due to lack of appropriate TBI models reproducing acceleration-deceleration forces and compatible with electroencephalography/myography (EEG/EMG)-based recordings of vigilance states. We therefore adapted Marmarou's impact acceleration model to allow for compatibility with EEG-headset implantation. Following implantation of EEG/EMG electrodes, we induced closed TBI by a frontal, angular hit with a weight-drop device (44 rats, weight 2500g, fall height 25cm). Subsequently, we tested our model's usefulness for long-term studies on a behavioral, electrophysiological and histological level. Neurological, motor and memory deficits were assessed with the neurological severity score, open field, and novel object recognition tests, respectively. EEG/EMG recordings were performed in both SHAM (n=7) and TBI (n=7) rats before and 1, 7 and 28 days after trauma to evaluate sleep-wake proportions and posttraumatic implant stability. Histological assessments included hematoxylin and eosin staining for parenchymal damage and hemorrhage and amyloid precursor protein staining for diffuse axonal damage. All rats survived TBI without major neurological or motor deficits. Memory function was impaired after TBI at weeks 1, 2, 3 and recovered at week 4. EEG implants were stable for at least 1 month and enabled qualitative and quantitative sleep analyses. Histological assessments revealed no major bleedings or necrosis but intense diffuse axonal damage following TBI. In conclusion, this approach fulfills major preconditions for experimental TBI models and offers a possibility to electrophysiologically study behavioral states before and after trauma.

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