Rapid eye movement sleep

Rapid eye movement sleep (REM sleep or REMS) is a unique phase of sleep in mammals and birds, characterized by the random rapid movement of the eyes, accompanied by low muscle tone throughout the body, and the propensity of the sleeper to dream vividly.

To elucidate the role of the basal ganglia during rapid eye movement sleep movements in Parkinson's disease (PD) Verma et al. recorded pallidal neural activity from four Parkinson's disease patients. Unlike desynchronization commonly observed during wakeful movements, beta oscillations (13-35 Hz) synchronized during REM sleep movements; furthermore, high-frequency oscillations (150-350 Hz) synchronized during movement irrespective of sleep-wake states. The results demonstrate differential engagement of the basal ganglia during REM sleep and awake movements [1)]

Togawa et al. evaluated phase-amplitude coupling (PAC), which reflects neuronal coding in information processing, using ECoG in 11 patients with intractable focal epilepsy. PAC was observed between slow waves of 0.5-0.6 Hz and gamma activities, not only during light sleep and slow-wave sleep (SWS) but even during wakefulness and rapid eye movement (REM) sleep. While PAC was high over a large region during SWS, it was stronger in the posterior cortical region around the temporoparietal junction than in the frontal cortical region during REM sleep. PAC tended to be higher in the posterior cortical region than in the frontal cortical region even during wakefulness. The findings suggest that the posterior cortical region has a functional role in REM sleep and may contribute to the maintenance of the dreaming experience [2)].

A study demonstrates the importance of assessing REM in children with generalized interictal epileptiform discharges (IEDs). as it reveals lateralized epileptogenic spikes. Seizure freedom may be achieved with multilobar resection in these children with generalized IEDs and normal/subtle changes on MRI. Generalized IEDs in children with normal/subtle changes on MRI should not preclude surgical resection [3)].

During sleep and wakefulness, REM onsets are associated with distinct intracranial potentials, reminiscent of ponto-geniculate-occipital waves. Individual neurons, especially in the medial temporal lobe (MTL), exhibit reduced firing rates before REMs as well as transient increases in firing rate immediately after, similar to activity patterns observed upon image presentation during fixation without eye movements. Moreover, the selectivity of individual units is correlated with their response latency, such that units activated after a small number of images or REMs exhibit delayed increases in firing rates. Finally, the phase of theta oscillations is similarly reset following REMs in sleep and wakefulness, and after controlled visual stimulation. The results suggest that REMs during sleep rearrange discrete epochs of visual-like processing as during wakefulness [4)].

1)
Verma AK, Acosta Lenis SF, Aman JE, Sanabria DE, Wang J, Pearson A, Hill M, Patriat R, Schrock LE, Cooper SE, Park MC, Harel N, Howell MJ, MacKinnon CD, Vitek JL, Johnson LA. Basal ganglia engagement during REM sleep movements in Parkinson's disease. NPJ Parkinsons Dis. 2022 Sep 12;8(1):116. doi: 10.1038/s41531-022-00382-z. PMID: 36097027.

2)
Togawa J, Matsumoto R, Usami K, Matsuhashi M, Inouchi M, Kobayashi K, Hitomi T, Nakae T, Shimotake A, Yamao Y, Kikuchi T, Yoshida K, Kunieda T, Miyamoto S, Takahashi R, Ikeda A. Enhanced phase-amplitude coupling of human electrocorticography selectively in the posterior cortical region during rapid eye movement sleep. Cereb Cortex. 2022 Mar 15:bhac079. doi: 10.1093/cercor/bhac079. Epub ahead of print. PMID: 35288751.
3)
Okanari K, Baba S, Otsubo H, Widjaja E, Sakuma S, Go CY, Jones KC, Nishioka K, Oba S, Matsui T, Ueno M, Ukitsu S, Rutka JT, Drake JM, Donner EJ, Weiss SK, Snead OC 3rd, Ochi A. Rapid eye movement sleep reveals epileptogenic spikes for resective surgery in children with generalized interictal discharges. Epilepsia. 2015 Jul 15. doi: 10.1111/epi.13081. [Epub ahead of print] PubMed PMID: 26174651.
4)
Andrillon T, Nir Y, Cirelli C, Tononi G, Fried I. Single-neuron activity and eye movements during human REM sleep and awake vision. Nat Commun. 2015 Aug 11;6:7884. doi: 10.1038/ncomms8884. PubMed PMID: 26262924.