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Brief communication

The effects of isolated brainstem lesions on human REM sleep

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Abstract

Background: Clinical and electrophysiologic data support the role of multiple brainstem structures responsible for sleep architecture. To determine if patients with isolated brainstem lesions have detectable abnormalities of sleep architecture with polysomnography (PSG).

Method: The objective of this study is to determine if patients with isolated brainstem lesions defined by magnetic resonance imaging (MRI), and without sleep complaints, underwent PSG. The data was compared to age-matched controls. Eight patients met inclusion criteria. Of the eight locations, one was midbrain, two were pontomesencephalic, four were pontine and one was pontomedullary.

Results: Four of the eight patients had a decreased percentage of Rapid Eye Movement (REM) sleep. The abnormal studies occurred in patients with a right paramedian pontine infarct, a left pontomedullary cavernous hemangioma (CH), a left pontine CH, and a right pontomesencephalic CH. REM sleep, as a percentage of total bed time, was 8.7, 12.3, 14.8, and 16.7%, respectively.

Conclusion: These findings concur with non-human data that depict pontine structures as the major generators of REM sleep.
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Keywords: Sleep; REM; Brainstem; Polysomnography; Magnetic resonance imaging

1. Introduction

Pharmacological and lesional studies in animals have led to the discovery of many anatomic structures responsible for generating the different stages of sleep [1,2]. Various structures within the brainstem contribute. In particular, bilateral lesions of the nucleus reticularis pontis oralis, ventral to the locus ceruleus, in cats have been shown to abolish Rapid Eye Movement (REM) sleep [1]. Similar data in humans is rare. Pathological processes are typically larger, extending beyond one brainstem level or beyond the brainstem entirely. Furthermore, patients may have an alteration of consciousness or may be comatose, limiting the utility of sleep studies. Prior to the advent of Magnetic Resonance Imaging (MRI), certainty regarding a localized lesion to the brainstem was significantly less. In this communication, we present the polysomnographic (PSG) data on eight consecutive patients with isolated brainstem lesions noted on MRI.

2. Methods

Patients eligible for inclusion in the study had identifiable lesions on MRI that were confined to the brainstem. The subjects had no complaints of insomnia, excessive daytime somnolence, or nighttime awakenings. Patients were excluded if they had an alteration of consciousness, any sleep complaints, clinical stigmata of multiple sclerosis, or any use of drugs or medications that could affect sleep architecture. Patients were also excluded if the MRI disclosed any intracranial abnormalities outside the brainstem. Upon identification of appropriate candidates, informed consent was obtained. The patients underwent PSG a minimum of 4 weeks after the onset of presentation. The patients were admitted to a devoted sleep laboratory on

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the neurology inpatient ward, and had one night of PSG on the second or third night of hospitalization. Each patient had a 7- to 8-h PSG using a Telefactor (West Warwick, RI) sleep-recording unit. A 16-channel montage was used, with six channels devoted to electroencephalography, two to electrooculography, three to electromyography (one to the chin and one to each lower extremity), three to respirations (nasal, abdominal and thoracic), and one for electrocardiogram and oxygen saturation.

All the acquired data was scored and interpreted by one neurophysiologist (B.J.), who was blinded to the MRI results. The sleep stages were scored according to the Rechtchaffen and Kales criteria [3]. The percentages of each sleep stage were calculated from total bed time and total recording time. The results were compared to age-matched normative values [4]. The Walter Reed Army Medical Center Institutional Review Board approved this study.

3. Results

Eight consecutive patients with lesions isolated to the brainstem were studied with polysomnography. Three patients had a cavernous hemangioma (CH) (one pons, one pontomedullary and one pontomesencephalic). Three patients had strokes (right pons in two and bilateral pons in the other), one had a midbrain glioma, and one had an arteriovenous malformation (AVM) that was extrinsic to, yet abutted, and indented the pons. Table 1 shows the MRI and PSG findings on the eight patients. Five of the patients had decreased REM percentage sleep (calculated from total recording time) with respect to age-matched controls. Patient number 5 was a 64-year-old woman with a bilateral pontine stroke, who had poor sleep efficiency (53%), and the percentages of all stages of sleep were spuriously low. The percentage of REM sleep to total sleep time was normal. All four patients with a bona fide REM percentage decrease had lesions involving the pons. Fig. 1 depicts their MRIs. Patient 1 had an acute onset of a left hemiparesis. Patient 2 had a progressive right hemiparesis, hemiataxia, and left cranial nerve V and VI abnormalities. Patient 3 had intermittent diplopia but had no fixed neurological deficits. Patient 4 had chronic headache and hemifacial paresthesias. None had neurological deficits implicating disease outside the brainstem. Patient number 6 had the extrinsic pontine AVM, and had normal, albeit borderline, REM percentage. Patient number 7 had a midbrain glioma, which spared the pons, and had a normal study. There were no instances of significant apnea or periodic limb movements.

Table 1
Polysomnographic and MRI data on eight patients

Patient number: MRI	Age/sex	Stage I% (to TTB to TST)	Stage II% (to TTB to TST)	Stage III/IV% (to TTB to TST)	REM (%) (to TTB (mean) to TST)	REM latency
1. R pontine CVA	72/F	19.3	59.3	3.0	8.7 (13.2)	152 min
		21.3	65.7	3.3	9.6	
2. L ponto-medullary CH	28/F	6.1	34.8	36.0	12.3 (17.8)	210
		7.0	39.0	40.2	13.8	
3. L pontine CH	18/F	3.4	43.6	29.1	14.8 (17.8)	154
		3.7	48.0	32.0	16.3	
4. R pons/midbrain CH	33/M	6.6	47.7	23.1	16.7 (18.2)	108
		7.1	50.7	24.5	17.7	
5. B pontine CVA	64/F	6.5	12.0	24.7	10.1 (13.2)	71
		12.2	22.5	46.3	18.9	
6. R pontine AVM	55/F	3.5	37.7	30.5	17.9 (17.6)	92
		3.9	42.1	34.0	20.0	
7. R midbrain glioma	34/F	2.1	23.9	44.9	24.9 (18.2)	67
		2.2	24.9	46.9	26.0	
8. R pontine CVA	66/M	24.1	22.9	14.8	21.9 (13.2)	68
		28.8	27.4	17.7	26.2	

Top numbers reflect percentage of sleep stage from total time in bed (TTB) and bottom number reflects percentage of sleep stage from total sleep time (TST). Abbreviations: B, bilateral; R, right; L, left; CVA, cerebrovascular accident; AVM, arteriovenous malformation; CH, cavernous hemangioma; reference values for age-dependent mean REM percentages in parenthesis [4].

4. Discussion

The literature of humans with brainstem lesions and sleep abnormalities consists of a few small series and case reports. This study is the largest series of patients with isolated brainstem lesions confirmed by MRI, and is the only one performed in a prospective manner. All eight patients were asymptomatic with respect to sleep complaints. Nonetheless, an abnormality in REM percentage was detected in four.

The first reported case of a brainstem lesion, and a sleep abnormality was described in 1971 [5]. A 36-year-old woman with vertebral artery trauma from a motor vehicle accident and locked-in syndrome was noted to have only 3–4% REM sleep. In 1973, Guilleminault reported a case of a patient with clinical signs of left cerebral and right pontine disease secondary to trauma [6]. The patient was noted to have marked decrease in total sleep time, but normal REM percentage. In 1976, Markand and Dyken did PSG on seven patients with locked-in syndrome due to a vascular etiology [7]. Three patients had absent REM, one had no sleep at all, two had decreased REM, and one was normal. An autopsy on one patient showed a bilateral pontine infarct, ventral greater than tegmental. There was also bilateral cerebellar involvement. None of the above cases had computed tomography (CT) or MRI confirmation of localization.