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PRIMARY SLEEP ENURESIS IN CHILDHOOD

POLYSOMNOGRAPHIC EVIDENCES OF SLEEP STAGE AND TIME MODULATION

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SUMMARY — The objective of this study was to evaluate enuretic events and its relations to sleep stages, sleep cycles and time durations in a selected group of children with primary essential sleep enuresis. We evaluated 18 patients with mean age of 8.2 years old (ranging from 5 to 12 years); 10 were males and 8 females (n.s.). They were referred to the Sleep Disorders Center with the specific complaint of enuresis since the first years of life (primary). Pediatric, urologic and neurologic workup did not show objective abnormalities (essential). The standard all-night polysomnography including an enuresis sensor attached to the shorts in the crotch area was performed. Only enuretic events nights were included. All were drug free patients for two weeks prior to polysomnography. In this report, only one polysomnography per patient was considered. The enuretic events were phase related, occurring predominantly in non-REM (NREM) sleep ($p<0.05$). There was no predominance of enuretic events among the NREM stages (n.s.). A tendency of these events to occur in the first two sleep cycles was detected but may be due to the longer duration of these cycles. The events were time modulated, adjusted to a normal distribution with a mean of 213.4 min of recording time.

KEY WORDS: enuresis, polysomnography, sleep, parasomnia.

Enurese noturna na infância: evidências polissonográficas de modulação por estágio e tempo de sono

RESUMO — Foram avaliadas 18 crianças, com idade variando de 5 a 12 anos (8,2 ± 2,3 anos), com enurese noturna idiopática primária, sendo 10 meninos e 8 meninas. Todas realizaram avaliação pediátrica, urológica e neurológica sem evidenciar etiologia para a enurese (idiopática). Todas apresentavam enurese desde os primeiros anos de vida sem controle prolongado (primária). Apresentavam enurese ao menos uma vez por semana por ocasião da monitorização e não faziam uso de medicações. Foi realizada polissonografia de noite inteira incluindo eletrencefalograma, eletroculograma, eletromiografia submentoniana e de tíbiais anteriores, termístores nasais e bucais; eletrocardiograma; pneumógrafo, oximetria transcutânea contínua e detector de emissão de urina. Somente as polissonografias em que houve episódio enurético foram incluídas nesta análise, sendo avaliada uma polissonografia por paciente. Durante a polissonografia, 77,8% das crianças tiveram um episódio enurético; 16,7% tiveram dois episódios; 5,6% tiveram três. Os episódios enuréticos mostraram maior ocorrência no sono não-REM (NREM) do que no REM ($p<0,05$). Dentre os estágios NREM não houve predomínio para a ocorrência de episódios enuréticos (n.s.). Observamos tendência para os episódios enuréticos surgirem nos dois primeiros ciclos de sono mas tal tendência pode ser atribuível à maior duração destes ciclos iniciais. Os episódios enuréticos se mostraram modulados também pelo tempo, ajustando-se a uma distribuição normal com média em 213,4 min de registro de sono.

PALAVRAS-CHAVE: enurese, polissonografia, sono, parassônia.

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Sleep enuresis is an everyday disorder in pediatric neurology clinics and an age-old problem for patients and families [1,3,6,15,17,18]. This leads to numerous therapeutic approaches [4,5,10,16,19,22]. However, its physiopathology and its links to sleep mechanisms are still largely unknown [13].

The objective of this report it to show relations between enuretic events, sleep stages, sleep cycles and time durations in a selected group among the enuretics, the children with primary essential sleep enuresis.

METHODS

A total of 18 children, 10 boys and 8 girls, mean age of 8.2 ± 2.3 years, with a range of 5 to 12 years, were evaluated consecutively, for the specific complaint of enuresis after having been referred to the Sleep Disorders Center. Diagnosed as primary essential sleep enuresis, the category primary enuresis was designated due to the fact that the condition had been continuous from infancy, and the category essential (idiopathic) enuresis was designated in view of the fact that no cause had been found after full pediatric, urologic and neurologic evaluation. All patients had had one or more enuretic events per week by the time they were submitted to polysomnography. Each had previously tried sleep hygiene methods, including fluid intake reduction and voluntary micturation before and during the night; all not to much benefit. None had been on medication for treatment of enuresis.

Standard all-night polysomnography included electroencephalogram (C3/A2, C4/A1); electroculogram, electromyogram of submentalis and anterior tibialis muscles; buccal and nasal airflow measured by thermocouples; respiratory effort detected by thoracic pneumogram; electrocardiogram; and continuous transcutaneous oxygen saturation monitoring. An enuresis sensor was attached to the shorts in the crotch area (Nytone Medical Prod. Inc.). Sleep staging followed the standardized criteria of Rechtschaffen and Kales [14]. All patients were drug free for two weeks prior to the polysomnography. In case no enuretic episode was detected in the first polysomnography, it was subsequently repeated until one was. In the present report only enuretic episodes nights data were included, consequently rendering only one night polysomnography per patient. When repeated polysomnograms were recorded, we choose to present in this report only the best adapted night.

RESULTS

During the polysomnography, enuretic events occurred only once in 14 patients (77.8%); twice in 3 patients (16.7%); and 3 times in 1 patient (5.6%). Polysomnogaphic data (Table 1) showed typically low sleep efficiency and interrupted sleep in this group of patients. Sleep apnea syndrome was ruled out in all patients by the polysomnographic findings and was not suggested by clinical evaluation.

Each child had 4 to 6 sleep cycles. However, in this group of children, enuretic events were present only in cycles 1 to 4. When the observed enuretic events in each cycle were compared with expected values no statistical correlation was found (χ^2 test, $p=0.80$, n.s.). The number of enuretic events in cycle 1 was 6 (26.1%) while the expected probability was 7 (32.0%); in cycle 2, the observed was 8 (34.8%) while the expected was 6 (28.2%); in cycle 3 the observed was 5 (17.4%) while the expected was 5 (20.8%); in cycle 4 the observed was 5 (21.7%) while the expected was 4 (15.6%); in cycle 5, not one was observed while the expected was 1 (2.9%); in cycle 6, not one observed nor expected. Therefore, enuretic events occurred at random among the sleep cycles, and the slightly higher number of episodes in the first two cycles were possibly due to longer duration of these initial night sleep cycles.

When sleep cycles 1 and 2 were added and compared with cycles 3 and 4, as well as with cycles 5 and 6, the occurrence of enuretic episodes also proved not to be cycle-related (χ^2 test, $p=0.67$, n.s.). The events occurred proportionally to the cycles duration. The number of observed enuretic events in cycles 1+2 was 14 (60.9%) while the expected probability was 13 (60.2%); in cycles 3+4, the observed was 9 (39.1%) while the expected was 9 (36.4%); in cycles 5+6, not one was observed while the expected was 1 (3.3%).

When enuretic episodes during REM sleep were compared with those in non-REM (NREM) sleep, a clear tendency of occurrence in NREM sleep was present (Binomial test, $p=0.014$). Enuretic events were not present in REM sleep while the number of expected episodes was 4 (17.4%); the number of observed events in NREM sleep was 23 (100%) while the expected was 19 (82.6%).

Table 1. Polysomnographic data of 18 children with primary enuresis.

		mean ± SD	mini	max	(CI (95%)
Total time in bed	min	455.6 ± 35.4	367	534	438.0; 473.2
Total sleep time	min	398.5 ± 51.9	269	481	372.7; 424.3
	%*	87.8 ± 11.3	55.6	99.4	82.1; 93.4
Total time awake	min	57.1 ± 55.5	3	215	29.5; 84.7
	%*	12.2 ± 11.3	0.6	44.4	6.6; 17.9
Sleep latency	min	3.4 ± 4.5	0	19	1.2; 5.7
REM latency (St 1)	min	130.5 ± 65.4	56	310	94.2; 166.7
REM latency (St 2)	min	128.7 ± 61.3	55	309	97.2; 160.2
Stage REM	min	70.4 ± 24.2	25	118	58.3; 82.4
	%***	17.4 ± 5.0	7.0	25.0	14.9; 19.9
REM density	min	7.8 ± 2.5	1.9	12.4	6.5; 9.0
	%**	11.1 ± 1.7	7.6	14.0	10.3; 12.0
NREM stages	min	328.1 ± 40.4	236	383	308.0; 348.2
	%***	82.6 ± 5.0	75.0	92.9	80.1; 85.0
Stage 1	min	6.1 ± 5.8	1	23	3.2; 9.0
	%***	1.6 ± 1.5	0.2	5.8	0.8; 2.3
Stage 2	min	117.4 ± 47.3	29	223	93.9; 140.9
	%***	29.8 ± 11.9	7.3	53.3	23.9; 35.8
Stage 3	min	16.0 ± 5.8	8	27	13.1; 18.9
	%***	4.0 ± 1.3	2.2	6.0	3.4; 4.7
Stage 4	min	188.6 ± 50.8	103	293	163.3; 213.9
	%***	47.2 ± 9.9	25.3	65.8	42.2; 52.1

%*, percentage in relation to total time in bed; %**, percentage in relation to total REM sleep time; %***, percentage in relation to total sleep time; CI, confidence interval.

Table 2. Enuretic events distribution in relation to sleep stages and sleep cycles.

		Cycle 1	Cycle 2	Cycle 3	Cycle 4
Stage 2					
	N	2	3		3
	%*	8.7	13.0		13.0
	%**	25.0	37.5		37.5
	%***	33.3	37.5		60.0
Stage 4					
	N	4	5	4	2
	%*	17.4	21.7	17.4	8.7
	%**	26.7	33.3	26.7	13.3
	%***	66.7	62.5	100.0	40.0
Total					
	N	6	8	4	5
	%*	26.1	34.8	17.4	21.7
	%**	26.1	34.8	17.4	21.7
	%***	100.0	100.0	100.0	100.0

%*, percentage in relation to the total number of enuretic events; %**, percentage in relation to the total number of events in each sleep stage; %***, percentage in relation to the total number of events in each sleep cycle.

In our group of patients, enuretic events were only present in stages 2 and 4 (Table 2). When compared with the expected occurrences, based on stages duration among NREM stages, no statistical correlation was observed (χ^2 p=0.08, n.s.). Enuretic events were not present in stage 1 while the expected number was 0.4 (1.8%); in stage 2 the number of enuretic events was 8 (34.8%) while the expected was 8.2 (35.8%); in stage 3 not one was observed while the expected number was 1.1 (4.9%); in stage 4 the observed number was 15 (65.2%) while the expected was 13.2 (57.5%).

The time elapsed from the onset of sleep until the enuretic event was evaluated in two ways: that which only included the first enuretic episode of the night, and that which included all episodes of the night. In the first case, when only the first enuretic episode of the night was included (N=18), the mean time was 198.4 ± 108.4 with minimum of 38 min and maximum of 463 min with confidence interval (95%) of 144.5; 252.4. In the second case, when included all enuretic episodes (N=23), the mean time was 213.4 ± 106.6 min with minimum of 38 min and maximum of 463 min and confidence interval (95%) of 167.3; 259.5. The time of enuretic event may be adjusted to a normal distribution with mean of 213.4 ± 106.6 min.

The patient with the shorter occurrence of enuretic event time (38 min) had two enuretic events and the second was in 422 min sleep time.

The mean number of arousals was 16.4 ± 9.6 with a minimum of 4 and a maximum of 44. The confidence interval (95%) was 11.6; 21.2. The mean number of body movements was 23.2± 9.2 with a minimum of 10 and a maximum of 42. The confidence interval (95%) was 18.6; 27.7.

Thee mean heart rate in REM sleep was 79.7 ± 11.9/min, with a minimum of 62 and a maximum of 99. The confidence interval (95%) was 73.8; 85.6. The mean heart rate in NREM sleep was 77.0 ± 12.1/min with a minimum of 59 and a maximum of 98. The confidence interval (95%) was 71.0; 83.0. The comparison between REM and NREM heart rates did not show a significant difference (Student's t test, t=0.68, p=0.502, n.s.).

The mean respiratory rate in REM sleep was 20.2 ± 3.0/min, with a minimum of 15 and a maximum of 28. The confidence interval (95%) was 18.7; 21.7. The mean respiratory rate in NREM sleep was 18.2 ± 2.5/min, with a minimum of 15 and a maximum of 23. The confidence interval (95%) was 17.0; 19.4. The comparison between REM and NREM respiratory rates showed a significantly higher index in REM sleep (Student's t test, t=2.18, $p<0.05$).

COMMENTS

Initial polysomnographic reports by Broughton[2] and Gastaut & col.[7] suggested enuresis as being a NREM disorder and attributed to an impairment in the arousal mechanisms. Subsequently, others failed to show correlations to specific sleep stage or to the arousal mechanisms[21]. However, age variation and type of enuresis (primary or secondary) were factors to be considered because some of these later reports did not deal only with children nor with primary enuresis[11,23]. Methodological variations of monitoring the urine void also introduced errors as sensors may be placed in the mattress or in the night clothes causing a delay before the urine reaches the sensors. Age, diagnosis and methodology may have introduced variations to such point that recently no specificity to sleep stages or cycles has been attributed in several texts[9,11,12,13].

In the selected group here studied the enuretic events were phase related, as a predominantly NREM sleep phenomenon, as reported by others[2,20]. We have not found any relations between enuretic event and each of the NREM sleep stages, as the events occurred proportionally to the duration of each one of them.

The higher number of enuretic events occurring in the first two sleep cycles, observed in our group of patients, may be attributable to the longer duration of these initial night cycles, and no statistical correlation was found. Inoue & col.[8] reported a higher tendency of enuretic episodes to occur in the second cycle but also in the third. On the other hand, in our group, the events were time modulated, occurring adjusted to a normal distribution with a mean of 213.4 min of recording time.

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