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FULL-LENGTH ORIGINAL RESEARCH

Dream recall frequency and content in patients with temporal lobe epilepsy

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Summary

Purpose: To evaluate morning dream recall frequency and content in patients with temporal lobe epilepsy (TLE).
Methods: Fifty-two patients with pharmacoresistant TLE submitted to a written dream diary during five consecutive days and continuous video–electroencephalographic (video-EEG) monitoring. A matched control group of 41 healthy subjects completed the same diary at home. The number of recalled dreams (including long dreams) and nonrecalled dream mentation were collected, and the Dream Recall Rate (DRR) was calculated. Hall and Van de Castle dream content analysis was performed.
Key Findings: Greater than 70% of patients with TLE (37 of 52) recall their dreams, but DRR rate in these patients is lower than in controls ($p \leq 0.001$). Dream recall does not appear to be influenced by the presence of neuropsychological deficits nor seizure frequency. In dreams descriptions, TLE patients (vs. controls) have a higher percentage of familiarity in settings and fewer dreams with at least one success.
Significance: Onirical activity of patients with TLE is different from that of healthy subjects. Our results support the role of mesial and neocortical temporal structures in dream experience. The selective activation of dysfunctional mesial structures may be responsible for some of the observed variability. However, dream content changes can also mirror social and psychological comorbidities of patients with epilepsy.
KEY WORDS: Dream analysis, Mesial temporal sclerosis, Epileptogenic zone, Epilepsy and sleep, Dreams and memory.

Dreaming is a cognitive function resulting from selective brain activation during sleep. Analysis of dream frequency and content has been sparsely undertaken in some neurologic pathologies caused by focal brain lesions. Although the first reference of recurrent nightmares in patients with epilepsy was made more than a century ago by De Santis, only a few studies, mostly case reports, have addressed the onirical activity (defined as sleep mentation recalled upon wakening) in patients with epilepsy. Some of these reports suggested that the main characteristics of the dreams of patients with epilepsy are its recurrent and stereotypical character, as well as the low rate of morning recalls (Epstein, 1964, 1979; Reami et al., 1991; Solms, 1997).

Different lines of evidence suggest the existence of a relationship between dreams and epilepsy, particularly temporal lobe epilepsy (TLE), and that both can be products of a common neurophysiologic pathway. *First*, during a temporal lobe seizure, dream-like cognitive and sensorial symptoms are often reported. The similarity between dreams and seizures was first emphasized by Jackson and Colman (1898) when they described the ''dreamy state'' in temporal lobe seizure semiology. Furthermore, dream descriptions including specific ictal phenomenology (cognitive, dysmnesic, visual, auditive, and uncinate) are known to occur in patients with epilepsy (Epstein & Hill, 1966; Epstein & Freeman, 1981; Reami et al., 1991; Vercueil, 2005). *Second*, the results of studies on brain electrical stimulation showed that the lateral temporal cortex can be responsible not only for the visual content in recurrent nightmares, but also for the visual epileptic aura in patients with epilepsy. In line with these findings, electrical stimulation of all of the structures of the mesial temporal lobe (Halgren et al., 1978; Bancaud et al., 1994; Bartolomei et al., 2004; Vignal et al., 2007) can lead to the ''dreamy state,'' with an important role of the amygdala and hippocampus in memory recall. *Third*, a relative activation of the limbic and paralimbic structures during rapid eye movement (REM) sleep, in comparison to non-REM (NREM) sleep and wakefulness, has been shown in several positron emission tomography (PET) studies (Maquet et al., 1996; Braun et al., 1997; Nofzinger et al., 1997; Braun et al., 1998; Maquet, 2000; Nofzinger et al., 2002).

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Well-designed prospective controlled studies about oniric al activity in patients with epilepsy are lacking. Therefore, with the aim of improving our knowledge on this topic, we conducted such a study to evaluate the morning dream recall rate and characterize the dream content in a homogeneous pharmacoresistant group of patients with TLE. This research is relevant to the better understanding of the relation between TLE and dreams, sleep, and memory.

Methods

Subjects

Onirical activity was evaluated in two groups of subjects: patients with TLE and healthy controls. Over a period of 36 months, we consecutively recruited patients with lesional pharmacoresistant TLE included in the epilepsy surgery evaluation program of our hospital and admitted for continuous video-EEG monitoring for five consecutive days (Monday through Friday). The diagnosis of TLE was done prospectively after multimodal analysis of clinical, neurophysiologic, neuropsychological, and neuroimaging findings. Neuropathologic examinations following surgery were completed in 67% of the patients. A control group of healthy subjects, matched for age and gender, was also evaluated for comparisons. None of the controls had any neurologic disease or other condition known to interfere with dream mentation including central nervous system–acting medications. All subjects, or their legal representatives, provided written informed consent for participating in the study, which was approved by our institution.

Onirical activity

A standardized written questionnaire (dream diary) was applied every morning during patient admission for dream recollection. The patients noted if they had or had not dreamed during the previous night, the number of dreams experienced, and if they remembered those dreams. Patients were asked to provide a spontaneous written description of each dream. For each patient and each morning, we determined the number of recalled dreams (including long dreams, i.e., with >40 words) and of nonrecalled dream mentation (i.e., when subjects remembered having dreamt but could not recall its content). The morning dream recall rate (DRR) was calculated by dividing the total number of dreams recalled by the product of the number of patients times the number of monitoring days. The control subjects completed the same dream diary at home during five consecutive days (Monday to Friday) and the same information was extracted for comparisons.

For every dream described, we applied the Hall and Van de Castle (1966) system of quantitative and systematic dream content analysis (DREAMSAT) (Schneider & Domhoff, 1995). This system rests on nominal categories, searches for significant regularities in a written text, provides a replicable body of descriptive empirical findings of dream content, and allows for controls comparisons. The methodology is fully described and is available to all researchers through DreamResearch.net (Schneider & Domhoff, 1995). Dream codifiers (CB, JP) were blinded with respect to the characteristics of the patients, including their epileptogenic zone and seizure activity.

Seizure activity

During the 5-day admission period, patients were under continuous video-EEG monitoring and seizures were recorded. Antiepileptic drugs (AEDs) were tapered by one third per day until day 3, or until three seizures were recorded, following a standardized protocol. We determined the number of seizures in the 24-h EEG period preceding each morning for dream collection. Therefore, for each patient, there were five dream diaries (one per morning) and four 24-h video-EEG recordings.

Data analysis

The primary objective was to compare the dream recall frequency and content between patients with TLE and controls. Exploratory analyses were also made for specific subgroups of TLE patients to evaluate the influence of the epileptogenic zone [mesial (MTLE) vs. nonmesial/neocortical (NMTLE)] and of the presurgical neuropsychological function on the dream recall frequency.

Nonparametric tests were used for group comparisons on one variable (Mann-Whitney U test), for comparison between dichotomous variables (two-sided Pearson chi-square test), and for evaluating differences in the distribution of the morning dream recalls and seizures frequency across the days of admission (Kruskal-Wallis H test). Spearman's rank correlation coefficient was computed for morning dream recall and seizure frequency. All statistical analyses were done using the SPSS 16.0 for Windows (Lisbon, Portugal). The level of significance for comparison between subgroups of patients with TLE was set at $p = 0.01$, to correct for multiple comparisons.

For content analysis, coding categories were computed in dreamSAT (Schneider & Domhoff, 1995). In this system, raw frequencies of Hall and Van Castle categories were analyzed using percentages and ratios to correct for the varying lengths of dream reports. The magnitude of the differences was calculated with the Cohen's h statistic, which corrects for the fact that standard deviations cannot be determined with data expressed in percentages.

Results

Dream recall

Fifty-six consecutive patients with TLE were admitted during the study period. Four patients refused to participate and 52 patients, with mean disease duration of 22.6 (3–51.3) years, were evaluated. The control group included 41 subjects. The two groups were well matched for age, gender,

Table 1. Clinical characteristics and morning dream recall in controls and patients with TLE

	Controls (n = 41)	TLE patients (n = 52)	p-value
Male/female (n)	20/21	26/26	0.92
Age (mean ± SD and range)	42.1 ± 12.4 (22–68)	37.9 ± 11.1 (20–61)	0.09
Level of schooling: no. of years (y) of attainment	4 y = 3 (7.3%)	4 y = 5 (9.6%)	0.73
	4–9 y = 8 (19.5%)	4–9 y = 18 (34.6%)	0.16
	9–12 y = 12 (29.2%)	9–12 y = 15 (28.8%)	1.0
	>12 y: 18 (43.9%)	>12 y: 14 (26.9%)	0.12
Morning dream recall (n/%)	36 (87.8)	37 (71.2)	0.05
DDR (mean ± SD)	0.78 ± 0.57	0.34 ± 0.33	<0.001
Morning dream recall with ≥40 words (n/%)	21 (51.2)	13 (25.0)	<0.01
Nonrecalled dream mentation (n/%)	21 (51.2)	25 (48.1)	0.76

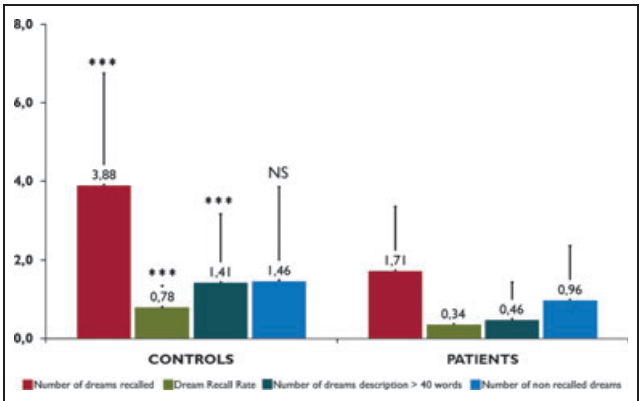

Figure 1.
Morning dream recall in patients with TLE and controls. Values represent the mean number per subject and error bars represent the standard deviation (SD). ***p ≤ 0.001; **p ≤ 0.01; NS p > 0.05.
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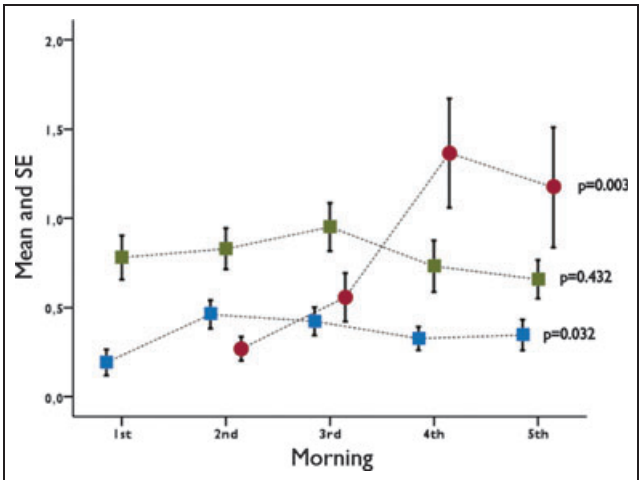

Figure 2.
Seizure and morning dream recall frequency during the study period. Red circles, mean seizure frequency by morning, which represents the mean seizure frequency in the previous 24 h video-EEG monitoring. Squares, mean dream recall frequency by morning in patients (blue) and in control subjects (green), which represents mean dream recall frequency in each morning. Bars = represent the standard error of the mean (SE).
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and level of schooling (Table 1). The number of subjects with dream recall, as well as the mean number of dreams, DDR and long dreams, was lower in patients with TLE (Table 1 and Fig. 1). There were no differences between groups for nonrecalled dream mentation.

Exploratory comparisons between NMTLE (n = 13) and MTLE (n = 39) patients did not shown significant differences in dream frequency analyses, with the exception of a lower number of patients with long dreams (0.0% vs. 33.3%; p = 0.016). Onirical activity was similar between patients with and without changes in the presurgical neuropsychological evaluation (Data S1).

Seizures and dreaming

Eleven patients (21.2%) were seizure-free during the video-EEG monitoring. Comparisons between patients with and without seizures did not show any significant difference for all parameters studied.

During admission, a total of 89 dreams were recalled and 175 seizures were recorded in video-EEG monitoring. As expected, the number of seizures increased until day 4 with a decrescendo thereafter (Fig. 2). This distribution was significantly different across the days of admission (p = 0.003), with a lower mean seizure frequency in the 24 h preceding the second morning in comparison to the fourth (p < 0.001) and to the fifth (p = 0.004) morning.

The distribution of the mean number of dreams recalled (Fig. 2) also varied across the days of admission (p = 0.032), being significantly higher in the second and third mornings in comparison to the first (p = 0.002 and p = 0.007, respectively). However, there was no significant correlation between seizure activity and dream recall frequency. The mean number of dreams recalled by control subjects was not different between study mornings (p = 0.432).

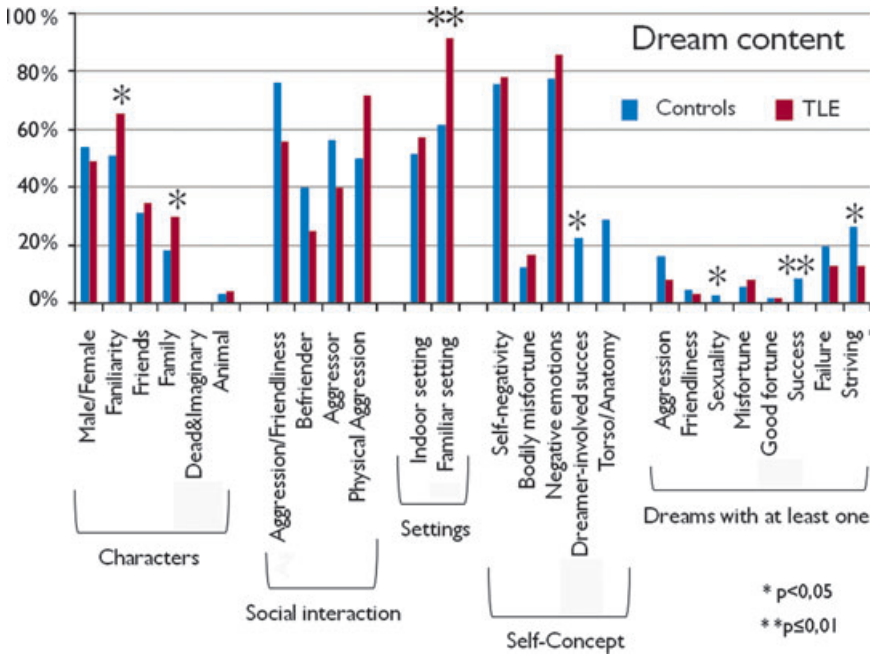

Figure 3.
Dream content analysis in patients with TLE and controls. Bars represent the percentage of dreams with the contents described (BLUE for controls and RED for patients with TLE).
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Dream content analysis

Hall and Van Castle content analysis (Fig. 3) showed that, in comparison to controls, patients with TLE had a higher percentage of a familiar setting ($p < 0.01$) in dream reports and a lower percentage of dreams with at least one success ($p < 0.01$).

Exploratory analyses of TLE subgroups showed that patients with NMTLE had a relative lower percentage of dreams reports with at least one failure ($p = 0.008$) and striving ($p = 0.008$).

Discussion

Greater than 71% of our patients had at least one morning dream recall during the 5-day period of video-EEG monitoring. A previous study using an ambulatory dream diary (Bonanni et al., 2002) reported that 85% of the patients with complex partial seizures are capable of recalling at least one dream per week. The results of our study are in close agreement with those findings, if corrected to the average video-EEG monitoring days. This finding provides further evidence for the capability of patients with pharmacoresistant partial epilepsy to recall their dreams.

However, morning DRR was lower in patients with TLE than in controls, as was the mean number of dreams and long dreams recalled and the proportion of patients with at least one long dream reported. The observed findings may be due to the epileptogenic lesion itself, as focal brain pathology is known to impair dream recall (Solms, 1997). In fact, temporooccipital areas have been associated with absent or reduced dream recall (Doricchi & Violanni, 1992; Solms, 1997; Bischof & Bassetti, 2004). Furthermore, limbic structures such as the hippocampus and the amygdala, which were dysfunctional in most of our patients, have been implicated in all recent models of dreaming (Solms, 1997; Hobson et al., 2000). Neuroimaging studies have also showed that one of the core functional characteristics of REM sleep is the activation of limbic and paralimbic structures (Maquet, 2000). In fact, an increase in the regional cerebral blood flow in the amygdala (Maquet et al., 1996; Nofzinger et al., 1997) and in the hippocampal formation (Braun et al., 1997; Nofzinger et al., 1997) during REM sleep has been shown in PET studies. Moreover, these functional mappings appear to apply not only to REM sleep but also to REM sleep dreaming, as all patients awakened during the REM sleep scan had dream recall (Maquet et al., 1996). The importance of a functional mesial temporal lobe for normal dreaming has as well been recently emphasized by Fell et al. (2006). These authors studied a population with medical intractable MTLE and found that successful memorization of dreams is accompanied by enhanced rhinal-hippocampal and intrahippocampal EEG coherence examined through deep electrodes. This reflects the existence of a strong anatomic and functional connectivity between limbic structures, which is fundamental to building declarative memories and to normal dream recall.

The dysfunction of the amygdala probably also contributes to some of the results of the dream content analysis. Patients with NMTLE had a relative lower percentage of dreams reports with failure and striving. These findings can reflect a malfunctioning amygdala in MTLE, knowing its role in threat recognition and avoidance. Despite the importance that has been given to limbic areas in recent dream research, a careful look into the studies reporting anatomic

correlates of dreaming, also reveals that the absent of dream recall in temporooccipital lesions is reported even in the lack of mesial involvement (Doricchi & Violanni, 1992; Solms, 1997; Bischof & Bassetti, 2004). This observation shows the importance of both limbic and neocortical structures in normal dreaming. In line with these findings, our results in subgroup analysis of patients with NMTLE vs. MTLE showed very similar dream recall rates. The only trend was toward a lower number of patients with NMTLE recalling long dreams, not explain by differences in the verbal ability of our patients. It has been shown that longer dream reports are frequently REM sleep dreams, due to their higher complexity (Cipolli et al., 2004). A plausible explanation lies in the presence of a relatively hyperactivated limbic system during REM sleep in MTLE, through the cumulative effect of seizures/interictal epileptic activity, using a possible identical neuronal network of dream generation (Epstein, 2002). In this way, it is possible that, patients with NMTLE share a comparatively less hyperactivated limbic system, leading to fewer longer dream reports.

Regardless of the description that both seizure activity and/or AED withdrawal can be associated with REM deprivation (Bazil et al., 2000; Bazil, 2003), we did not found a significant correlation between seizure and dream recall frequencies, in accordance with the results of the study by Bonanni et al. (2002). It is nonetheless relevant that future studies on focal epilepsy dreams use neurophysiological correlation directly assessing seizure-induced sleep disturbances.

Although associations between cognitive function (general intellectual and abstractive ability) and dream recall have been reported in patients with epilepsy (Bonanni et al., 2002), we did not find differences in dream recall between patients with and without neuropsychological impairment. Therefore, at least in our study, the results are probably not biased by this potential confounder. Moreover, patients and controls were similar in nonrecalled dream mentation frequencies. If memory deficits were the culprit, patients were expected to have higher frequencies in this variable.

Furthermore, the lower DRR in patients with TLE (vs. controls) is probably not related to the inpatient clinical setting of this study, as suggested by other authors (Hobson et al., 2000; Domhoff, 2005). Our results are in close agreement with those reported by the study of Bonanni et al. (2002) in an ambulatory setting. In addition, our patients were daily encouraged to report their dreams, whereas controls were contacted only at the end of the 5-day period. This difference could have in fact slightly over estimated patients' DRR.

According to the theory of continuity (Domhoff et al., 2006; Domhoff & Schneider, 2008), waking thought patterns, behaviors, and concerns are reflected in dreams, and these are the main source of dream elements. A number of the dream content differences found in our study (such as the low percentage of recalled dreams with at least one success) can be explained in light of this theory, given the absence of future perspectives and the low quality of life scores detected in patients with pharmacoresistent epilepsy (Mikati et al., 2006; Kobau et al., 2007). However, some of the findings can also be explained by the regional specialization of the brain areas involved in the hyperactivated epileptogenic region. Patients with TLE had a higher percentage of familiarity in dream's settings than controls subjects. There was also a trend toward higher familiarity in characters. This observation can be explained partially by the social isolation (McCagh et al. 2009) of these patients, but also by the activation of structures known to be involved in the production of feelings of familiarity (hippocampus, amygdala, and rhinal cortex) (Bancaud et al., 1994; Bartolomei et al., 2004; Vignal et al., 2007). In fact, human temporal lobe neurons respond preferentially to familial or personally relevant items, as recently shown by Viskontas et al. (2009). Future studies should specifically address the mechanism of characters (Kahn et al., 2000) and settings recognition in the dreams of patients with TLE, to further explore this finding.

Conclusions

Our study provides further evidence that most patients with pharmacoresistant partial epilepsy have the ability to recall their dreams, although the DRR in this group is lower than in controls, supporting the role of mesial and neocortical temporal structures in dream experience.

Social isolation, absence of future perspectives, and quality of life seem to be reflected in the dream content of patients with TLE. However, specific activation of medial temporal structures involved in the production of feelings of familiarity is also postulated. This study contains significant data contributing to our understanding of the relationship of TLE with dreams, sleep, and memory.

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Disclosure

None of the authors has any conflict of interest to disclose.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data S1. Dream recall and seizure frequency in patients with TLE according to the neuropsychological evaluation.

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