Published in final edited form as:

Epilepsia. 2015 November ; 56(11): e182–e185. doi:10.1111/epi.13189.

Epileptic auras and their role in driving safety in people with epilepsy

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Summary

The aim of our study was to evaluate the role of auras in preventing motor vehicle accidents (MVA) among medically-refractory epilepsy patients.

The Multicenter Study of Epilepsy Surgery database was used to perform a case-control study by identifying patients who had seizures while driving that led to MVAs (Cases) and those who had seizures while driving without MVAs (Controls). We compared presence of reliable auras and other aura-related features between the two groups.

215 out of 553 patients reported having seizure(s) while driving; 74 were identified as 'Controls' and 141 as 'Cases'. The two groups had similar demographic and clinical features. The presence

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[*]See the Appendix for a listing of members of the Multi-Center Study of Epilepsy Surgery.

Contributions

Vineet Punia MD, MS contributed to the study design, data analysis and drafting manuscript.
Pue Farooque MD contributed to study design, data analysis and drafting manuscript.
William Chen contributed to data analysis and drafting manuscript.
Lawrence J. Hirsch MD contributed to study design and revising manuscript
Anne T. Berg, PhD contributed to study design, and revising manuscript
Hal Blumenfeld MD, PhD contributed to the study design, data analysis and drafting manuscript.

Disclosure

Vineet Punia, Pue Farooque and William Chen have no disclosures to report. Lawrence J. Hirsch has received research support or honoraria from UCB-Pharma, Upsher-Smith, Lundbeck, Eisai, Sunovion, Neuropace, GSK, Allergan, Natus and Neuropace. Anne T. Berg has received research support from NINDS and the Pediaric Epilepsy Research Foundation and is a member of advisory boards for ESAI and Citizens United for Research in Epilepsy. Hal Blumenfeld has received research support from NIH/NINDS the Loughridge Williams Foundation and the Betsy and Jonathan Blattmachr Family.

of reliable auras was not different between the two groups (67% in Cases vs 65% in Controls; OR = 0.89, 95% CI 0.49 – 1.61, p = 0.76). In addition, the groups did not differ in the proportion of patients who reported longer (>1 minute) auras (OR 0.7; 95% CI 0.28 – 1.76; p = 0.47), or who thought that their auras were sufficiently long to protect themselves (OR 1.19; 95% CI 0.62 – 2.00; p = 0.77).

Our study questions the long-held belief of a protective role of reliable auras against MVAs in people with epilepsy.

Keywords

Epilepsy; Driving; Motor Vehicle Accidents; Auras; Seizures

Introduction

Epilepsy profoundly impacts quality of life. Loss of driving privileges is emblematic of the disadvantages faced by people with epilepsy (PWE) and is a chief concern among PWE when asked to rate their quality of life[1]. Previous studies report that at least half of seizures that occur during driving cause accidents[2, 3]. Identification of risk factors predisposing or protecting PWE from motor vehicle accidents (MVA) is key to the ability of physicians and regulators to give fair and effective advice. A few studies have attempted to evaluate seizure-related features including auras and their associations with MVA risk, with conflicting results[2, 4–6]. Krauss et al[4] and Gastaut and Zifkin[2] report less likelihood of having MVA if seizures were preceded by an aura whereas Taylor et al[5] found no protective benefit of auras.

The Multicenter Study of Epilepsy Surgery (MSES) enrolled patients with medically refractory epilepsy across seven centers[7]. Driving data were gathered as part of an initial evaluation with a portion of the results published in the past[3]. This self-reported data identified PWE who had seizures while driving as well as subpopulations with or without MVA. This provides an opportunity to study auras between the two subpopulations to investigate the effect of auras on MVA risk.

Methods

All data were accessed via the MSES database located at the primary site, Yale University, maintained under human studies institutional review board approval. Eligibility criteria for MSES enrollment were: ≥12 years of age; failure of ≥ 2 first-line antiepileptic drugs; and at least 20 partial or secondarily generalized seizures during the previous 2 years[7]. MSES research associates administered a structured questionnaire and clinical data were obtained from medical record review [7]. We analyzed these data to identify patients with seizures while driving, and follow-up questions to establish an “Accident” group (cases) and “No Accident” group (controls) (Figure 1). Subsequent analyses compared these two groups in terms of demographic and clinical information, as well as description of auras (Figure 1).

Aura descriptions were obtained by MSES for each seizure type (generalized tonic-clonic, complex partial, simple partial). We classified patients' auras as "Reliable" if their description for any of these seizure types excluded ambiguous terms like "sometimes," "I used to," "might," or "maybe." We classified patients' auras as "Unreliable" if they had no auras or used ambiguous terms for all seizure types. In a more conservative analysis to increase the specificity we classified patients as having "Reliable" auras only if they unambiguously reported auras before all seizure types. Questions about isolated auras (Figure 1) were used to identify patients with long (> 1 minute) or short auras. Patients were also asked if their seizures causing loss of consciousness had an aura that was long enough for them to protect themselves (Figure 1), providing data on patients' subjective sense of safety due to auras.

For statistical analysis, cases and controls were compared using odds ratio and 95% confidence intervals. P-values were calculated using Fisher's exact test with $p < 0.05$ considered significant.

Results

Of 553 total patients evaluated for MSES, 215 reported having a seizure while driving. All patients were older than 16 years of age. 141 cases formed the "Accident" group (65.6%) and 74 controls formed the "No Accident" group (34.4%) (Figure 1). Supplemental table 1 provides demographic and clinical details, which did not differ significantly between the groups.

Reliable auras

Reliable auras were present in 67.4% of patients in the Accident group, and in 64.9% in the No Accident group (OR 0.89; 95% CI 0.49 – 1.61; $p = 0.76$) (Table 1). Similar non-significant differences were found when the distribution of reliable auras was analyzed between the two groups according to the related seizure types (Table 1). In addition, more conservative criteria for reliable auras, requiring that all seizure types had no mention of any ambiguous terms for aura occurrence (see Methods), similarly led to no significant difference in reliable auras between the groups, with reliable auras present in 40.4% of the Accident group and 44.6% of the No Accident group ($p = 0.56$, data not shown in the Table).

Aura duration

The majority of cases (92, 64.5%) and controls (39, 75.7%) reported having isolated auras that were similar to their usual auras preceding seizures (see Isolated aura questions, Figure 1). We used data from isolated auras in these 131 subjects to examine aura duration in the Accident and No Accident groups. We divided auras into those lasting ≤1 minute or >1 minute, arbitrarily chosen with the idea that 1 minute may be sufficiently long to prevent MVA. 16 patients (17.4%) in the Accident group reported long auras (>1 minute), statistically similar to 9 (23.1%) in the No Accident group (OR 0.7; 95% CI 0.28 – 1.76; $p = 0.47$) (Table 1).

Auras and subjective sense of safety

Eighty-three subjects (39.9%) reported that the duration of their auras was “nearly always” long enough so that they could protect themselves if their seizures led to loss of consciousness; with statistically similar numbers in the Accident and No Accident groups, at 53 (39.0%) and 30 (41.7%) respectively (OR 1.19; 95% CI 0.62 – 2.00; p = 0.77) (Table 1)

Discussion

A consensus statement from the American Academy of Neurology (AAN) and American Epilepsy Society (AES) postulates that having “consistent and prolonged auras” is a favorable modifier to reduce the seizure-free duration before PWE may drive[8]. This modifier is considered in 11 states in the USA[9]. However, our results suggest that PWE with reliable auras do not have lower MVA risk.

Similar to our findings, Taylor et al. used a self-completed questionnaire to demonstrate no protective benefit of auras[5]. In contrast, Gastaut *et al.* reported less MVA risk in partial seizures with aura than without aura[2], however their sample size was smaller than ours and a standardized questionnaire was not used. A case-control study by Krauss et al. found auras to have a protective role against MVA[4], however it is not clear if their controls had seizures while driving. In our study, all cases and controls had seizures while driving, allowing us to compare these groups on the basis of aura reliability, duration and subjective sense of protection leading us to conclude that none provided a benefit in reducing MVA risk.

Aura duration has been cited by patients as a factor influencing the protective value of auras[4]; however this concept has not been formally studied. Data on duration of auras preceding seizures was unavailable in our study, but we found that isolated auras (which were similar to reliable auras preceding seizures in the majority of subjects) lasting >1 minute were equally common in patients with MVA as in those without MVA. Further, our study also suggests that auras may provide a false sense of safety because PWE who thought that their auras provided them sufficient duration to protect themselves occurred at a very similar frequency among subjects with or without MVAs. Some patients may even attempt to “drive home during auras before their seizures impaired their driving” leading to MVA despite having an aura[4].

There are several limitations to our study including its retrospective nature and dependence on self-reported data. Future prospective studies of PWE designed to objectively identify seizure-specific factors affecting driving should help overcome these limitations. Another important limitation is the specific MSES patient population that had medically refractory epilepsy with high seizure burden. Further studies should be done in patients with less severe epilepsy where reliable auras might be a more favorable indicator. In addition, no data were available on the influence of reliable auras on driving behavior in PWE (e.g. driving more often due to presumed safety), which may have an impact on the rate of MVAs. Ultimately, prospective studies using driving simulators may allow reproducible testing in the safe environment of EEG monitoring units while capturing objective driving performance both interictally and ictally[10].

The AAN has asked for development of better evaluation tools to assess driver safety[11]. Our current study, we believe, is a step in that direction. Based on our results, we propose that the assumed protective role of reliable auras in preventing MVA needs to be reconsidered.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Study Funding

This work was supported by NIH R01 NS055829, CTSA UL1 RR0249139, the Loughridge Williams Foundation and by the Betsy and Jonathan Blattmachr Family.

We thank George Touloumes for preparing the figure and we thank all of the study participants who made this research possible.

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Appendix

Center locations and site PIs in the Multicenter Epilepsy Surgery Study (MSES) were as follows: Yale University—New Haven, CT, Susan Spencer, MD (Principal Investigator); Jefferson Medical College—Philadelphia, PA, Michael Sperling, MD; Columbia University —New York, NY, Carl Bazil, MD; Minnesota Comprehensive Epilepsy Program

(MINCEP)—Minneapolis, MN, Thaddeus Walczak, MD; University of Rochester School of Medicine—Rochester, NY, Giuseppe Erba, MD; Montefiore Medical Center—Bronx, NY, Shlomo Shinnar, MD; New York University—New York, NY, Orrin Devinsky, MD. Additional MSES PIs not located at surgical centers were as follows: UCLA—Los Angeles, CA, Barbara Vickrey, MD, MPH; Northern Illinois University—DeKalb, IL, Anne Berg, PhD.

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

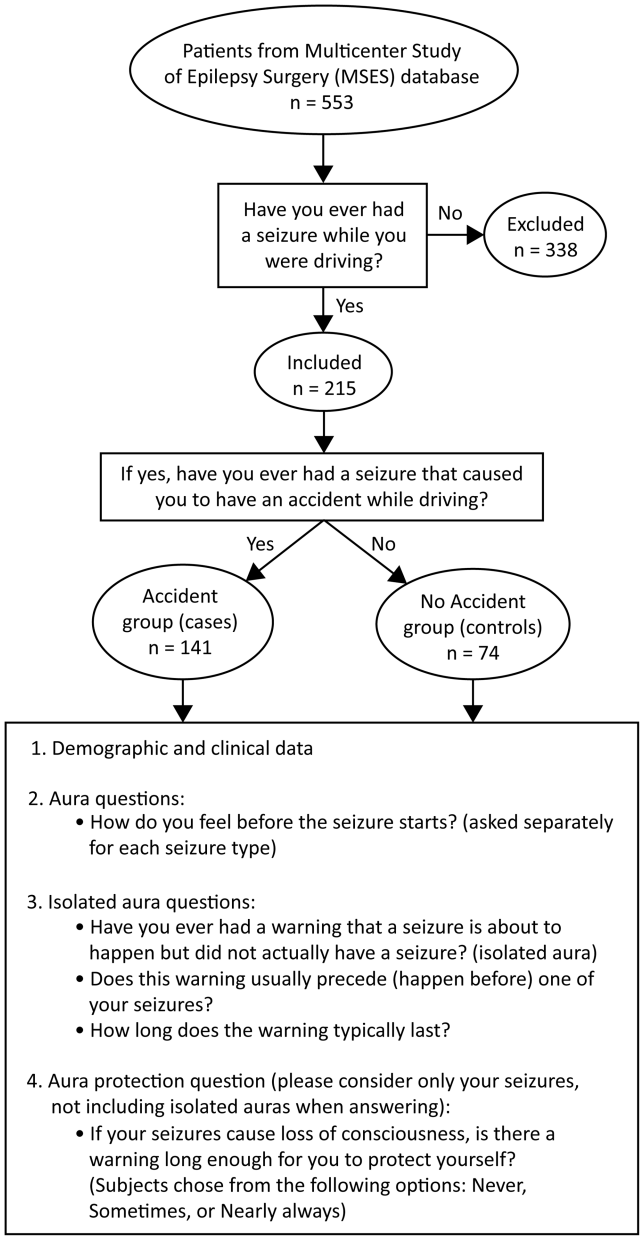

Figure 1.

Schematic showing derivation of study sample for cases and controls (oval shapes), and questions used for analysis (rectangular boxes).

Table 1

Comparison of auras in the Accident group (cases) and No Accident group (controls).

Characteristics	Seizure type	Response	Accident Cases	No Accident Controls	Odds Ratio (CI)	*1* p value
Auras	All n =215	Reliable	95 (67.4%)	48 (64.9%)	0.89 (0.49 – 1.61)	0.76
		Unreliable	46 (32.6%)	26 (35.1%)		
	2 GTC n =152	Reliable	38 (39.6%)	24 (42.9%)	1.14 (0.58 – 2.23)	0.73
		Unreliable	58 (60.4%)	32 (57.1%)		
	2 CPS n =194	Reliable	81 (61.4%)	30 (48.4%)	0.59 (0.32–1.09)	0.12
		Unreliable	51 (38.6%)	32 (51.6%)		
	2 SPS n = 52	Reliable	16 (55.2%)	13 (56.2%)	1.05 (0.35–3.18)	1.00
		Unreliable	13 (44.8%)	10 (43.8%)		
Duration of isolated auras	*3* All n =131	≤1 minute	76 (82.6%)	30 (76.9%)	0.7 (0.28–1.76)	0.47
		>1 minute	16 (17.4%)	9 (23.1%)		
Duration sufficient to protect?	*4* All n =208	Nearly always	53 (39.0%)	30 (41.7%)	1.19 (0.62– 2.00)	0.77
		Sometimes/Never	83 (61.0%)	42 (58.3%)		

Number of subjects (% within group) are shown for each subgroup. CI, confidence interval; GTC, generalized tonic-clonic seizures; CPS, complex partial seizures; SPS, simple partial seizures.

1 p values obtained by Fisher's exact test unless otherwise indicated.

2 Number of seizure types do not add to total number of all patients (215) because some patients had more than one seizure type.

3 Only subjects with isolated auras similar to those preceding their usual seizures (see Isolated aura questions in Figure 1) were included in this analysis.

4 Subjects with seizures that did not cause loss of consciousness or where this was unknown were not included in this analysis (see Aura protection question in Figure 1).