Efficacy of the Atkins diet as therapy for intractable epilepsy

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Abstract—The ketogenic diet is effective for treating seizures in children with epilepsy. The Atkins diet can also induce a ketotic state, but has fewer protein and caloric restrictions, and has been used safely by millions of people worldwide for weight reduction. Six patients, aged 7 to 52 years, were started on the Atkins diet for the treatment of intractable focal and multifocal epilepsy. Five patients maintained moderate to large ketosis for periods of 6 weeks to 24 months; three patients had seizure reduction and were able to reduce antiepileptic medications. This provides preliminary evidence that the Atkins diet may have a role as therapy for patients with medically resistant epilepsy.

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The ketogenic diet is an effective therapy for pediatric epilepsy that mimics the effects of starvation by providing a high fat, low to moderate protein, and very low carbohydrate diet.[1,2] Calories are restricted to 75% of the recommended daily allowance. Seizure control is likely attained by creating ketone bodies as a source for brain metabolism. Although not traditionally utilized in this population, it may have some role for adults as well.[3]

The Atkins diet also restricts carbohydrates, but unlike the ketogenic diet, it does not restrict consumption of calories or proteins. Within the past year, the first two reports of the benefits of the Atkins diet for weight loss without significant hyperlipidemia were published in the medical literature.[4,5] It also reportedly can induce ketosis, which may decrease appetite and mobilize fat stores. Dr. Atkins' New Diet Revolution recommends checking urine ketones as "chemical proof you're consuming your own stored fat."[6] With its comparatively fewer dietary restrictions, the Atkins diet may be less restrictive than the ketogenic diet. We hypothesized that the Atkins diet can induce metabolic ketosis and might reduce seizures in patients with epilepsy.

Methods. Six patients were enrolled on the Atkins diet as an open trial at the Johns Hopkins Hospital Department of Neurology over a 2-year period (table). We measured urinary ketones and monitored patients' weight. In those on the Atkins diet for 2 months or longer, we assessed serum lipid profiles and urine calcium and creatinine. No patient had medications altered for the first 2 months on the diet.

Results. We treated three male and three female patients with epilepsy (age range, 7 to 52 years) with the Atkins diet. Patients had previously failed therapy with 2 to 18 anticonvulsants (median 6.5). One child (Patient 2) had previously been on the ketogenic diet. The adult patients (ages 42 and 52) had vagal nerve stimulators in place but these were not adjusted during the trial. Cases 1, 2, and 4 are presented in greater detail here.

Patient 1. A 7-year-old girl was seen in epilepsy clinic with a history of seizures beginning at 10 months of age with head drops, progressing over 6 years to multiple other seizure types occurring 70 to 80 times per day. Anticonvulsants administered with only partial success included phenobarbital, phenytoin, carbamazepine, valproic acid, levetiracetam, lamotrigine, topiramate, and zonisamide. EEG revealed left central-temporal slowing on several occasions, and results of two MRI were normal.

The decision was made to try the ketogenic diet. We recommended eliminating carbohydrates in order to acclimate the child to the restrictions of the ketogenic diet prior to admission. *Dr. Atkins' New Diet Revolution* was recommended, with instructions to adhere to the very limited carbohydrate induction phase (10 g/day).

Over a 3-day period, seizures stopped. Urine ketones were checked and were 80 mg/dL (large). The child remained seizure-free and the ketogenic diet admission was cancelled. At the time of this publication, now 5 months on the Atkins diet, the child has been tapered off zonisamide and remains seizure-free. Laboratory values at 2 months were urine calcium to creatinine ratio 0.15 (normal < 0.2), cholesterol 233 mg/dL, high density lipoprotein (HDL) 48 mg/dL, low density lipoprotein (LDL) 151 mg/dL, and triglycerides 168 mg/dL. After losing 6 pounds, her carbohydrates were increased to 20 g per day without worsening of seizures.

Patient 2. A 10-year-old boy was seen first at age 5 because of intractable absence and generalized tonic-clonic seizures. He had significant behavioral problems and had

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Table *Case descriptions*

Patient	Age, y	Sex	Seizure type	Prior anticonvulsants attempted	Best seizure response, % reduction	Duration of Atkins diet, mo	Highest level of ketosis, urine	Cholesterol, mg/dL	Remains on the Atkins diet?
1	7	Female	Multiple	8	100	5	Large	233	Yes
2	10	Male	Absence and generalized tonic-clonic	2	100	4	Large	117	Yes
3	12	Female	Complex partial	5	20	1.5	Large	N/A	No (restrictive)
4	18	Female	Complex partial	5	90	20	Large	219	Yes
5	42	Male	Multiple	18	0	3	Moderate	245	No (ineffective)
6	52	Male	Atonic and complex partial	9	0	8	Small	172	No (unable to maintain ketosis)

N/A = not available.

been diagnosed with pervasive developmental disorder. He had no improvement on carbamazepine, and only limited improvement on valproic acid. EEG revealed three per second spike-wave discharges and an MRI had normal results. The ketogenic diet was tried with subsequent normalization of the EEG, dramatic improvement in his behavior, and seizure reduction. He remained on a 3:1 ratio ketogenic diet for 2.5 years without any side effects, discontinuing it because he was seizure-free and due to perceived restrictiveness over time.

One year later the family began noticing worsening of aggressive and oppositional behaviors, associated with staring spells. An EEG revealed recurrence of three per second spike-wave discharges. As the family had concerns about the prior restrictiveness of the ketogenic diet, the Atkins diet was initiated at home. During the first month with 10 to 20 g of carbohydrates per day, his behavior improved, staring spells disappeared, and ketones were large. When additional carbohydrates were added, his behavior deteriorated and seizures recurred. He continues to be seizure-free without anticonvulsants and his behavior has improved with risperidone. He is moderately ketotic; his urine calcium to creatinine ratio is 0.14, cholesterol 117 mg/dL, HDL 60 mg/dL, LDL 46 mg/dL, and triglycerides 54 mg/dL.

Patient 4. An 18-year-old woman started the Atkins diet for intractable complex partial seizures occurring two to eight times per week since age 15. She had tried carbamazepine, phenytoin, valproic acid, levetiracetam, and topiramate without success. EEG revealed bilateral temporal spike waves and results of an MRI were normal.

The Atkins diet was started after the patient had shown interest in trying the ketogenic diet. Carbamazepine at 1,200 mg/day and topiramate 300 mg/day were maintained. Her seizures decreased to two to four simple partial seizures per month clustered around her menstrual periods. Ketones were consistently large, and lipid profile showed cholesterol of 219 mg/dL, HDL 62 mg/dL, LDL 142 mg/dL, and triglycerides 77 mg/dL. Topiramate was tapered and discontinued; carbamazepine was lowered to 800 mg/day. Her weight also was reduced from 158 to 117 pounds over a 1-year period.

Discussion. What role might the Atkins diet play in the management of epilepsy in the future? In this very limited series of six patients, and with a relative short duration of seizure freedom in two of our three successful outcomes, we do not recommend the Atkins diet as a replacement for the ketogenic diet. However, these results raise important questions about the level of restrictions on calories and protein imposed by the ketogenic diet. Because our institution has a large population referred for treatment with the ketogenic diet, there is occasionally a waiting period during which we often restrict carbohydrates as a test of patient compliance and possible efficacy. The Atkins diet, with its easily readable and widely available paperback, may be a means to test these possibilities over a several-week period.[6] Ketosis, when attained, occurred typically within days and was maintainable. This may also be of use for patients a long distance from an epilepsy center who cannot easily travel for the ketogenic diet admission and follow-up. In addition, as with our second case, the Atkins diet may be a more desirable option for patients with behavioral problems that would make the restrictiveness of the ketogenic diet too difficult.

We suggest maintaining patients on a maximum 10 g of carbohydrate per day induction phase at least initially, the typical amount provided on the ketogenic diet, in consultation with a registered dietitian. Patients or their parents should read *Dr. Atkins' New Diet Revolution*.[6] Medications should be left unaltered for at least 1 to 2 months if possible to discern efficacy. A multivitamin and calcium supplement should be provided daily. We advise that urine ketones be checked by families at least weekly, or as indicated for seizure control. In addition, serum lipid profiles and urine calcium to creatinine ratios should be checked regularly. In situations where weight loss is excessive, calories from fats and proteins should be increased. If still ineffective in increasing weight, carbohydrates should be slowly liberalized by 10 g per day as tolerated.

Acknowledgment

This study is dedicated to the memory of Robert C. Atkins.

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Frequency of epilepsy in patients with psychogenic seizures monitored by video-EEG

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Abstract—This study examined the frequency of epilepsy in a consecutive series of patients who received a definitive diagnosis of psychogenic nonepileptic seizures (PNES) after completing inpatient video-EEG (VEEG) monitoring. Of the 1,590 patients receiving definitive diagnosis, 514 (32.3%) were diagnosed with PNES. Twenty-nine (5.3%) of these patients were found to have both PNES and epilepsy. When strict diagnostic criteria are applied, there is little overlap between epileptic seizures and PNES among patients referred for VEEG monitoring.

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The prevalence of epilepsy in patients with psychogenic nonepileptic seizures (PNES) has been estimated as 10 to 50% of patients with intractable seizures and 10 to 30% of referrals to video-EEG (VEEG) diagnostic centers.[1-5] Up to 20% of patients with PNES are reported to have co-occurring epilepsy when stricter criteria of presence of unequivocal epileptiform discharges are applied.[2-5] However, the frequency of this dual diagnosis varies considerably across studies and may reflect differing diagnostic inclusion criteria for determining epilepsy and PNES (i.e., reliance upon clinical history, presence or absence of interictal/ictal EEG abnormalities, inpatient or outpatient diagnostic setting). In addition, sample sizes examined in several studies were small.[1]

This clinical diagnostic issue is important.[6,7] First, the delay in diagnosis of PNES may be longer given the assumption that the events are all epileptic. Second, a delay in appropriate psychiatric treatment for PNES is likely if events are assumed to be entirely neurologically based. In addition, there are medical and socioeconomic costs associated with missed PNES.[8]

We studied the co-occurrence of PNES and epilepsy in a consecutive series of patients who completed inpatient VEEG diagnostic monitoring.

Methods. We reviewed patients consecutively admitted to the University of Alabama at Birmingham Hospital inpatient VEEG diagnostic monitoring unit between July 1, 1998, and December 31, 2002. The University Institutional Review Board approved the clinical research database. None of the referred patients had had previous inpatient VEEG monitoring. All patients were referred for characterization of paroxysmal events of altered movement, mental state, emotion, sensation, or experiences. Patients were admitted for one of three reasons: 1) undiagnosed events, uncertain whether epileptic seizures, psychogenic events, or something else, with inadequate response to therapy; 2) probable epileptic seizures, classification of seizure type needed to select therapy; 3) probable epileptic seizures, localization of seizure focus needed to plan for possible surgery.

All patients received 24-hour continuous inpatient VEEG diagnostic monitoring. Typical length of stay on the monitoring unit was 3 days (range 1 to 7 days). The evaluation consisted of digitized EEG and analog audiovisual data recorded on magnetic tape using Nicolet/BMSI 5000 (Nicolet, Madison, WI) system. Electrodes were placed in accordance with the International 10–20 system, and included anterior temporal (FT9 and FT10) electrodes. All EEG were recorded in accordance with the American Clinical Neurophysiology Society guidelines. Analysis of interictal awake and sleep samples was assisted by the use of spike detector program (Telefactor Corporation).

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