Examining the Dietary Amino Acid Characteristics in Patients on Ketogenic Therapy

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ABSTRACT

Ketogenic Therapy (KT) is a high fat, adequate protein, low carbohydrate diet shown to reduce seizures in patients with intractable epilepsy. While KT has been used for decades, the building blocks of the dietary components such as amino acids have not been examined. The usual diet prescription ratio of grams of fat to grams of carbohydrate plus grams of protein assumes that the all protein is the same and has the same effect on the therapy as carbohydrate. To evaluate dietary protein characteristics in patients on KT, data were collected via weekly 24 hour dietary recalls taken from 14 patients on KT. The Minnesota Database (NDS) was used to analyze these recalls. Some of the dietary protein characteristics are listed in the table below.

Amino Acid Parameter	Minimum	Maximum
Ketogenic to Gluconeogenic	0.22	0.35
Branched –chain to Aromatic	1.64	2.12
Essential to Non-essential	0.66	0.82

The characteristics of dietary amino acids vary among pediatric patients on ketogenic therapy for seizures. Characteristics such as the ratio of ketogenic amino acids to gluconeogenic amino acids may impact the therapy and these potential impacts need to be evaluated.

INTRODUCTION

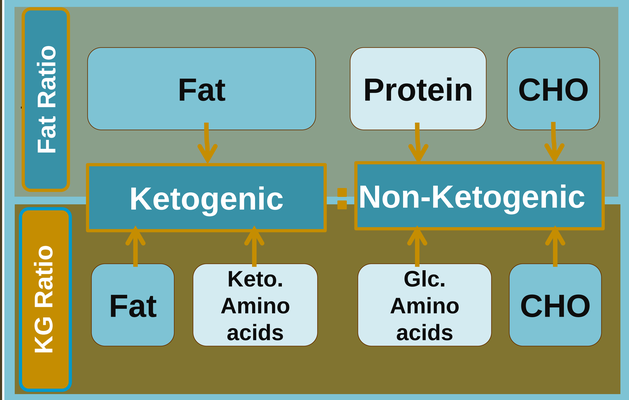
Ketogenic Therapy (KT) is a high fat, adequate protein, and low carbohydrate diet used to treat intractable epilepsy. It is prescribed as a ratio of fat in grams to grams of protein plus carbohydrate. This includes a fixed amount of protein and calories. Such a fat ratio is calculated with the assumption that fat is ketogenic while protein and carbohydrate are non-ketogenic. However, protein is both ketogenic and gluconeogenic. Hence, a new method of calculating the ketogenic ratio should be introduced that considers protein degradation. Additionally, amino acid characteristics such as branched chain and aromatic structures as well as essential and non-essential may be considered. Hence, individual amino acid characteristics may be examined to determine how protein influences patients on KT and how to improve KT.

MATERIALS AND METHODS

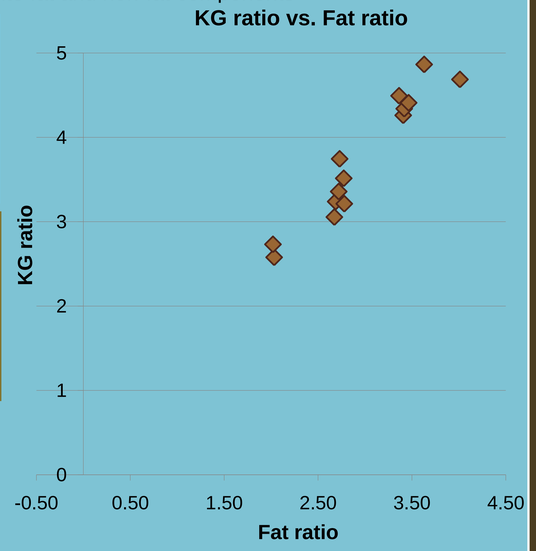
- Data were collected from weekly, 24-hour dietary recalls from 14 patients on KT. The parents of the patient were asked to record for one day per week what their child ate. This information was collected via daily records, clinic, email or phone call.
- Recalls were entered, audited, and sent to a dietician who analyzed the recalls using the Minnesota Database (NDS).
- NDS gave a breakdown of the amounts of each amino acid (excluding glutamine and asparagine), the amount of animal or vegetable protein, and total protein for the whole day. Ratios/calculations were based on these values.
- Patients had a fasting blood draw. Blood draws reported values for beta-hydroxybutyrate (B-hb), lactate (lac), and glucose (glc).

KG RATIO

Protein is not solely non-ketogenic. In order to represent the fat ratio as a true ratio of ketogenic to non-ketogenic components, the KG ratio considers the breakdown of protein into fat and non-fat components



Calculation. The KetoGator (KG) ratio is calculated by adding the fat component to the ketogenic amino acids (lys and leu). For amino acids that are ketogenic and gluconeogenic (phe, trp, tyr, and lle), half of the their amounts were added to both the ketogenic and non-ketogenic components. Gluconeogenic amino acids (arg, cys, gly, ser, thr, asx, phe, met, val, glx, his, and pro) were added to carbohydrate.



R^2	P-value
0.915	8.50e-8*

*indicates significance

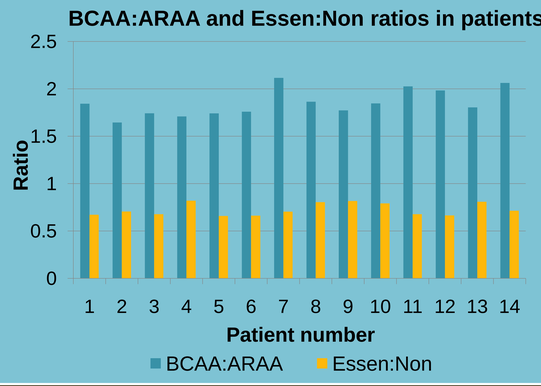
KETO:GLC, BCAA:ARAA, and ESSEN:NON

The amounts of individual amino acids were used to explore the relationships between different amino acids based on their characteristics such as degradation pathways (ketogenic or gluceoneogenic), structural differences (branched-chain or aromatic), and quality (essential and non-essential).

Ketogenic to Gluconeogenic. The underlying assumption is the more ketones, the better KT works. As the ratio increase keto:glu vs, fasting B-hb increases and glc decreases. Linear regression shows this trend but does not have a significant p-values. The latter may be remedied by increasing the n value.

Fasting	Keto:glc ratio	Trend
b-hb	p=0.34	Increase
glc	p=0.42	Decrease

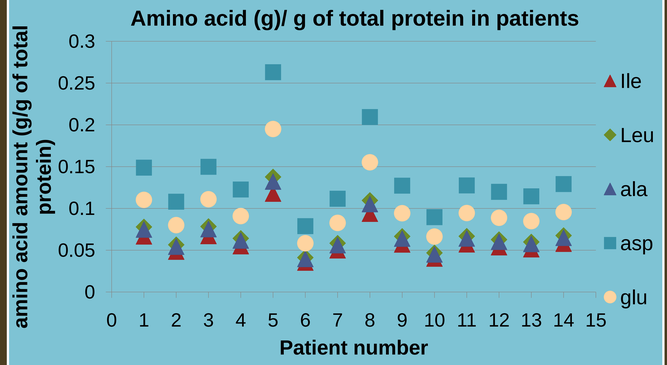
Branched-chain to Aromatic. KT has been said to increase the transport of BCAA across the blood brain barrier, which compete with ARAA.
Essential to Non-essential. Used to gauge if patients are receiving more essential or non-essential amino acids.



These ratios do not show much variability. Patients on KT receive more BCAA than ARAA (1.5-2 ratio), and more non-essential than essential (0.5-0.75 ratio).

AMINO ACIDS AND PROTEIN

Amino acid Variability. The amino acid amounts (g/g of total protein) not displayed showed little variation. No patients received the same amount of total protein or the same amount of a given protein constituent.



Amino Acid variability in diet recalls

Amino acid (grams/day)	Mean	Stdev	Range
Aspartate (asp)	4.06	2.02	1.20-9.34
Glutamate (glu)	3.74	2.14	0.81-6.91

Asp and glu showed the most variation of all amino acids.

Pro:CHO ratio. The "one" of the fat ratio is protein plus carbohydrate. The ratio of these may be used to examine the one and compare it to the qualitative review of these macronutrients used clinically (i.e. grams per day).

Pro:CHO ratio vs. Total protein and Total CHO

Pro:CHO ratio vs.	Total protein (g/day)	Total CHO (g/day)
R^2	0.300	0.429
P-value	0.042*	0.011*

Low p-values and weak correlations suggest the ratio and total amounts are different. The same results were found using grams/kg of body weight.

*indicates significance

CONCLUSIONS

- Amino acid variability, especially with excitatory amino acids such as glutamate and aspartate, suggests the total gram amount of protein does not describe its quality or potential therapeutic effects.
- The protein plus carbohydrate portion of the fat ratio (always one) shows that the ratio of these macromolecules is variable and may need greater consideration.
- More analysis must be done on the amino acid profiles in patients on KT with a greater number of patients. The calculation of a new ratio (KG ratio) using protein's characteristics as presented needs further scrutiny as a way of improving KT.