Nutritional aspects of CAPD and the potencial use of amino acid containing dialysis solutions

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SUMMARY

Some CAPD patients may develop malnutrition which appear to be brought about, by a combination of decreased appetite with increased nutrient loss in dialysate. The appetite suppresion is related to absortion of dextrose from dialysate and results in a reduced intake of protein. This factor combined with a significant loss of 6-12 g. of protein per day in the dialysate leads to protein malnutrition. Low serum albumin and transferrin, together with decreased total body nitrogen have been observed in many patients.

In order to study the potencial use of aminoacids (AA) in peritoneal dialysis, 6 non-diabetic patients on CAPD have been evaluated in terms of: a) Daily AA losses; b) Plasma AA profile; c) AA absortion via peritoneum using 2 litres of a dialysate solution contaning 2 % AA; d) Effectiveness of this kind of solution as dialyzing fluid compared to a conventional, 2-litres, dextrose-4,25 % solution.

Results showed: a) Daily losses of 2 grams of AA; b) AA plasmatic essential AA levels are lower than that of controls. In the case of non-essential AA, citruline and half-cystine higher, being the remaining AA lower than in controls; c) Absortion of 85-95 % of the AA infused in a 6 hour dwell time; d) AA solution is as effective as conventional dextrose solution in terms of ultrafiltration and removal of potassium, urea, and creatinine.

Key words: CAPD, Nutrition in CAPD, Aminoacids in CAPD.

RESUMEN

Un cierto número de pacientes en DPCA desarrollan malnutrición, debido probablemente a la combinación de ingesta inapropiada más pérdida de nutrientes en el dializado.

La reducción de ingesta se comprueba en 13 pacientes, que al cabo de un año de DPCA han pasado de 1,46 g/kg. de ingesta proteica diaria a 1,06 g/kg.

La reducción del apetito (y, por tanto, de la ingesta) se pone en relación con la absorción de glucosa del dializado, junto con la sensación de plenitud producida por la presencia de 2-3 litros de líquido intraabdominal.

La influencia de la absorción de glucosa se demuestra al comprobar que conejos no urémicos sometidos a DPCA reducen su ingesta proteica de 169 g/día de purina a 43 g/día usando líquido de diálisis (LD) con glucosa al 1,5 % y hasta 5 g/día si el LD utilizado es con glucosa al 4,25 %.

Las pérdidas vía dializado se estiman en 6-12 g. de proteínas y 2 g. de aminoácidos al día.

Así pues, la demostrada reducción de ingesta, unida a las pérdidas en el dializado causa malnutrición que afecta fundamentalmente al metabolismo proteico y se traduce en bajos niveles de albúmina y transferrina sérica junto a la disminución del nitrógeno corporal total.

De modo más preciso se comprueba en 6 pacientes sometidos a CAPD que sus niveles de aminoácidos esenciales (AAE) son inferiores a los controles. En el caso de los no esenciales (AANE), son igualmente inferiores, excepto la citrulina y cisteína, claramente superiores en los enfermos respecto al control.

Investigando las eventuales ventajas de añadir AA al LD, se infundieron 2 litros de una solución conteniendo un 2 % de aminoácidos (mezcla AAE y AANE) a 6

pacientes no diabéticos, comparándose pérdidas en el dializado de potasio, urea, creatinina, cambios de osmolaridad del mismo y modificaciones de niveles de glucemia y AA en plasma obtenidos con este LD con los mismos parámetros en los mismos pacientes usando LD convencional con dextrosa al 4,25 %.

A lo largo de 6 horas de intercambio se demuestra similar eficacia depuradora para potasio, urea y creatinina. La osmolaridad del LD cae en el tiempo al mismo ritmo en los dos regímenes, produciéndose una ultrafiltración (500-600 ml.) comparable.

Por otra parte, se absorben el 85-95 % de los AA del LD, produciéndose una elevación de nivel plasmático máxima a la hora de iniciado el intercambio.

Se concluye que las soluciones de aminoácidos son eficazmente dializantes, además de proporcionar un aporte de nitrógeno similar al de una comida rica en proteínas.

Palabras clave: DPCA, nutrición en DPCA, aminoácidos en DPCA.

A number of CAPD patients may develop malnutrition which appears to be brought about by a combination of decreased appetite, and hence intake of nutrients, with increased nutrient loss in the dialysate. In a group of 13 patients whose daily protein and caloric intake in the beginning of CAPD was 1.5 g. per kg., and 35 kCal/kg. respectively, intake decreased spontaneously after one year on CAPD even though they were being advised continuously, during their visits to the clinic, to maintain the initial protein and a caloric intake (Table I) [1]. This observation, that patients on CAPD decrease their intake, has been made in many centers; it appears to result from a decrease in appetite and a feeling of fullness, although these factors are difficult to evaluate quantitatively in patients. To gain information on the etiology of appetite suppression during CAPD we have turned to performing CAPD in non-uremic rabbits. Normal non-dialyzed rabbits eat on the average 169 g. of Purina Chow a day. As soon as they are placed on CAPD with 300 ml. (100 ml/kg.) of 1.5 % dextrose per exchange, their average food intake decreases to 43 g. per day, which decreases further to 5 g/day if the dialysis solution is changed from 1.5 to 4.25 g. % dextrose. As soon as CAPD is discontinued, even if the animals are kept attached to the machine and have their peritoneal catheter in place, they start eating again, consuming an average of 120 g. a day. These preliminary experiments suggest the following conclusions: First that, under these conditions, some factor(s) related to CAPD has influenced appetite so that these animals eat less; and secondly that the hypertonic solution has an additional effect and further decreases the appetite.

In patients the decrease in appetite result in a reduced intake of many nutrients including protein. This factor, combined with a significant loss of 6-12 g. of protein per day, most as albumin [2] in the dialysate leads to clear evidence of protein malnutrition. Low serum albumin and transferrin frequently have been observed in many patients. Furthermore, total body nitrogen, measured by neutron-activation analysis, decreased [1]. Surprisingly, total body potassium which some investigators consider to be a good index of lean body mass shows an increase at a time that total body nitrogen decreases. We believe that total body potassium is a good index of lean body mass only in the healthy state and that in disease states, like malnutrition, total body nitrogen is a better index of the long term nitrogen balance.

If poor appetite combined with high protein losses is the main reason for the development of malnutrition in these patients, we will have to find a way to increase protein intake *via* a route other than the oral. One way of doing this is to provide proteins in the form of amino acids in the peritoneal dialysis solution [3].

In order to study the potential use of amino acids in peritoneal dialysis, we have tried to answer the following questions: a) What are the daily amino-acid losses and

TABLE I

CHANGES IN PROTEIN INTAKE AND CALORIC INTAKE FROM DIET AND DIALYSATE GLUCOSE ABSORPTION AT 0, 6 AND 12 MONTHS

	0	6	12 months
Protein intake (g/kg.)	1.46 ± .09	1.15 ± .11	1.06 ± .09 **
Kcals. intake from diet + dialysate	2179 ± 113	1858 ± 88	1877 ± 89 *
Kcals/kg. BW	36.5 ± 2.3	30 ± 2.3	28.9 ± 1.3 **

* 0-12 months $p < 0.05$.
** 0-12 months $p < 0.01$.

the plasma amino-acid abnormalities in CAPD patients who are dialyzed with the conventional glucose Dianeal solution; b) Will the peritoneal dialysis solution with amino acids have the same osmotic effect as glucose-containing solutions, and thus produce satisfactory ultrafiltration; c) Is a solution with amino acids a good dialysis solution with respect to solute removal; and d) what percentage of amino acids, present in the dialysis solution, will be absorbed over a six hour period.

Daily amino-acid losses and plasma amino-acid abnormalities

In a group of six non-diabetic patients on CAPD, we found that the average daily amino acid losses was 2 g. per day [4]. These findings are in agreement with previous findings on amino-acid losses in CAPD [5-7]. On a weekly basis, these amino-acid losses on CAPD are slightly less than those reported for patients on hemodialysis (20-25 g/day) and intermittent peritoneal dialysis (11-53 g/day) [4].

Plasma amino acid abnormalities in patients on CAPD

A variety of conditions can lead to plasma amino-acid abnormalities (Table II). A combination of these causes such as uremia, malnutrition, hypercatabolism etc. may be present in patients on CAPD and may result to abnormalities in the plasma amino-acids.

TABLE II

COURSES OF PLASMA AMINO-ACID ABNORMALITIES IN DIALYSIS PATIENTS

Abnormal absorption and/or metabolism of nutrients
Accumulation of uremic «toxins» in blood
Superimposed catabolic illness(es)
endocrine disorders
reduced capacity of the kidney to synthesize or degrade hormones, amino-acids, peptides and small proteins
loss of amino-acids and proteins in the dialysate solution

Figure 1, shows the profile of the essential amino-acids in the six non-diabetic patients compared with sex matched controls. The mean of almost all the essential amino-acids were significantly lower than that of controls.

Figure 2 shows the profile of the non-essential amino-acids in this same group of patients. The mean levels of some amino-acids were significantly lower than that of the controls, whereas citrulin and half-cystine were higher than in normal controls.

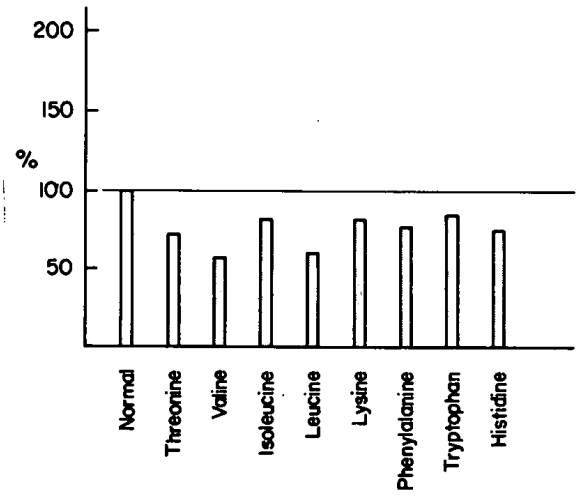

Fig. 1.—*Plasma levels of essential amino-acids in non-diabetic patients on CAPD (% normal).*

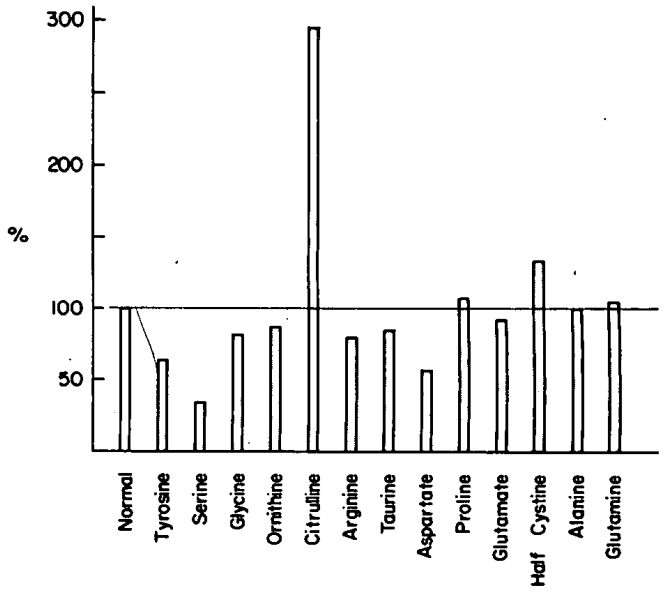

Fig. 2.—*Plasma levels of non-essential amino-acids in non-diabetic patients on CAPD (% of normal).*

Amino-acid absorption via the peritoneal route

In this phase of the study, we infused the six non-diabetic patients over six hours with two litres of a dialysate solution containing 2 % amino-acids (a mixture of essential and non-essential amino-acids) [8]. We then compared the plasma amino-acid changes produced by this solution and compared them with those produced by the infusion of 4.25 mg. % Dianeal solution with dextrose. These two solutions have a similar osmolality.

Figure 3 shows the changes in the dialysate osmolality during the six-hour infusion; they were similar in the two solutions. As a result of these similar osmolality changes, the two solutions produced similar amount of ultrafiltration 560 ml. and 500 ml. respectively, sugges-

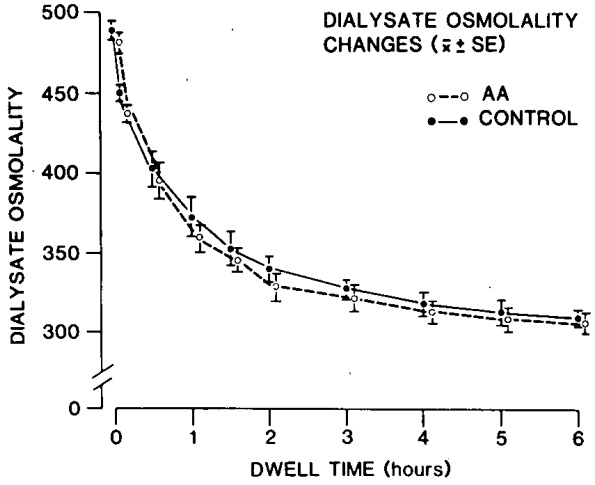

Fig. 3.—*Osmolality changes in the amino-acid and control solution over six hours of infusion.*

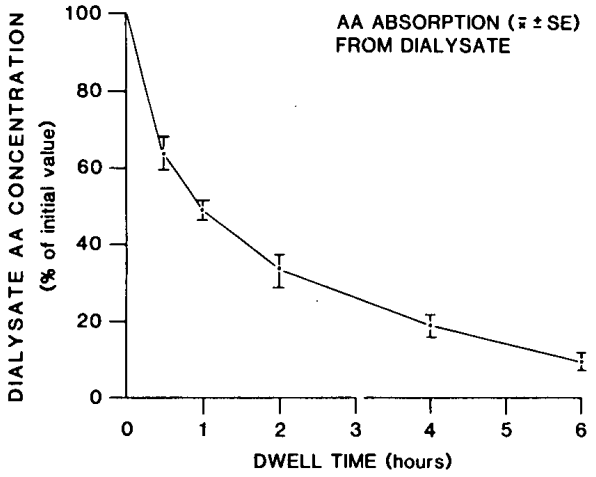

Fig. 4.—*Changes in amino-acid concentration and the amino-acid containing solution over six hours dwell in the peritoneal cavity.*

ting that the amino acid mixture is a satisfactory osmotic agent.

Figure 4 shows the changes in the dialysate amino acid concentrations during the infusion time. The results are expressed as a percentage of the initial value, which is considered as 100 %. By the sixth hour, 85-95 % of the amino acids present in the solution had been infused into the patient.

During the same time that the amino-acids were absorbed from the peritoneal cavity, the plasma amino-acids increased, peaked at one hour, and later decreased to almost the preinfusion levels (fig. 5). The plasma amino-acid levels at one hour were three times the initial level, which is similar to the amino-acid levels reached after a protein meal [9].

In contrast to the plasma glucose changes during the infusion of glucose containing dialysis solution, blood glucose did not change during the amino-acid infusion (fig. 6).

Figures 7, 8, and 9 shows that the urea, creatinine, and potassium removal were similar with the two solutions

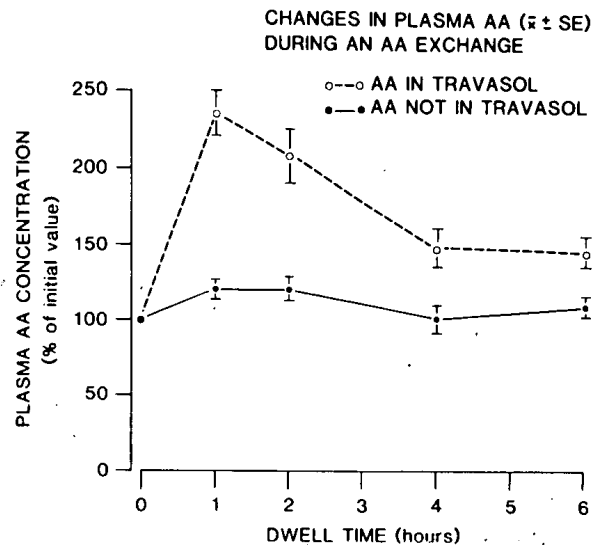

Fig. 5.—*Changes in plasma amino-acids during the six hour infusions with amino-acid containing solution.*

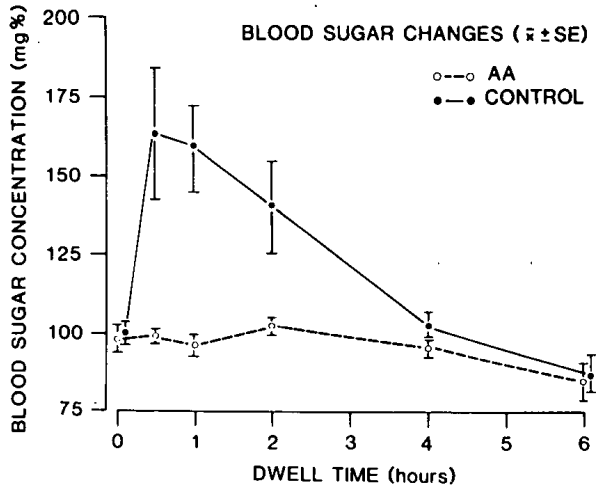

Fig. 6.—*Blood sugar changes during the control and the amino-acid containing infusion.*

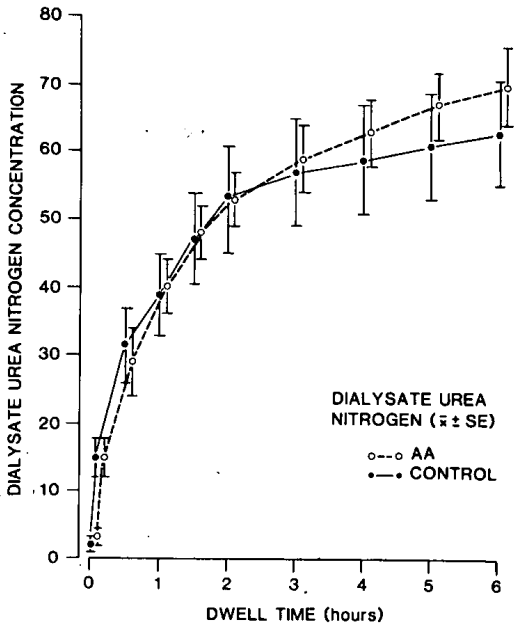

Fig. 7.—*Dialysate urea nitrogen equilibration between a control and the amino-acid containing solution.*

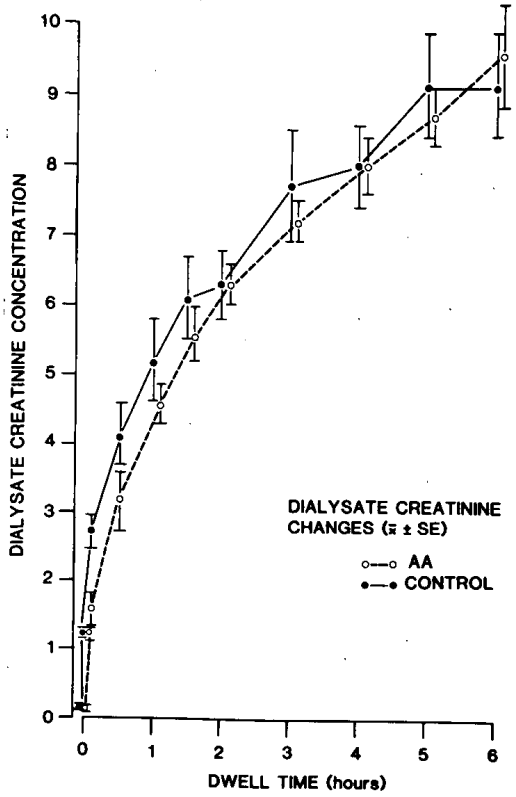

Fig. 8.—*Dialysate creatinine equilibration in the control and amino-acid containing solution.*

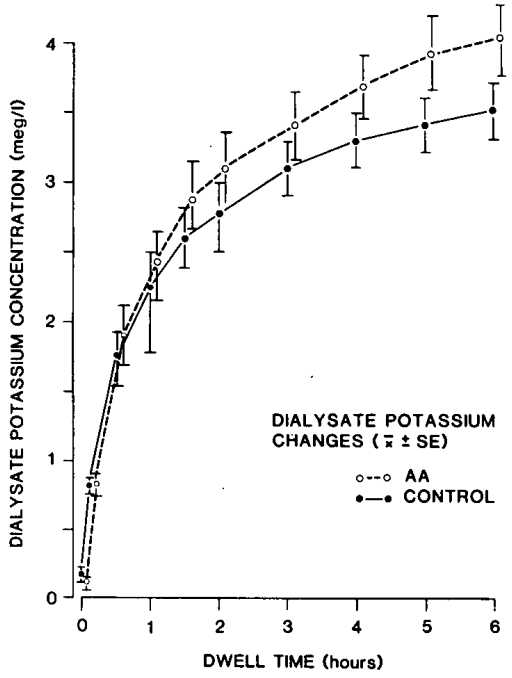

Fig. 9.—*Dialysate potassium concentration in the glucose and amino-acid containing solutions.*

suggesting that, with respect to dialysis, the amino-acid solution is comparable to glucose solution.

In conclusion, our experience indicates that:

a) Patients on CAPD are losing approximately two grams of amino-acids a day, and they have plasma amino-acid abnormalities similar to those produced in malnutrition.

b) An amino-acid-containing dialysate solution (2 %) is an effective solution with respect to ultrafiltration and solute removal.

c) Amino-acids can be absorbed by the peritoneal route and produce an increase in plasma amino-acids to levels similar to those observed after a protein meal. The results of the long-term administration of amino-acid solutions will be the subject of further study.

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