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DIALYSIS II

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THE EFFECT OF CALCIUM CARBONATE ADMINISTRATION ON NITROGEN METABOLISM IN PATIENTS ON HAEMODIALYSIS

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Summary

Various parameters of 11 patients on chronic haemodialysis were compared before and after calcium carbonate supplementation. A significant decrease in protein catabolic rate and a significant increase in serum albumin, transferrin and pseudocholinesterase were noted after eight weeks of calcium carbonate administration, although there was no significant change in dietary energy or protein intake. In addition there was no significant change in serum parathyroid hormone. Thus the correction of metabolic acidosis with calcium carbonate in patients on haemodialysis improves protein utilization.

Introduction

Altered protein metabolism is one of the common and serious problems of patients with chronic failure [1]. Among the factors that influence protein synthesis and degradation in uraemia, metabolic acidosis has been inadequately investigated. Increased urea production has been described in uraemic animals with metabolic acidosis [2] and it has been shown that administration of sodium bicarbonate results in a significant decrease in serum urea in patients with chronic renal failure [3]. An improvement in nitrogen balance of non-dialysed uraemic patients treated with sodium bicarbonate was found in a previous study [4].

This study assesses the effect of the correction of metabolic acidosis with calcium carbonate supplementation on protein metabolism in patients on haemodialysis.

Methods

Eleven patients (mean age 51 years, range 38 to 69 years) were selected for this investigation. They were treated by haemodialysis four to five hours (three times weekly) for nine months to 10 years. All patients were without complications; none had proteinuria or a systemic disease and their residual renal function

was minimal ($GFR < 3 \text{ ml/min}$).

Dietary protein and energy intake were calculated weekly from detailed three day home food records by the same dietitian. Protein catabolic rate was calculated from kinetically measured urea generations [5]. Midweek predialysis blood urea nitrogen, serum calcium, pH, bicarbonate, albumin, transferrin, pseudocholinesterase and parathyroid hormone (PTH) were measured by conventional methods. All of the above parameters were measured weekly during the three week control period and twice after eight weeks of calcium carbonate supplementation. Two to four grams of calcium carbonate were administered daily during the supplementation period.

The Student's paired test was used to compare the changes of the parameters of each patient. All values were expressed as mean \pm SD. Results were considered statistically significant for $p < 0.05$.

Results

The dietary energy intake of our patients was $25.2 \pm 5.8 \text{ Cal/kg/day}$ and their dietary protein intake was $0.95 \pm 0.31 \text{ g/kg/day}$. Only three patients had a low

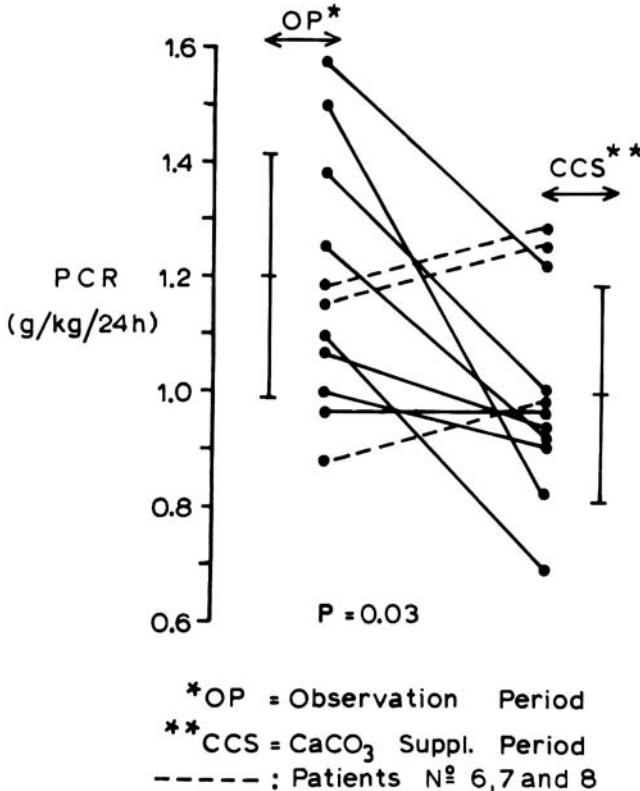


Figure 1. Changes in protein catabolic rate in 11 patients on haemodialysis before and after calcium carbonate supplementation.

(<0.9g/kg/day) dietary protein intake (0.4, 0.6 and 0.7g/kg/day). In spite of this, during the control period nine of the 11 patients had a mean protein catabolic rate greater than that of their dietary protein intake. There was a positive correlation between dietary protein intake and protein catabolic rate ($r=0.64$, $p=0.034$) indicating the reliability of the assessment of home food records. The mean values of serum pH, bicarbonate and calcium increased significantly ($p=0.0002$, 0.002 and 0.001 respectively), after calcium carbonate supplementation. Blood urea nitrogen and protein catabolic rate decreased significantly ($p=0.014$ and 0.032) despite the fact that dietary protein intake and dietary energy intake remained unchanged (Figure 1). Only four of 11 patients had a protein catabolic rate greater than their dietary protein intake and protein catabolic rate increased in two of these four patients after calcium carbonate administration. Both patients had a low dietary protein intake. In addition, protein catabolic rate remained unchanged in the third patient with a low dietary protein intake. There was a positive correlation of protein catabolic rate and blood urea nitrogen ($r=0.7$, $p=0.014$).

A significant increase in serum pseudocholinesterase ($p=0.003$), transferrin ($p=0.01$) and albumin ($p=0.03$), was noted (Figure 2). It is of interest that all patients had an increase in serum pseudocholinesterase activity. However serum transferrin and albumin did not change in the three patients with low dietary protein intake.

Serum PTH did not change significantly after calcium carbonate supplementation.

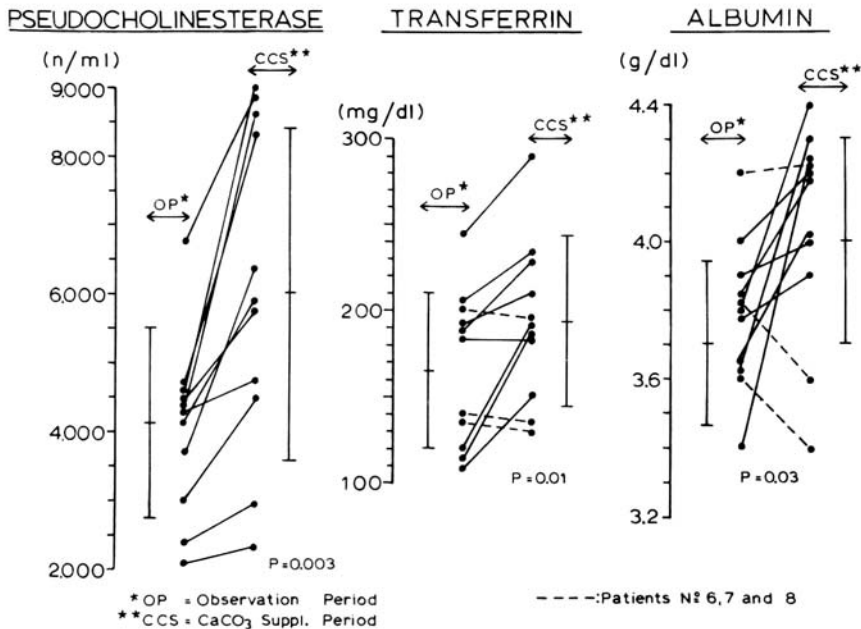


Figure 2. Changes in serum pseudocholinesterase, transferrin and albumin before and after calcium carbonate supplementation.

Discussion

The disturbance of protein metabolism in chronic renal failure is mainly the result of the deficient nutrient intake. Poor appetite and/or inappropriate dietary advice frequently results in a low dietary energy and protein intake. In addition, the removal of nutrients with dialysis, altered metabolism of nutrients, endocrine disorders and uraemic toxins play a key role in the development of malnutrition [1]. These aberrations sometimes potentiate each other [1]. Malnutrition is a serious problem in uraemic patients and there is evidence that it is the main cause of their high morbidity [6].

Chronic renal failure leads to metabolic acidosis. Haemodialysis treatment partially corrects this acidosis by supplying the patients with a buffer source. There is experimental evidence that metabolic acidosis increases urea production [2]. In a previous study, a significant improvement of nitrogen balance of non-dialysed patients was achieved when serum bicarbonate was increased from 15.8 to 23.4mEq/L after sodium bicarbonate supplementation [4]. However, little is known on the effect of metabolic acidosis on protein metabolism in patients on haemodialysis.

In this study, a significant decrease in protein catabolic rate was observed after the increase of pre-dialysis serum pH and bicarbonate from 7.27 and 14.3mEq/L to 7.38 and 20.3mEq/L respectively, even though each patient had the same protein and energy intake during the whole study. The relatively high protein catabolic rate of our patients might be the result of their relatively low calorie intake [7] and the high percentage of low biological value of the ingested protein. There is experimental evidence that metabolic acidosis stimulates protein breakdown in muscle tissue [8]. Thus, the significant decrease in protein catabolic rate in our patients after the correction of metabolic acidosis could be the result of the decreased protein degradation.

Serum albumin, transferrin and pseudocholinesterase were used as indicators of visceral protein status and liver protein synthesis. A significant improvement of the above parameters was noted. This might be due to the correction of metabolic acidosis, which decreases the activity of the liver enzymes responsible for protein synthesis.

Glucose intolerance is one of the responsible factors for increased protein catabolism [9]. It has been shown that the correction of secondary hyperparathyroidism in uraemic patients and children leads to an improvement of glucose intolerance [10]. However, we were not able to note a significant change in PTH. Therefore, secondary hyperparathyroidism could not have related to the increased protein catabolism.

Calcium carbonate has been administered in patients on haemodialysis for the correction of hypocalcaemia, hyperphosphataemia and metabolic acidosis. The findings of this study suggest that the correction of metabolic acidosis with calcium carbonate in patients on chronic haemodialysis, who have an adequate protein intake, improves protein utilization.

References

- 1 Kopple JD. *Kidney Int* 1978; 14: 340
- 2 Simon D, Luke RJ. *Proc Soc Exp Biol Med* 1976; 137: 1073

- 3 Blom Van Assendelft PM, Dorhout Mees EJ. *Metabolism* 1970; 19: 1053
- 4 Papadoyannakis NJ, Stefanidis CJ, McGeown M. *Am J Clin Nutr* 1984; 40: 623
- 5 Sargent JA, Gotch FA. *Kidney Int* 1975; 7: 535
- 6 Acchiardo SR, Moore LW, Latour PA. *Kidney Int* 1983; 24: 5
- 7 Munro HN. *Kidney Int* 1978; 14: 313
- 8 Schroch H, Cha CM, Goldstein L. *Biochem J* 1980; 188: 557
- 9 Mitch WE, Clark AS. *Kidney Int* 1983; 24: S2–S8
- 10 Mak RH, Turner C, Haycock GB et al. *Kidney Int* 1983; 24: S128–S133