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ORIGINAL ARTICLE

Correlations of dietary energy and protein intakes with renal function impairment in chronic kidney disease patients with or without diabetes

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Abstract Dietary energy and protein intake can affect progression of chronic kidney disease (CKD). CKD complicated with diabetes is often associated with a decline in renal function. We investigated the relative importance of dietary energy intake (DEI) and dietary protein intake (DPI) to renal function indicators in nondiabetic and diabetic CKD patients. A total of 539 Stage 3–5 CKD patients [estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2 using the Modification of Diet in Renal Disease equation] with or without diabetes were recruited from outpatient clinics of Nephrology and Nutrition in a medical center in Taiwan. Appropriateness of DEI and DPI was used to subcategorize CKD patients into four groups:(1) kidney diet (KD) A (KD-A), the most appropriate diet, was characterized by low DPI and adequate DEI; (2) KD-B, low DPI and inadequate DEI; (3) KD-C, excess DPI and adequate DEI; and (4) KD-D, the least appropriate diet, excess DPI and inadequate DEI. Inadequate DEI was defined as a ratio of actual intake/recommended intake less than 90% and adequate DEI as over 90%. Low DPI was defined as less than 110% of recommended intake and excessive when over 110%. Outcome measured was eGFR. In both groups of CKD patients, DEI was significantly lower ($p < 0.001$) and DPI higher ($p = 0.002$) than recommended levels. However, only in the nondiabetic CKD patients were KD-C and KD-D significantly correlated with reduced eGFR compared with KD-A

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at increments of −5.63 mL/min/1.73 m^2 (p = 0.029) and −7.72 mL/min/1.73 m^2 ($p = 0.015$). In conclusion, inadequate energy and excessive protein intakes appear to correlate with poorer renal function in nondiabetic CKD patients. Patients with advanced CKD are in need of counseling by dietitians to improve adherence to diets.

Introduction

Chronic kidney disease (CKD) is a global public health issue [1]. According to the US Renal Data System (2009), the prevalence of end-stage renal disease (ESRD) in Taiwan was the highest among countries investigated in 2009 [2]. A high prevalence of proteinuria (up to 60%) has been reported for Type 2 diabetic patients in Asia, suggesting an impending pandemic of renal and cardiovascular diseases in this ethnic group [3]. Once chronic renal failure develops, renal function declines much faster in patients with diabetes than in those without the disease [4,5].

Dietary energy intake (DEI) and dietary protein intake (DPI) are considered the most significant determinants of nutritional status in humans [6]. The optimal energy intake for CKD patients, as suggested by kidney disease outcomes quality initiative (KDOQI) guidelines, is 35 kcal/kg/d for individuals under the age of 60 and 30–35 kcal/kg/d for those aged 60 years or older [7]. However, CKD patients commonly have lower energy intake than what is recommended [8–11]. The dietary protein need of healthy adults, as recommended by the Institute of Medicine, is about 0.8 g/kg/d, an intake that helps maintain nitrogen balance [12]. One meta-analysis has suggested that a protein-restricted diet can slow down progression and loss of residual renal function in patients with advanced CKD [13]. KDOQI guidelines recommend a DPI of about 0.6–0.75 g/kg/d for patients with advanced CKD [14–16], defined as having a glomerular filtration rate (GFR) of less than 25 mL/min/1.73 m^2 [17]. To date, very few studies have investigated the DEI and DPI status in CKD patients with or without diabetes in Asia.

In this study, we analyzed DEI and DPI status (intake vs. recommended levels) in nondiabetic and diabetic patients with CKD Stages 3–5 and evaluated the relationships between appropriateness of DEI and DPI and the renal function indicator as estimated GFR (eGFR).

Methods

Study population

This study enrolled CKD patients visiting outpatient clinics of the Department of Nephrology and Nutrition and Dietetics at Kaohsiung Medical University Hospital between November 2002 and October 2009. This patient population comprised a subset of population of patients just enrolled in a pre-ESRDs shared-care program established by the National Health Insurance in Taiwan (http://www.nhi.gov.tw/english) and were scheduled to receive counseling from a dietitian for their first visit. The study population consisted of newly recruited patients (as described above) and a population of similar patients from a previous study (study period November 2002 and July 2005) [11]. This extended the study period for CKD patients and enabled us to simultaneously study independent association between intake status of energy in combination with that of protein and renal function indicators in a subgroup of patients with or without diabetes.

The study only included patients with KDOQI-defined CKD Stages 3–5 (eGFR < 60 mL/min/1.73 m^2). We calculated eGFR using the Modification of Diet in Renal Disease (MDRD) equation: $186 \times \text{serum creatinine}^{-1.154} \times \text{age}^{-0.203} \times 0.742$ (if female) [18]. For those patients who were selected, we also calculated eGFR using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation, which takes into consideration creatinine, age, sex, and a four-level variable for race [19], as well as the Cockcroft–Gault (CG) formula [20]. We excluded patients currently on dialysis and those with incomplete dietary intake records, missing renal function measurements, and missing values of confounding factors included in our multivariable models. After exclusion, we were left with 539 patients to include in our analysis, and allowed to adjust for more known risk factors than our previously study [11]. These CKD patients were further classified into those with a diagnosis of diabetes ($n = 172$; recorded in the medical charts) and those without diabetes. Diagnosis of diabetes was generally based on guidelines and diagnostic criteria established by the American Diabetes Association [21]. The criteria included fasting plasma glucose over 126 mg/dL or symptoms of diabetes (polyuria, polydipsia, and unexplained weight loss) plus casual plasma glucose concentration of 200 mg/dL or more, or a 2-hour plasma glucose level of 200 mg/dL or more during an oral glucose tolerance test using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water [21]. In addition, dietitians routinely checked the laboratory records for blood glucose or hemoglobin A1c (HbA1c), as well as medication use to confirm whether a patient was diabetic or not. The protocol for this study was approved by the Human Ethics Committee of Kaohsiung Medical University Hospital, Taiwan.

Clinical laboratory measurements and dietary record collection

During outpatient visits, anthropometric indices were routinely measured and recorded by registered nurses. The routine clinical laboratory measurements included total