Protein Diet and Estimated Glomerular Filtration Rate

Supatra Lohsiriwat
Department of Physiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand
Email: supatra.loh@mahidol.ac.th

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ABSTRACT

Chronic kidney disease (CKD) is a common health problem worldwide. CKD staging or classification, together with patients’ prognosis and treatment plan depend on the patients’ kidney function which is assessed by measurement of glomerular filtration rate (GFR). Estimated GFR can be obtained using serum or plasma creatinine as a main variable in equations or formulae such as Cockcroft-Gault equation, MDRD equation (Modification of Diet in Renal Disease), the Schwartz and Counahan-Barratt formulae. These equations, though widely accepted, still have to be adjusted or validated among different groups of patients according to the variation in some factors such as race, diet, and genetic heterogeneity. Diet, especially the high protein load, can affect GFR representing the renal functional reserve. A high protein diet can cause an increase in GFR that lasts for many hours. Long-term consumption of vegetarian diet which is low in protein and contains only protein from plant sources can cause a low baseline GFR while the renal functional reserve is still preserved. This paper aims to remind of the role of protein diet effect on GFR measurement especially when assessing the renal function in vegetarians or individuals on long-term low-protein intake.

Keywords: Protein Diet; Glomerular Filtration Rate; eGFR; Vegetarian

1. Introduction

Chronic kidney disease (CKD) is becoming an increasing health problem worldwide as the patients with end stage renal disease (ESRD) need dialysis and/or transplantation which need complicate health care and also a high cost of health service. CKD stages were most often classified based on Kidney Disease Outcome Quality Initiatives (K/DOQI) which classified CKD patients into 5 stages according to their glomerular filtration rate (GFR) [7]. So the measurement of GFR should be reliable and accurate.

Intake of cooked meat has a significant effect on serum creatinine concentration and GFR. Miscategorization of CKD is possible if measurements are made after high protein diet [8], and in individuals with exceptional dietary intake such as vegetarian [9].

2. GFR Measurement: Clearance Technique

GFR provides the best index of overall kidney function especially glomerular function. GFR is not measured directly but can be assessed by clearance technique using creatinine, inulin, radionuclide-labeled markers, radiocontrast markers or other substances that are freely filtered but not transported in the renal tubules. Clearance (C) of a substance is the rate at which an indicator substance is removed from plasma per unit concentration, specifying a volume from which all of the substance is removed per unit time. Clearance can be calculated from the formula $C = UV/P$, where $C$ is clearance in ml/min, $U$ means the urine concentration of the substance in mg/mL, $V$ means the urine volume in one minute and $P$ means plasma concentration of the substance in mg/mL [10,11].

3. Estimated GFR (eGFR)

Clearance method needs accurate urine collection which is not easily accomplished, time consuming and can be cumbersome leading to inadequate compliance and unreliability. In 1976 Cockcroft and Gault proposed the prediction of creatinine clearance from serum creatinine ($S_{cr}$)
blood concentration of creatinine rises, presenting a re-
ccreted from the renal tubules. With a decrease in GFR,
while approximately 3% of creatinine in the urine is se-
acid [17]. Creatinine is freely filtered by the renal glomeruli.
The plasma valine was strongly correlated to the GFR
growth hormone and glucagon did not differ significantly.
concentrations of valine, lysine, and IGF-I were higher than
after a high protein diet of animal source, plasma con-
centrations of valine, lysine, and IGF-I were higher than
after a vegetable protein diet, while the plasma levels of

Creatinine has a molecular weight of 113 D. It is a break
down product of creatine and phosphocreatine in muscle,
and is usually produced at a rather constant rate in the
body. Creatinine generation is proportional to muscle
mass. The liver plays important role in formation of
creatinine through methylation of guanidine aminoacetic
acid [17]. Creatinine is freely filtered by the renal glomeruli.
There is no renal tubular reabsorption of the substance,
while approximately 3% of creatinine in the urine is se-
creted from the renal tubules. With a decrease in GFR,
blood concentration of creatinine rises, presenting a re-
ciprocal relationship between GFR and serum creatinine
concentration.

In CKD patients with reduced glomerular and nephron
function, serum creatinine rises and renal tubular secre-
tion of creatinine is in relatively higher proportion.

Elevated level of serum creatinine usually indicates
reduced GFR, but normal level does not exclude possi-
bility of reduced GFR especially when renal damage is
not immense. Renal clearance representing GFR is a
more accurate method to measure kidney function.

Serum creatinine level can be affected by numerous
factors. It is slightly increased just after ingestion of high
meat diet, vigorous exercise, or due to some drugs that
block tubular secretion of creatinine especially in CKD
patients who already have high concentration of creati-
nine in the blood. Serum creatinine level is lower in indi-
viduals with muscle wasting, malnutrition, dietary pro-
tein restriction, and advanced liver disease. So in CKD
patients with severe malnutrition and severe muscle
wasting, serum creatinine might not be as high as in
those with more muscle mass though their kidney func-
tions are in the same level.

5. Protein Diet and GFR, Renal Functional
Reserve

The capacity of the kidney to increase its renal blood
flow and GFR after a dietary protein load is called renal
functional reserve [22]. The increase in GFR after high
protein diet can be due both to an increase in the serum
creatinine concentration and the known postprandial in-
crease of true GFR [8,22]. Healthy vegetarians are
known to have a statistically reduced baseline GFR [18]
but the ability to increase the GFR after high protein diet
is still maintained [23], unlike in patients with a reduced
number of nephrons whose renal functional reserve may
be diminished or absent [22].

Protein diet from animal source produced more incre-
ment in postprandial GFR compared to that from vegeta-
ble source [21]. Kontessis et al. in 1995 reported that,
after a high protein diet of animal source, plasma con-
centrations of valine, lysine, and IGF-I were higher than
after a vegetable protein diet, while the plasma levels of
growth hormone and glucagon did not differ significantly.
The plasma valine was strongly correlated to the GFR
[20].

6. The Classification of Chronic Kidney
Disease in Vegetarian

Since the classification of chronic kidney disease is
based on baseline GFR [7], and strict and long-term
healthy vegetarians are known to have a statistically re-
duced baseline GFR [18], therefore physicians need to
bear this in mind when dealing with diagnosis and classi-
fication of chronic kidney disease in vegetarians. Barai et
al. reported that basal GFR in 109 healthy Indian subjects
consuming vegetarian diet for 10 days was 82.4 ± 12.7
mL/min/1.73sq.m. which was significantly lower than
the normal value of 120 - 130 mL/min/1.73sq.m. in
western population [24]. They suggested that the conven-
tional cutoff value of 60 mL/min/1.73sq.m. for defining
chronic kidney disease might not be appropriate in India.
Preiss et al. in 2007 concluded in their report that mis-
classification of chronic kidney disease is possible if measurement of serum creatinine and GFR estimation are made after meat-containing meals [8]. Wiseman et al. measured GFR (as 51Cr-EDTA clearance) in vegans and lactovegetarians in comparison to omnivorous control subjects matched for age [25]. They found lower GFR in vegans and lactovegetarians but higher mean urinary albumin excretion rate in the omnivores.

In Thailand, it is our Thai tradition to consume rice meals with more carbohydrate and local vegetables, with less meat than the western style, especially in the rural area. The effect of meat on baseline serum creatinine and GFR estimation may play some minor part when dealing with diagnosis and classification of chronic kidney disease.

7. Conclusion

Vegetarians and individuals consuming long-term low-protein diet exhibit low baseline GFR though their renal functional reserve is still preserved. To assess renal function or survey of the prevalence of CKD using single measurement of baseline GFR, these low protein consumers may be mistaken as patients with early stages of CKD.

REFERENCES


