POSTPRANDIAL SERUM CREATININE INCREASE IN NORMAL SUBJECTS AFTER EATING COOKED MEAT

F K Jacobsen, C K Christensen, C E Mogensen, F Andreasen, N S C Heilskov

Medical Department I, Aarhus Amtssygehus, Denmark

Summary

Ingestion of meals containing cooked meat caused a marked postprandial increase in serum creatinine concentration, whereas ingestion of raw meat had no effect on serum creatinine. A peak mean value was seen 3 hours after the start of meals. No change in creatinine clearance was observed. Analysis of serum creatinine by conventional autoanalyser and by an ion exchange method ("true creatinine") showed a high degree of correlation, making a possible effect of non-creatine chromogens unlikely. It was shown that creatinine is produced from creatine when meat is boiled.

Introduction

The effects of diet on serum creatinine concentration are reported only very sporadically in the literature [1,2], and it is commonly stated that serum creatinine concentration is independent of diet [3–14]. However during an investigation we observed marked transient increases in serum creatinine concentrations after ordinary meals containing cooked meat. We describe here further investigation of this finding, which we believe has practical importance in nephrology and clinical medicine.

Methods

Experiment 1

The experiment was carried out over 2 separate days in 6 healthy young medical students.

On the first day they met, fasting, at 8 a.m. and were then served an ordinary breakfast without meat (egg, bread, butter, cheese, marmalade, coffee). At 12 midday they were served a meal of 500g of goulash, containing 250–300g of beef. At 5 p.m. they were served a meal of sandwiches without meat. Blood
samples for creatinine measurements were taken at 8 a.m. just before the breakfast, at 10 a.m. at 12 noon just before the midday meal, and then at hourly intervals over the next 10 hours, until 10 p.m. Urine samples were collected hourly for creatinine clearance determinations.

On another day, some days later, the same procedures were carried out with the exception of the midday meal, which instead of goulash, was an ordinary hospital meal without meat.

**Experiment 2**

Groups of 6 healthy young medical students were given one of the following 5 types of meals: A) 300g of raw beef, B) 300g of fried beef, thoroughly done (10 minutes), C) 300g of boiled beef, ingested along with the water (boiled for one hour and a half), D) 500g of goulash, containing 250–300g of beef (cooked for one hour and a half), E) 500g of stew, containing 250g of pork (cooked for one hour). Blood for creatinine determination was taken just before ingestion of the meals and 3 hours after the start of the meals.

**Experiment 3**

Forty-two grams of minced beef, free of fat and tendons, were boiled in 1000ml of demineralised water. Two specimens, each of 10ml, for creatine and creatinine determination were collected every 20 minutes for 3 hours, beginning at the time of boiling.

Creatinine concentrations were measured on a Technicon® Auto-Analyser SMA 6/60 - system using a dialyser procedure and Jaffé’s reaction. Furthermore 39 serum specimens from experiment 1 were analysed for creatinine by an ion exchange method ('true creatinine') [15]. Creatine concentrations were determined by converting creatine into creatinine by acid hydrolysis combined with autoclaving, and creatine concentrations were calculated by subtraction of the previous creatinine concentrations from the subsequent creatinine concentrations.

We used the method of paired comparison for testing significance of differences.

**Results**

On the day when a meal of goulash was served (Figure 1) serum creatinine sharply increased from a pre-ingestion value of 86μmol/L ± 10.2 (SD) reaching a mean peak value of 175μmol/L ± 11.9 (SD), p <0.001, 3 hours later. Ten hours after the start of the meal serum creatinine was still increased, 113μmol/L ± 8.7, p <0.001, just above the upper normal level of 110μmol/L.

On the day when a normal hospital meal without meat was served (Figure 1) a small increase was noted one hour after the midday meal (88μmol/L ± 12.2 (SD) → 92μmol/L ± 12.2 (SD)), but altogether the curve is practically flat.

No significant change in creatinine clearance was found throughout the ex-
Figure 1. Serum creatinine in 6 healthy young men after a midday meal of 500g of goulash, containing 250–300g of beef (A) and after a meal without meat (B) (Mean ± SEM).

A high degree of correlation between serum creatinine as measured by autoanalyser and by ion exchange method on 39 serum specimens from the day of goulash was found (y = 1.04 + 2.1, r = 0.99).

As shown in Figure 2 ingestion of 300g of raw beef did not influence serum creatine at all. A moderate increase was found after ingestion of 300g of fried beef (84μmol/L ± 13.8 (SD) → 110μmol/L ± 14.0 (SD), p <0.01), whereas ingestion of 300g of boiled beef ingested along with the cooking water caused a pronounced postprandial increase (87μmol/L ± 10.8 (SD) → 163μmol/L ± 17.9 (SD), p <0.001). After a meal of goulash, containing 250–300g of beef, a parallel increase in serum creatinine was seen, and also after a meal of stew, containing 250g of pork, a pronounced increase was noted (79μmol/L ± 7.3 (SD) → 147μmol/L ± 12.0 (SD), p <0.001).

Figure 3 shows that when minced beef was boiled in demineralised water, the creatine concentration decreased while the creatinine concentration at the same time increased in the supernatant.
Figure 2. *Serum creatinine after meals:*

A) 300g of raw beef
B) 300g of fried beef, thoroughly done
C) 300g of boiled beef
D) 500g of goulash, containing 250–300g of beef
E) 500g of stew, containing 250g of pork

Mean ± SEM (n = 6)
Figure 3. Creatine and creatinine concentrations in the supernatant from 42g of beef boiled in 1000ml of demineralised water.
A) Creatine concentration
B) Creatinine concentration

Discussion

This study demonstrates that ingestion of meals containing cooked meat causes a postprandial increase in serum creatinine concentration in normal man. Ingestion of an ordinary large meal of goulash, containing 250–300g of beef, was followed
by approximately a doubling of serum creatinine from 86μmol/L to 175μmol/L 3 hours after the start of the meal, and as long as 10 hours after ingestion of the meal values above the normal level were found. Ingestion of raw beef did not influence serum creatinine at all, whereas ingestion of fried beef and especially boiled beef, ingested along with the cooking water, gave rise to a marked post-prandial increase in serum creatinine. The high degree of correlation of creatinine values determined by autoanlyser and by an ion exchange method makes a possible effect of non-creatinine chromogens improbable. Furthermore it is demonstrated that the concentration of creatine decreases while the concentration of creatinine increases when minced beef is boiled in water, indicating that creatinine is produced from creatine in meat during the cooking procedure. Subsequently it is ingested and absorbed with the meals.

The findings in this study have a number of practical implications. Blood for serum creatinine determination should be drawn in fasting patients or after breakfast without meat. Furthermore, increased values after meals should be evaluated with caution. In uraemic patients protein restriction may lead to a fall in serum creatinine concentration which is not due to improvement in kidney function. Variation in the daily intake of cooked meat is likely to influence urinary output of creatinine and more accurate creatinine clearance determinations should be obtainable when proper attention is paid to diet. When no proper attention to diet is taken the creatinine clearance value may vary and may furthermore be overestimated, since the serum creatinine concentration is usually measured in the morning, when the concentration is lowest.

Acknowledgments

Analysis of a number of serum samples for creatinine by an ion exchange method was kindly carried out by dr. med. C. Rud and cand. pharm. S. Vedsø, Vejle sygehus, Denmark. Laboratory assistants of the Department of Clinical Chemistry, Aarhus Amtssygehus are thanked for skilful technical assistance.

The staff of the hospital kitchen at Aarhus Amtssygehus are thanked for much valuable help.

References

5 Baum, N, Dichoso, CC and Carlton, CE (1975) Urology, 5, 583
7 Dunea, G and Freedman, P (1968) JAMA, 204, 161
8 Hamburger, J (1966) Nephrology, Philadelphia

511
Open Discussion

VALEK (Prague) This was a very interesting paper, which reminds us of the paper of Barrett and Addis published in 1947. I am sure that Dr Jacobson will be happy to hear that in Czechoslovakia 20 years after World War Two patients were forbidden to eat meat during the creatinine clearance test, especially roast meat, because creatinine changes. Later, because the creatinine clearance test is a very approximate method, we have not prescribed any diet. Of course blood samples are collected in the morning before breakfast.