Single-Injection Inulin Clearance Using Only One Blood Sample as a Suitable Procedure to Measure Glomerular Filtration Rate

K.	Klaus	Jung ^a
W.	Wolfgang	Henke ^a
B.-D.	Bernd-Detlef	Schulze ^b
K.	Karin	Sydow ^c
K.	Klaus	Precht ^b
S.	Silke	Klotzek ^a

Departments of ^aExperimental Organ Transplantation, ^bInternal Medicine and ^cNuclear Medicine, University Hospital Charité, Humboldt University Berlin, FRG

Dr. K. Jung, Department of Experimental Organ Transplantation, University Hospital Charité, Humboldt University Berlin, Leninallee 49, D-10117 Berlin (FRG)

Dear Sir,

In a previous paper of this journal we described two sensitive and reliable assays to determine low concentrations of inulin in serum [1]. These refined methods make it possible to use the single-shot technique with inulin as suitable procedure in the routine practice to measure the glomerular filtration rate (GFR). Here we report on our approach.

In 21 patients (12 women, 9 men; mean age 38 years) suffering from chronic renal diseases, the isotope clearance of ^{99m}Tc-diethylenetriamine pentaacetic acid (DTPA) and the elimination kinetics of inulin were simultaneously measured. ^{99m}Tc-DTPA clearance calculated by the single compartmental model analysis of the disappearance curve of ^{99m}Tc-DTPA was used as reference GFR [2]. Twenty megabecquerel of ^{99m}Tc-DTPA was injected into the medial antecubital vein, and radioactivity was measured in blood samples taken 60, 90 and 120 min after injection. As shown in previous studies, this technique gives identical values in comparison with the standard inulin method with continuous infusion [2]. The single-injection inulin clearance was calculated from the plasma elimination kinetics of inulin after an injection of 5 g inulin (Laevasan GmbH, Linz, Austria). The timing of the clearance started with the beginning of the injection. Samples for the determination of inulin concentrations were taken at 7 different time intervals (20, 45, 90, 120, 145, 180 and 240 min) after injection. GFR was calculated from these data by applying the monocompartment system [3–5] and using only 1 blood sampling. This procedure considers that GFR is inversely proportional to the plasma inulin concentration [6]. A factor k_0 being optimal for all 21 individuals (N) to calculate GFR was determined. In the first step, a factor k_i was calculated for each time point according to equation 1. For these calculations, the GFR of all individuals ($i = 1$ to N) measured by the ^{99m}Tc-DTPA method (GFR_{DTPA}) were considered:

$$GFR_{DTPA} = \frac{V}{k_i} \cdot \frac{1}{t} \cdot \frac{1}{N}$$

where C_t and I_t correspond to the inulin concentration (mg/100 ml) and the dosis of injected inulin (mg), respectively; t indicates the sampling time after injection. The second step comprised the calcu-

DTPA clearance, ml/min/1.73 m^2

Fig. 1. Correlation between the glomerular filtration rate measured by $^{99\text{m}}\text{Tc}$ -DTPA clearance and the single-injection inulin clearance at 120 min after inulin bolus injection. The regression line was $Y_{\text{inulin}} = -3.3 + 1.01 X_{\text{dtpa}}$ (ml/min/1.73 m^2); the corresponding 95% confidence intervals were -20.8–6.0 for the intercept and 0.90–1.27 for the slope, respectively.

lation of the plasma inulin clearance (G_I) of the individuals at the corresponding time points according to equation 2:

Using this equation, G_I values at the 7 different sampling times were calculated. Regression analyses between G_I and DTPA values corrected for the body surface area of 1.73 m^2 were performed [7]. Thus, the optimal factor k_0 defined as k_1 of equation 2 giving the best agreement between G and DTPA values could be calculated. Using this calculation model, inulin concentrations measured at 120 min resulted in clearance values nearly identical with DTPA values (fig. 1). For all patients investigated, the median value of “ Tc -DTPA was $91.2 \text{ ml/min/1.73 m}^2$ (arithmetic mean $\pm$ SD: 92.4 ± 40.8)

Single-Injection Inulin Clearance

695

Truniger B, Donath A, Kappeler M: Simplified clearance techniques. The single injection method and its modifications. *Helv Med Acta* 1967/68; 19:116–129.

Rosenbaum JL, Kramer MS, Raja RM, Manchanda R, Lazaro N: Determination of inulin and p-aminohippurate clearances without urine collection. *Nephron* 1973;10:347–354.

Hall JE, Guyton AC, Farr BM: A single-injection method for measuring glomerular filtration rate. *Am J Physiol* 1977; 232: F72-F76.

Watschinger B, Kobinger I: Clearancebestimmungen mit Poly-fructosan S (Inutest). *Wien Z Inn Med* 1965;45:219–228.

Passing H, Bablok W: A new biometrical procedure for testing the equality of measurement from two analytical methods. *J Clin Chem Clin Biochem* 1988;21:709–720.

Payne RB: Creatinine clearance: A redundant clinical investigation. *Ann Clin Biochem* 1986;23:243–250.

and that of inulin clearance $88.2 \text{ ml/min/1.73 m}^2$ (arithmetic mean $\pm$ SD: 94.1 ± 42.7). The factor k_0 was 0.1992 at that time. Thus, the factor 996 (resulting from equation 2: $5,000 \times 0.1992$) divided by the inulin concentration found at 120 min after injection and corrected for the surface area gives plasma inulin clearance values comparable to the $^{99\text{m}}\text{Tc}$ -DTPA.

In conclusion, our study demonstrates that a single-injection inulin clearance using only 1 blood sampling provides reliable information on GFR. The recommended procedure is simple and expeditious to be suitable for routine use. It could replace unreliable endogenous creatinine clearance measurements [8] and would be an alternative method to isotope techniques.

References

Jung K, Klotzek S, Schulze BD: Refinements of assays for low concentrations of inulin in serum. *Nephron* 1990; 54:360–361.