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-1017 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 99mTc-diethylentriamine pentaacetic acid (DTPA) and the elimination kinetics of inulin were simultaneously measured. \( ^{99m}\text{Tc-DTPA} \) clearance calculated by the single compartmental model analysis of the disappearance curve of \( ^{99m}\text{Tc-DTPA} \) was used as reference GFR [2]. Twenty megabecquerel of \( ^{99m}\text{Tc-DTPA} \) 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 (Laevosan 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 \( ^{99m}\text{Tc-DTPA} \) method (\( \text{GDTpa} \)) were considered:

\[
N \sum_{i=1}^{\text{GDTpa}} \frac{\Gamma \times t_i}{\nu \times L \times N \times t_i}
\]
where $C_t$ and $l$ correspond to the inulin concentration (mg/l00 ml) and the dose of injected inulin (mg), respectively; $t$ indicates the sampling time after injection. The second step comprised the calculation of the plasma inulin clearance ($G'$) of the individuals at the corresponding time points according to equation 2:

$$G' = \frac{kl00}{100}$$

Using this equation, $G'$ values at the 7 different sampling times were calculated. Regression analyses between $G'$ and DTPA values corrected for the body surface area of 1.73 m2 were performed [7]. Thus, the optimal factor $k$ defined as $k_0$ 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 $G'$ was 91.2 ml/min/1.73 m2 (arithmetic mean ± SD: 92.4 ± 40.8).

Single-Injection Inulin Clearance


and that of inulin clearance 88.2 ml/min/1.73 m2 (arithmetic 3 mean ± 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 × 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 $99m$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 expedients 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