ORIGINAL ARTICLE

Inulin and Creatinine Clearances in Children with Renal Disease

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ABSTRACT To know how far the kidneys have been damaged, renal function in children suffering from renal disease must be measured. The aim of this study was to measure inulin and creatinine clearances in children suffering from renal diseases, and to know how would be the correlation between them. In this cross-sectional study sample size was estimated by the one-sample for estimating the population proportion, and data analysis was done by the Pearson product moment correlation and analysis of variance. Simultaneous measurements of inulin and creatinine clearance levels in 112 children were performed at Kariadi General Hospital, Telogorejo Hospital and St Elisabeth Hospital in Semarang, over the period from March 1991 to July 1993. Creatinine clearance (C_{cr}) showed positive correlation with inulin clearance (C_{in}) in all patients with mixed (normal and decreased) renal functions: C_{cr} = 8,41 + 1,00 C_{in} (r = 0,99; p <0,001; n = 112). Further it revealed that the difference between these two clearances was a function of the severity of the renal failure. These results were in accordance with those published in previous studies. **[Paediatr Indones 1997; 37: 20-24]**

Introduction

The importance of measuring or estimating of renal function or glomerular filtration rate (GFR) in children suffering from renal diseases is to know how far the kidneys have been damaged,[1] as GFR is the aspect of renal function that correlates closely with the ability of the kidneys to maintain the composition of the body fluids within the ranges compatible with life.[2] Three methods to measure GFR are C_{in} (gold standard), radioisotope clearance (C_{ra}) (accurate) and C_{cr} (sufficiently accurate).[3,4] There are

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limitations for the utility of clearance methods. C_{in} takes a long time to perform, the procedure is difficult, very expensive, and is not practical for routine use in clinical practice. C_{ra} is available only in a well -equipped and expensive health center. In clinical practice GFR is measured by endogenous C_{cr}. The advantages of knowing the level of GFR are the ability to detect the presence of decreased renal function, to know the severity of renal failure, to adjust drug and nutrient dosage on patients with decreased renal function, to know the results of treatment efforts, to follow the course of renal failure, and to prevent the progressivity of renal failure.

This study was performed since pediatric renal diseases in our country comprised about 2.3% of the hospitalized children, of which the frequency of renal failure was about 25%.[5] Every child in the community could suffer from renal disease irrespective of their socioeconomic class, education, in urban or rural area. The aim of this study was to measure the levels of GFR, expressed by C_{in} and C_{cr}, in children suffering from renal diseases, and to know how would be the correlation between them.

Methods

The procedures of this study were in accord with the "Pedoman Etik Penelitian Kedokteran Indonesia",[6] which is in accord with the ethical standards of the Committee on Human Experimentation in accord the Helsinki Declaration of 1975. This cross-sectional study was performed in children suffering from renal diseases, boys and girls, aged 2-14 years, admitted to the children ward of Kariadi General Hospital, Telogorejo Hospital, or St Elisabeth Hospital in Semarang. The sample size was estimated by the one-sample for estimating the population proportion.[7]

Measurements of the standard C_{in}[8] and the conventional endogenous C_{cr}[4] were undertaken simultaneously. A solution of 10% inulin as reagent was made by the method of CAS 9005-80-5.[9] Inulin concentration in plasma (P_{in})(mg/dl) and in urine (U_{in})(mg/dl) were assayed by UV-method for D-fructose.[10] Creatinine concentration in plasma (P_{cr}) and in urine (U_{cr}) were assayed by Abbott Spectrum Autoanalyzer. Urine flow was V ml per minute. Renal clearance formula of standard C_{in} is $[(U_{in} \times V): P_{in}]$ ml/min/1.73m^2 and that of conventional endogenous C_{cr} is $[(U_{cr} \times V): P_{cr}]$ ml/ min/ 1.73m^2.[4]

To diagnose the status of renal function (normal or decreased), a standard renal function status test, namely IKA-1984, was utilized, based on the normal values for P_{cr} in children according to age and sex.[11] The high clinical agreements (kappa >0,80) between IKA-1984 and other four standard renal function status tests, i.e., Schwartz,[12] Feld,[13] Barratt[14] and Chantler,15 indicate that IKA-1984 method was accurate.[16,17] Data were analyzed by the Pearson product moment correlation and the analysis of variance.[18]

Results

Simultaneous measurements of standard C_{in} and conventional endogenous C_{cr} were performed in 112 children suffering from renal diseases, aged 2-14 years, consisted of 60 (60.9%) boys and 44 (39.1%) girls, over the period from March 1991 to July 1993 (29 months). The range of the standard C_{in} was from 3 to 177 ml/min/1.73m^2 and that of the conventional endogenous Ccr was from 4 to 196 ml/min/1.73m^2. Utilizing the IKA-1984 standard renal function status test revealed that there were 86 (76.7%) children with normal and 26 (23.3%) children with decreased renal function.

Creatinine clearance had positive correlation with C_{in} in 112 children with mixed renal functions (normal and decreased) showed by the regression equation as follows: $C_{cr} = 8.41 + 1.00\ C_{in}$ ($r = 0.99$; $p < 0.001$: $n = 112$). Further it was revealed that the dif-ference between C_{cr} and C_{in} (ml/min/-1.73m^2) was a function of the severity of renal failure, the more severe the renal failure the more bigger the difference between C_{cr} and C_{in} (Table 1).

Table 1. Summary of analysis of variance

Source of Variance	Sum of Squares	df	Mean square	F	p
Severity of renal failure	239.4	2	119.7	6.97	0
Residue	446.49	26	17.17		
Total	685.89	28	24.49		

(Sum of squares for residue = sum of squares for total variation-sum of squares for within group variation)

Discussion

The results of this study showed that the levels of C_{cr} were higher that those of C_{in}. This was in accord with those published by previous studies as follows:

1. Arant *et al* measured endogenous C_{cr} and C_{in} simultaneously. It was shown that $C_{cr} = 0.912\ C_{in} + 9.51$ ($r = 0.94$ and $p < 0.001$). At low levels of renal function the $C_{cr} > C_{in}$ (GFR) by an average of 20%. Within normal and moderately reduced renal function the ratio of C_{cr} to C_{in} for practical purposes can be assumed to be unity.[19]
2. Chantler and Holiday state when GFR is normal, tubular secreted is about 20% of the filtered creatinine, i.e. $U_{cr} \times V$ =120% filtered creatinine. As GFR declines, the percent of $U_{cr} \times V$ that is secreted rises in a variable way to an average of 160% of filtered creatinine when GFR is 40-80 ml/min/1.73m^2; it may reach values that are > 200% of filtered creatinine when GFR is < 40 ml/min/1.73 m^2. Consequently C_{cr} as a measure of residual GFR tends to progressively overestimates GFR or Cin.[20]
3. Hellerstein *et al* measured standard C_{in} and endogenous C_{cr} simultaneously and

found a regression equation $C_{in} = 0.86\ C_{cr} - 6.5$ ($r = 0.95$).[21]

4. Levery *et al* stated an equation that showed the relationships between the sum of urine creatinine ($U_{cr} \times V$), GFR, P_{cr} and sum of tubular secreted creatinine (TS_{cr}) was $U_{cr} \times V = GFR \times P_{cr} + TS_{cr}$. Rearrangement of the above mentioned equation resulted in the next equation: $C_{cr} = GFR + TS_{cr}/P_{cr}$. Because $C_{in} = GFR$, so it was proved that the level of C_{cr} was higher than that of Cin.[22]

Inulin clearance is accurate and C_{cr} is sufficiently accurate. Up till now in clinical practice the GFR is measured by C_{cr} because drug dosage adjusted on patients with decreased renal function is still expressed by C_{cr}.

Conclusions

Positive correlation was observed between inulin and creatinine clearances performed in children with renal disease. The difference between them was a function of the severity of renal failure, the more severe the renal failure the bigger the difference.

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