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Original Article

Physiology Section

Correlation of 2 Hours and 24 Hours Creatinine Clearance in Renal Donors After Unilateral Nephrectomy

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ABSTRACT

Background: The kidney performs numerous specialised functions in an effort to maintain constancy of the internal composition of body fluids.

Aim: This study was done to ascertain the feasibility of estimating creatinine clearance as an outpatient procedure over a 2 hours period instead of doing the study over a 24 hours period.

Material and Methods: Eighteen renal donors, Twelve females and Six males, who were closely related to recipients, were chosen. This study was done on renal donors who attended the Nephrology Department of Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai–03 India. To estimate creatinine clearance in 24 hours urine, 24 hours urine sample was collected from 9 am on the first day to 9 am on the next day, after first emptying the bladder. Then, creatinine clearance was calculated by using standard formula, CC=UV/Pt X 1.73m^2/BSA of the individual.

Results: There was no significant differences in mean creatinine clearance values by collecting 2 hours and 24 hours urine samples from renal donors in different stages of post nephrectomy period. It has been shown that 2 hours collection of urine sample is as good as 24 hours urine sample for estimating creatinine clearance.

Conclusion: Hence it was proved that measurement of creatinine clearance could be done as an outpatient procedure, as the patient needed only 2 hours of hospital stay.

Key words: Glomerular filtration rate (GFR), Plasma creatinine, Plasma clearance of creatinine

INTRODUCTION

The kidney performs numerous specialised functions in an effort to maintain constancy of the internal composition of body fluids. It is important to carefully assess the renal function in health and disease undoubtedly. The most important parameter which can assess renal function is determination of Glomerular Filtration Rate (GFR). Glomerular filtration is the first step in urine formation and the GFR is about 20% of renal plasma flow. The normal human kidney contains approximately 1 million glomeruli [1,2] each of which is approximately 150- 200 microns in diameter. The total surface area provided for filtration is approximately 1 square meter. Approximately 180 l/day or 125 ml/min of tubular fluid are produced from the rich renal plasma flow by the process of ultrafiltration.

The GFR represents the rate at which the ultrafiltrate of the plasma is formed by the glomeruli and is indicative of the functional renal mass. The clearance of a substance is defined as the rate at which it is cleared from plasma per unit concentration. The clearance of a substance x (Cx) is given in the following.

Cx=Ax/PxWhere, Ax is the amount of x eliminated from the plasma, Px is the average plasma concentration.

Hence Cx is expressed in units of volume per time. The value of clearance does not represent an actual volume, but it is a virtual volume of plasma that is completely cleared of the substance per unit of time without reference to the route of elimination. The value for clearance is related to the efficiency of elimination. The greater the rate of elimination, the higher is the clearance. For a substance that is cleared by renal excretion,the clearance formula can be rewritten as,

Cx=Ux X V/Px where, Ux is the urinary concentration of x and V is the urine flow rate. The term Ux X V is defined as the urinary excretion rate of x.

Although inulin clearance is a precise measure of GFR it involves intravenous infusion where as creatinine is synthesised in the body and does not need infusion [3]. Urinary creatinine is derived from endogenous creatinine from metabolism of muscle creatine and creatine phosphate. However some creatinine (10-20%) is secreted in urine by the proximal tubules of kidneys, but the excess urinary creatinine partly compensated by over estimation of plasma creatinine due to presence of non-creatinine chromogens, which reacts with reagent during estimation. The use of creatinine clearance, Ccrn, as an index of GFR, rests on the assumption that creatinine is an ideal filtration marker; consequently creatinine clearance would be equal to GFR.

Therefore, GFR= Ccrn = Ucrn X V/Pcrn.

Where Ccrn is creatinine clearance.

Ucrn is urinary creatinine.

Pcrn is plasma creatinine.

V is the volume of urine.

The use of plasma creatinine as an index GFR is based on the additional assumption that creatinine is excreted only by renal excretion and the patient is in a steady state of creatinine balance.

Gcrn= Ucrn X V. Where Gcrn is creatinine generation rate. The plasma level (Pcrn) would be inversely related to GFR as follows Pcrn = Gcrn / GFR =Ucrn X V / GFR.

Creatinine is variably secreted by proximal tubules of nephrons. Tubular secretion of creatinine accounts for 10-40% of creatinine excreted in the urine in normal individuals. If there is decrease in tubular secretion, serum creatinine is increased and urinary creatinine is decreased. In renal diseases 50-60% of creatinine is secreted. On an average, in normal individuals,creatinine clearance exceeds GFR by 10 ml/min/1.73m^2. Creatinine may also be reabsorbed by the tubules to a limited extent. Reabsorption of

creatinine may be caused by its passive back diffusion from the lumen to blood, because of high tubular creatinine concentration that occurs during low urine flow (<0.5ml/min). The maximum effect of creatinine reabsorption would be 5 to 10% decrease in creatinine clearance.

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Aim and Objective

To ascertain the feasibility and to assess the reliability of estimating creatinine clearance by using 2 hours urine sample as an outpatient procedure in lieu of doing the study over a 24 hours period. This is done by correlating the clearance values obtained by using 2 hours and 24 hours samples of urine.

MATERIALS AND METHODOLOGY

Sample size: Eighteen renal donors, Twelve females and Six males, who were closely related to recipients.

Exclusion criteria: Recent urinary tract infections, comorbid illnesses like diabetes, hypertension.

Parameters studied: Plasma creatinine and creatinine clearance.

Methodology: This study was done on renal donors attending the Nephrology Department of Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai–03, India. After obtaining written consents from donors, the study was done after eliciting a proper history including personal history (smoking, alcoholism, diet), family history including hypertension, diabetes, renal disease, past history of previous surgeries, illnesses were recorded.

General examination was done,which included measuring subject's height, weight, pulse, blood pressure, blood grouping typing and doing HIV test.

Plasma samples were collected at 8 am. In these samples, plasma creatinine was estimated using Jaffe's method(alkaline picrate) [4].

To estimate the creatinine clearance in 24 hours urine, 24 hours urine sample was collected from 9 am on the first day to 9 am on the next day after first emptying the bladder. The donor passed urine for the whole 24 hour period into collecting jar after drinking enough water, avoiding non-vegetarian food, and by collecting the urine till the last drop.

Then, creatinine clearance was calculated by using standard formula, CC=UV/ Pt X 1.73m^2/BSA of the individual.

Where, U- Concentration of creatinine in the urine, which was estimated by Jaffe's method where urine sample was used instead of plasma samples.

V- Volume of urine during 24 hours period.

P- Concentration of creatinine in the plasma.

t- Time during which urine was collected for 24 hours which was converted to 1440 minutes.

BSA- Body surface area of an individual estimated by nomogram using height in cms and weight in kgs.

Estimation of creatinine clearance in 2 hours urine sample was done by collecting 2 hours urine sample in the morning after first emptying the bladder at 7 am. Then, the subject was abstained from voiding urine for 2 hours and at the end of 2 hours, at 9 am,urine was collected.

CC=UV/ Pt X 1.73m^2/BSA of the individual.

Where,

U- Concentration of creatinine in the urine.

V- Volume of urine during 2 hours period.

P- Concentration of creatinine in the plasma.

t- Time during which urine was collected for 2 hours which is converted to 120 minutes.

RESULTS

Baseline values

Plasma creatinine: 0.8-1.2 mg/dl.

Urinary creatinine: 17-19mg/kg/day.

Urine output: 1.5-2.0 litre/day.

There was no significant differences in mean creatinine clearance values by collecting 2 hours and 24 hours urine samples in renal donors in different stages of post nephrectomy period [Table/Fig-1].

n=18	2 hours creatinine clearance ml/min Mean + SD	24 hours creatinine clearance ml/min Mean + SD	t–test	p–value	Significance
Post donation 12 days	40.89+3.55	43.55+5.73	1.67	0.10	Not significant
Post donation 6 weeks	46.50+5.96	48.61+6.13	1.05	0.30	Not significant
Post donation 12 weeks	47.89+6.66	49.39+6.10	0.71	0.49	Not significant

[Table/Fig-1]: Correlation between 2 hours and 24 hours creatinine clearance analysed using student t–test
p–value >0.05 not significant

DISCUSSION

Aim of this study was to ascertain the feasibility of estimating creatinine clearance an as outpatient procedure over a 2 hours period instead of doing the study over a 24 hours period. For this objective, reliability of using a 2 hours urine sample of estimating creatinine clearance instead of collecting a 24 hours urine sample and then the correlation of creatinine clearance values obtained in 18 healthy kidney donors after surgery in post donation period. The results of the study showed that there was no significant difference in creatinine clearance values estimated by collecting 2 hours and 24 hours urine samples in all the periodic estimations done on 18 subjects.

It has been shown that 2 hours collection of urine sample is as good as 24 hours urine sample for estimating creatinine clearance [5,6]. Hence it has been proved that measurement of creatinine clearance can be done as an outpatient procedure, as the patient needs only 2 hours of hospital stay. The test is done by collecting a 2 hours urine output and sampling the plasma once during the 2 hours period. Two hours collection affords more timely diagnosis, appropriate monitoring and treatment. The risk of error in collection, handling and storage by patients and laboratory personnel is less. Two hours sampling of urine also helps in monitoring the acute changes in renal function [7]. They are time and cost effective.

CONCLUSION

This study done on 18 healthy kidney donors, (12 females, and 6 males) was to examine the feasibility of estimating creatinine clearance over a 2 hours period in outpatients, instead of collecting 24 hours urine sample. This study has clearly stated that a 2 hours collection of urine and a single collection of plasma during the 2 hours period at any time of day are as reliable as a 24 hours study for estimating plasma clearance of creatinine.

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