IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
Volume 4, Issue 2 (Jan. - Feb. 2013), PP 41-44
e-ISSN: 2279-0853, p-ISSN: 2279-0861.
www.iosrjournals.org

Assessment of glomerular functions in renal donors before and after donation

Dr. Viji Devanand [1], Dr.S.U.Chithrapavai [2]
[1] *(Department of Physiology, Stanley Medical College, The TN Dr.MGR Medical University, Chennai, India)*
[2] *(Department of Physiology, Stanley Medical College, The TN Dr.MGR Medical University, Chennai, India)*

Abstract: *Growth of residual renal tissue in response to loss of other renal tissue is termed as compensatory hypertrophy. The functional adaptation is characterized by an increase in GFR which began 2 weeks after unilateral nephrectomy due to growth of the remaining kidney. Although increases in total renal weight have been reported in 24 hours, the total increase of about 50% in mass following unilateral nephrectomy is not achieved for 2 to 4 weeks. The degree of loss of renal mass is a key determinant of compensatory growth. Aim of this study is to observe the rate and extent of recovery in renal function in the post donation period after kidney donation. The objective is to follow the progressive changes in three parameters of renal function namely plasma creatinine level, plasma urea level and the creatinine clearance values in the preoperative and in different stages of post- donation period. 18 renal donors, 12 females and 6 males, who were closely related to recipients, were selected. This study was done in renal donors attending the nephrology department in Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai - 03. After obtaining written consent from donors the study was done after eliciting a proper history. There was significant difference in creatinine clearance values in different stages of post donation period as compared with the pre operative values and significant difference in creatinine clearance values in the pre operative and in different stages of post-donation period. Plasma Urea showed a rise of 3% in 2 week period post donation as compared to pre donation levels, but this fell by 2.5% resulting in only a 0.5% rise at the end of 6 week period post donation, with no further decrease during the study period. Statistical analysis by Anova showed no significant difference in plasma urea levels in the post- donation period as compared to pre donation levels. Plasma Creatinine showed a rise of 8% in 2 week period post donation as compared to pre donation levels, but this fell by 3% resulting only in 5% rise at the end of 6 week period post donation with no further decrease during the study period. Statistical analysis by Anova showed no significant difference in plasma creatinine levels in the post donation period as compared to pre donation levels. Creatinine Clearance of the study showed that there was significant difference in Creatinine Clearance of post donation period as compared to pre donation levels. The mean Creatinine Clearance value was approximately 58% of pre donation value at end of 12 weeks. Hence this study confirms that there is a mild improvement in the function of surviving kidney after renal donation as indicated on 8% rise in creatinine clearance by end of 12 weeks. There is a structural and functional adaptation during compensatory hypertrophy, which is a glomerular hyperplasia as well as hypertrophy and renal tubular cell hypertrophy. The results indicate that there is a very slight but significant increase in creatinine clearance. Other studies have indicated that there is a 10-15% increase in the SNGFR after nephrectomy or destruction of nephrons by disease.*

Keywords: *creatinine clearance, pre operative, post donation, renal donors.*

I. Introduction

The filtration of fluid through the glomerular capillaries begins in the human foetus between the 9th and 12th week of intrauterine life. The process of birth brings a sudden surge in GFR. The adult levels are reached between 1 and 2 years of age and there is approximately a 25 fold increase in GFR. The rise in GFR during infancy is due to an increase in the number of functional nephrons.

The term cell growth indicates either an increase in cell number or an increase in cell size. The hypertrophic growth processes involve an increase in the physical size of the cell. The increase in physical cell size associated with hyperplasia does not result in permanently enlarged cell, but a transient enlarged state until the cell divides in mitosis.

The glomerulus consists of a folded basement membrane, which separates the endocapillary compartment from the extracapillary compartment. The glomerulus consists of four types of cells; the mesangial cell, endothelial cell, visceral glomerular epithelial cell or podocyte cell and parietal glomerular epithelial cell. All the cells except visceral glomerular epithelial cell retain the ability to proliferate in the mature glomerulus. In compensatory hypertrophy, there is glomerular hyperplasia which occurs in mesangial, endothelial and parietal glomerular epithelial cells.

Growth of residual renal tissue in response to loss of other renal tissue is termed as compensatory hypertrophy. The functional adaptation is characterized by an increase in GFR[1] which began 2 weeks after unilateral nephrectomy due to growth of the remaining kidney[2]. The most notable increase was found in single nephron glomerular filtration rate (SNGFR) and in net absorption of solutes and water[3].

The structural adaptation is in the remaining glomeruli. The glomeruli increase in volume by approximately 50% in the superficial or deep cortex, in the mesangial, endothelial and epithelial cells, extra cellular matrix and capillary lumen which also expand to similar degrees[4]. There is a relative increase in numbers of mesangial, endothelial and epithelial cells. The length and number of capillaries increase. The proximal tubule mainly, ascending limb of Henle segment and distal tubule also hypertrophy.

Because the glomerular ultrafiltration coefficient (K_f) is usually a product of filtering surface area (S) and its hydraulic conductivity (K), the expansion of S by glomerular enlargement should cause greater K_f, K remaining constant. However calculations of K_f from micropuncture measurements of glomerular pressures and flows usually demonstrate no increase in K_f, following substantial loss of renal mass[5].

Although increases in total renal weight have been reported in 24 hours, the total increase of about 50% in mass following unilateral nephrectomy is not achieved for 2 to 4 weeks[6]. The degree of loss of renal mass is a key determinant of compensatory growth. The metabolic processes like ammoniagenesis and oxygen consumption with heightened transport is increased in remaining nephrons after unilateral nephrectomy[7,8]. Augmentation of RNA synthesis has been observed within the first 4 hours after unilateral nephrectomy, levels of DNA rise after those of RNA, but mitosis returns returns to a basal level by about 2 weeks after unilateral nephrectomy[9]. The growth factors like IGF- 1, EGF, are produced and elevated within the kidney during compensatory growth[10,11].

Aim

To observe the rate and extent of recovery in renal function in the post donation period after kidney donation.

Objectives

The objective of this study is to follow the progressive changes in three parameters of renal function namely plasma creatinine level, plasma urea level and the creatinine clearance values in the preoperative and in different stages of post- donation period.

II. Materials And Methodology

Sample size: 18 renal donors (12 females and 6 males), who were closely related to recipients.
Exclusion criteria: Recent urinary tract infections, co morbid illness like diabetes, hypertension.
Parameters studied:
Plasma creatinine - by Jaffe's method [12]
Plasma Urea - by Berthelot method [13]
Creatinine clearance - by standard formula [14]

Methodology:

This study was done in renal donors attending the nephrology department in Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai - 03. After obtaining written informed consent 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, illness were recorded. General examination was done which included measuring subject's height, weight, pulse, blood pressure, blood grouping and typing and HIV test.
Statistical analysis: Statistical analysis was done using ANOVA, Creatinine clearance was also analysed using multiple comparison procedure by Bonferroni t test

III. Results

TABLE 1: Comparing plasma urea levels between Pre donation and different stages of post donation using ANOVA

	M ± SD	F test	P value
Pre-Donation	20.80 ± 1.68	0.705	0.55
Post-Donation-12 days	21.53 ± 1.71		
Post-Donation-6 weeks	21.49 ± 1.81		
Post-Donation-12 weeks	21.44 ± 1.63		

* P value = < 0.05 Significant

TABLE 2: Comparing plasma creatinine levels between Pre donation and different stages of post donation using ANOVA

	M ± SD	F test	P value
Pre-Donation	0.90 ± 0.07	2.43	0.07
Post-Donation-12 Days	0.97 ± 0.09		
Post-Donation- 6 Weeks	0.95 ± 0.08		
Post-Donation-12Weeks	0.95 ± 0.09		

* P value = < 0.05 Significant

TABLE 3: Comparison between pre donation and different stages of post donation Creatinine Clearance was analyzed by using ANOVA

	N	Mean	S.D	F test	Significance
Pre-Donation	18	84.13	8.27	F=165.49	P=0.001*
Post-Donation-12 Days	18	42.22	4.15		
Post-Donation- 6 Weeks	18	47.25	5.84		
Post-Donation-12 Weeks	18	48.74	6.38		

* P value = < 0.05 Significant

As shown in TABLE 3: There was significant difference in creatinine clearance values in different stages of post donation period as compared with the pre operative values.

TABLE 4: Multiple comparison procedure by Bonferroni t test of Creatinine clearance.

	Mean Difference	P Value
Pre-donation vs Post-donation – 12 Days	41.92	0.001*
Pre-donation vs Post-donation – 6 Weeks	36.89	0.001*
Pre-donation vs Post-donation – 12 Weeks	35.34	0.001*

*P value = < 0.05 Significant

There was significant difference in creatinine clearance values in the pre operative and in different stages of post-donation period.

IV. Discussion

The objective of the study is to compare the progressive changes in three parameters of renal function, namely Creatinine Clearance, Plasma urea & Plasma Creatinine in the pre operative and different stages of post - donation period in 18 healthy donors, the rate and extent of recovery in renal transfer in post- donation period is assessed.

According to TABLE 1 Plasma Urea showed a rise of 3% in 2week period post donation as compared to pre donation levels, but this fell by 2.5% resulting in only a 0.5% rise at the end of 6 week period post donation, with no further decrease during the study period. Statistical analysis by Anova showed no significant difference in plasma urea levels in the post- donation period as compared to pre donation levels.

As seen in TABLE 2 Plasma Creatinine showed a rise of 8% in 2 week period post donation as compared to pre donation levels, but this fell by 3%resulting only in 5% rise at the end of 6 week period post donation with no further decrease during the study period. Statistical analysis by Anova showed no significant difference in plasma creatinine levels in the post donation period as compared to pre donation levels.

As seen in TABLE 3 and 4 Creatinine Clearance of the study showed that there was significant difference in Creatinine Clearance of post donation period as compared to pre donation levels. The mean Creatinine Clearance value was approximately 58% of pre donation value at end of 12 weeks.

Hence this study confirms that there is a mild improvement in the function of surviving kidney after renal donation as indicated on 8% rise in creatinine clearance by end of 12 weeks. There is a structural and functional adaptation during compensatory hypertrophy, which is a glomerular hyperplasia as well as hypertrophy and renal tubular cell hypertrophy[15]. This functional adaptation is manifested as a rise in single nephron glomerular filtrate rate [SNGFR][16]. According to Van Acker, amount of creatinine excreted by single nephron17 remains constant during different periods. Even though there is a circadian rhythm in GFR[18] there is no further change in the excretion of creatinine, because creatinine is cleared from plasma both on glomerular filtration and tubular secretion. When the filtered amount is decreased there is compensatory increase in tubular secretion and vice versa. Hence during compensatory hypertrophy of the kidney there is hyperplasia and hypertrophy of the glomeruli in the surviving kidney, causing an increase in the filtering surface area of the glomerulus & consequently in the SNGFR.

Hence the significant increase in SNGFR must definitely cause an increase in clearance of various substances filtered and an improvement in renal excretory function.

V. Conclusion

This study done with 18 healthy kidney donors (12 females and 6 males) was done to examine the rate and extent of recovery of renal function after the loss of one kidney[16]. The results indicate that there is a very slight but significant increase in creatinine clearance of the single kidney[17]. Other studies have also indicated that there is a 10-15% increase in the SNGFR after nephrectomy or destruction of nephrons by disease. Hence the significant increase in SNGFR must definitely cause an increase in clearance of various substances filtered and an improvement in renal excretory function.

References

[1] Lui PL, Gallery ED, Grigg R, Mahony JF, Gyory AZ. Renal function well preserved after uninephrectomy. J.Urol.1992 Feb 147:337-9.
[2] Argiles A, Mourad G, Basset N, Axelrud, Cavadore C, Haiech J,Moin C, Cadadore JC, Demaille JG. Acute adaptative changes to uninephrectomy in humans. Kidney Int1987, Nov.32, 714-720.
[3] Hayslett JP, 1979. Functional adaptation to reduction in renal mass. Physio Rev.59: 137-169.
[4] Olivetti G and et al 1980. Morphometry of renal corpuscle during post natal growth and compensatory hypertrophy. Kidney Int 17: 438-454.
[5] Hostetter TH, Olson JL, Rennke GH, Venkatachalam MA, Brenner BM 1981. Hyperfiltration in remnant nephrons; a potentially adverse response to renal ablation. Am J Physiology 241: F85-93.
[6] Malt R 1969. Compensatory growth of the kidney. North England Journal Med 280: 1446-1459.
[7] Klahr S, Schwab SJ, Stokes TJ 1986. Metabolic adaptation of the nephron in renal disease. Kidney Int. 29 : 80-89.
[8] Nath KA, Croatt AJ, Hostetter TH 1990. Oxygen consumption and oxidant stress in surviving nephrons. Am J Physio. 258 : F 1354-62.
[9] Fine LG 1986. The biology of renal hypertrophy. Kidney International 29 : 619.
[10] Fine LG, Hammerman MR, Abboud HE, 1992. Evolving rule of growth factors in the renal response to acute and chronic disease. J Am Soc. Nephrol 2 : 1163-70.
[11] Hammerman MR, O' Shea M, Miller SB 1993. Role of growth factors in regulation of renal growth. Annual Review Physiology 305-321.
[12] Bonsens RW,Taussky HA,Colorimetric determination of creatinine by the Jaffe's reaction.Journal Biology Chemistry 1945;981.
[13] J.K. Fawcett,J.E. Scott.A rapid and precise method for determination of urea.J clin Pathology 1960 13:156-159.
[14] Rhodes PG,Rhodes RS,Standard formula is more accurate than other methods like CG formula.Clinical Pharmacology 1987 May;6(5):399-406.
[15] Clinical nephrology – Renal hyperplasia and hypertrophy by Patricia Preisig, Pg.739.
[16] Influence of unilateral nephrectomy. Removal of one kidney resulted in a significantly increased growth of the remaining kidney during the first week after surgery. Transplantation 1990 April 49 : 686- 689.
[17] Dicker SE, Shirley DG. Mechanism of compensatory renal hypertrophy 1971. J.Physiology 219 : 507-524.
[18] Van Acker BA et al. Discreprancy between circadian rhythms of inulin and creatinine clearance. Journal of Lab Clinical Medicine 1992 Sep. 120 : 400-10.