RENAL FUNCTION AND ADAPTIVE CHANGES AFTER RADICAL OR PARTIAL NEPHRECTOMY: A SINGLE CENTRE STUDY

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ABSTRACT

OBJECTIVES

To study the renal function before partial or total nephrectomy and to study change in renal function and adaptive change in the retained kidney after partial or total nephrectomy.

Place and Duration: The prospective study of 40 patients was conducted by the Dept. of Nephrology and Dept. of Urology, Mahatma Gandhi Medical College and Hospital, Jaipur from July 2012 to July 2014

METHODS

The data for the study was obtained from all the patients undergoing nephrectomy at Mahatma Gandhi Medical College and Hospital, in the study duration. 20 patients from the donor nephrectomy group and 20 from nephrectomy group were considered. Open Nephrectomy was performed by a lumbar incision in all 40 patients. After tracheal intubation and general anaesthesia, the nephrectomy was performed through an incision under the left or right costal margin. GFR of both kidneys before surgery and of the unilateral retained kidney were determined in each subject using the Tc-99m DTPA Scans. Donors underwent the first follow-up at 1 month after surgery and then at 6 months and 1 year after surgery. The follow-up included measurements of blood pressure, urinary protein, serum creatinine, and GFR of the retained kidney by Tc-99m DTPA scan as well as volume of the retained kidney by ultrasound examination.

RESULTS

A total number of 80 patients were included in this study. In donor group female to male ratio was 4:1 and in disease group male to female ratio was 3:1. Maximum no. of patients was of age group 50-60 years in both groups, with mean age of 44.8±6.7 years in donor group and 48.7±5.5 years in disease group. In disease group majority patients who underwent nephrectomy were suffering from RCC. Th98ere was no significant effect on blood pressure, haemoglobin, blood sugar level, urine pH., urine specific gravity after nephrectomy in both groups. In both groups 24-hour urine protein increased from preoperative level to 11.3% in donor group and 17.1% in disease group after 6 month of nephrectomy. There was initial rise of serum creatinine in both donor (23.5% increase) and disease group (18.8% increase) at 1 month. After 6 month in there was decline in percentage increase of serum creatinine in both donor (15.2%) and disease group (14.3%). GFR was raised significantly at 1 month in both donor (29.4% increase) and disease (16.1% increase), but after 6 month it stabilized in both donor (31.5%) and disease (17.2%) group. Kidney volume increased significantly at 1 month in both donor (21.5% increase) and disease (13.3% increase) group and it stabilizes after 6 month in both donor (22.3%) and disease (14.8%) groups. Age has a significant effect on post nephrectomy rise of GFR. In donor group young age group (<50 yrs.), GFR increased to 35.6% at 1 month and upto 38.4% after 6 months. Old age group (>50 yrs.), GFR increased to 26.9% at 1 month and 28.2% after 6 month of donation. Gender and BMI did not have a significant effect on both the groups

CONCLUSION

After unilateral nephrectomy, the morphology, structure function, and hemodynamic parameters of the retained kidney show adaptive compensatory changes, that stabilized by 6 months. The compensatory changes included elevated GFR and ERPF in the retained kidney, increased kidney volume. Age, preoperative creatinine level, and HTN were statistically significant predictive factors affecting the change in GFR after unilateral nephrectomy. In present study showed that the compensatory change in the GFR of the remaining kidney declined with increasing age in both the younger donors and older nephrectomy groups. Although the follow-up period in this study was limited to 1 year after nephrectomy, the results reveal that even patients with normal GFR levels should be followed for more than 1 year to determine the fate of renal function after nephrectomy.

KEYWORDS

Nephrectomy, Renal Function, Renal Transplantation.

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INTRODUCTION: In the past, unilateral nephrectomy in patients with a functioning contralateral kidney was not regarded as a very major undertaking, with a view that the remaining kidney would fulfil the excretory function. As time has passed, investigative modalities have improved and functional parameters are being carefully scrutinized. It was observed that although the remaining kidney does continue to function valiantly, nevertheless, it undergoes self-mutilation in the form of glomerulo-sclerosis and interstitial injury.[1]

The deterioration of renal function after partial nephrectomy is nearly insignificant clinically. In 1-year postoperative observation, the renal function does not improve. This causes potential compensatory mechanisms to be insufficient. The surgical removal of a normal kidney elicits dramatic changes in the remaining kidney. Both size and functions, primarily glomerular filtration rate (GFR) and renal plasma flow (RPF), increase almost immediately following unilateral nephrectomy.[2]

Renal transplantation is the optimal treatment for end stage renal disease. It is associated with a lower morbidity and mortality than dialysis treatment[3] and it is also more cost effective[4] a requirement for transplantation is donation. There are two sources of renal donors; cadaveric and living donors. Despite big efforts, the source of cadaveric donors diminishes in many countries. At the same time, the number of patients treated for end stage renal disease is increasing. The increasing waiting list for cadaveric kidneys and the superior results of kidney transplantation from live donors[5,6] have brought living donor issues to the forefront of the transplantation arena, with a development of new and better surgical techniques for donor nephrectomy.

Renal function after renal surgery depends on the volume of renal parenchyma loss and improves in the postoperative period. However, the knowledge on kidney function after total and partial nephrectomy is still insufficient. This thesis examines the global renal function and compensatory hyper function of the non-operated kidney.

OBJECTIVE: To study the different response in renal function after nephrectomy of a normal kidney and to assess the adaptive changes in both of the donor and disease groups by analysing the factors affecting GFR in both groups.

PATIENTS AND METHODS: This prospective study was included patients of nephrectomy admitted in Department of Urology and Department of General surgery, Mahatma Gandhi hospital from July 2012 to July 2014. The first study group consisted of 20 patients undergoing donor nephrectomy in renal transplantation and 20 patients in nephrectomy group for a diseased kidney.

The patients were subjected to a complete pre-operative work up as per protocol i.e. history taking and general physical examination to identify any anatomical disorders or congenital anomalies. Complete blood count, urine analysis, urine for culture and sensitivity, coagulation profiles, electrolyte tests and renal function tests were conducted along with X-Ray KUB, Non-enhanced CT were performed. All indices of the retained kidney were measured pre and post donor nephrectomy using B-ultrasound. GFR of both kidneys before surgery and of the unilateral retained kidney were determined in each subject using the Tc-99m DTPA Scans.

Quantitative scans of Tc-99m DTPA uptake in the kidneys were taken using a gamma camera-based Gates method. The subject was injected intravenously with 285 MBq (5 mCi) Tc-99m DTPA, and the Gates analysis was performed 2–3 min after the tracer was injected. The exact injection dose required for quantitation was determined by measuring the syringe uptake immediately before and after injection, and a decay correction was performed from the time of injection to the time of scintigraphy. Regions of interest were assigned for each kidney and perirenal semilunar background region. All GFR values were corrected on the basis of depth and normalized correction. In this study, we used this value as the preoperative or postoperative GFR.
Patients unfit for surgery, those who did not consent for the procedure or who could not be followed up till the end of the study were be excluded from the study.

Donors underwent the first follow-up at 1 month after surgery and 6 month to 1 year after surgery. The follow-up included measurements of blood pressure, urinary protein, serum creatinine, and GFR of the retained kidney by Tc-99m DTPA scan as well as volume of the retained kidney by ultrasound examination. All data were expressed as mean values±standard errors. The significance level was set at $P<.05$. The data were analysed using SPSS17.0 statistical software package. Paired comparisons were performed using the student t test.

RESULTS: A total number of 40 patients were included in this study. In both donor and disease group 20 patients were included who underwent nephrectomy from 2012 to 2014. 80% were female and 20% were male. In the disease group total (n) 20 patients were included in which 75% were male and 25% were female. [Table 1]

Sex	Donor group	%	Disease group	%
Female	16	80	5	25
Male	4	20	15	75
Grand Total(n)	20	100	20	100

Table 1: Sex distribution in both the groups

In the donor group maximum no. of patients 8(40%) were seen in the age group of 50-60 years of age, as most of the donors were parent to the recipient, 6(30%) patients were from the age group of 40-49 years, 25% patients were of age group 30-39 years and 1(5%) patient was of age group 20-29 years. In the disease group maximum no. of patients 12(60%) were seen in age group of 50-60 years of age because of incidence of renal cell carcinoma more common in this age, 7(35%) patients were from the age group of 40-49 years, 1(5%) patient was of age group 30 - 39 years. [Table 2]

Age range(yrs)	Donor	%	Disease	%
20-29	1	5	-	-
30-39	5	25	1	5
40-49	6	30	7	35
50-60	8	40	12	60
Grand Total	**20**	**100**	**20**	**100**

Table 2: Age Distribution

Mean age in donor group was 44.8±6.7 years and in disease group 48.7±5.5 years.

In the donor group, 9 patients (45%) were of normal BMI, 7(35%) patients were borderline obese, 3(15%) patients were underweight and 1 (5%) patients was obese. In disease group maximum no. of patients 12(60%) were of normal BMI, 5(25%) patients were borderline obese, 2(10%) patients were obese and 1 (5%) patients was under weight. [Table 3] In the donor group mean BMI was 24.1± 2.5 preoperatively and in disease group mean BMI was 24.5±2.1 preoperatively.

BMI range	Donor	%	Disease	%
15-20	3	15	1	5
20-25	9	45	12	60
25-30	7	35	5	25
>30	1	5	2	10
Grand Total	20	100	20	100

Table 3: Body Mass Index

In the donor group none of the patient had hypertension pre-operatively. One month post-operatively in donor group only 1(5%) patient had hypertension. On second follow up in donor group 1 (5%) patient had hypertension. In the disease group pre-operatively 5(25%) patients were normotensive, 7(35%) patients were pre- hypertensive, and 8 (40%) patients were having hypertension. Post operatively after 1 month 7(35%) patients had pre hypertension, 6(30%) patients had hypertension. On second follow up 6(30%) patients had pre hypertension, 8(40%) patients were hypertensive. [Table 4]

Parameter	Donor Group			Disease Group		
BP(mm of hg)	PRE-OP	1 month	After 6 month	PRE-OP	1 month	After 6 month
Normal %	20(100%)	1995%	19(95%)	5(25%)	7(35%)	8(40%)
Pre hypertension%	-	1(5%)	-	7(35%)	7(35%)	6(30%)
Hypertension%	-	-	1(5%)	6(30%)	6(30%)	8(40%)
Grand Total	**20**	**20**	**20**	**20**	**20**	**20**

Table 4: Blood Pressure Changes in both groups pre and post operatively

In the donor group pre operatively all patients had normal blood glucose level and none of the patient had high blood sugar post operatively at 1 month and after 6 months of nephrectomy. In the disease group pre operatively 16(80%) patients had normal blood glucose level and 4(20%) patients had a high blood sugar >120mg/dl, these patient were discharged on oral hypoglycaemic drug. One month post operatively 4(20%) patients had high blood sugar level and after 6 months 3(15%) patients had high blood glucose level despite of oral hypoglycaemic drugs. [Table 5]

Parameter	Donor group			Disease group		
RBS RANGE (mg/dl)	Pre op	1 mth	After 6 mth	Pre op	1 mth	After 6 mth
60-120%	20(100%)	20(100%)	20(100%)	16(80%)	16(80%)	17(85%)
>120%	-	-	-	4(20%)	4(20%)	3(15%)
Grand Total	20	20	20	20	20	20

Table 5: Random Blood Sugar Levels pre and post operatively in both groups

Pre-operatively GFR of both kidneys is compared and GFR difference of more than 5 ml/min was taken as significant. In the donor group maximum 12(60%) patients have equal GFR of both kidney, 6(30%) patients had GFR of right kidney more than left and in 2(10%) patients let kidney GFR was more than right kidney. In the disease group pre operatively maximum 9(45%) patients had GFR of right kidney more than left kidney, 6(30%) patients had left kidney GFR more than right kidney, 5 (25%) patients had equal GFR. [Table 6]

GFR(ml/min)	Donor No.	%	Disease	%
R<L	2	10	6	30
R=L*	12	60	5	25
R>L*	6	30	9	45
Grand Total	20	100	20	100

Table 6: Comparison of Renographic GFR between right and left kidneys before disease in the donor group

In the donor group 18(90%) patients had left nephrectomy and 2(10%) patients had right nephrectomy. In the disease group maximum 7(35%) patients had nephrectomy for left non function kidney, 2(10%) patients for right non-functional kidney, 6(30%) patients for left renal cell carcinoma, 4(20%) patients for right renal carcinoma and 1(5%) patient for right renal vein thrombosis. [Table 7]

Indication & Side	Donor	%	Disease	%
Kidney (LT)	18	90		
Kidney (RT)	2	10		
Non- Functioning Kidney (LT)			7	35
Non- Functioning Kidney (RT)			2	10
Renal Cell Carcinoma (LT)			6	30
Renal Cell Carcinoma (RT)			4	20
Renal vein Thrombosis (RT)			1	5
Grand Total	20	100	20	100

Table 7: Indication for Surgery

In the donor group no patient had anaemia preoperatively and post operatively at 1 month and after 6 month of nephrectomy. In the disease group 5(25%) patients were anaemic post operatively and at 1 month of nephrectomy 2(10%) patients were anaemic and after 6 month of nephrectomy still 2(10%) patients were anaemic. [Table 8]

Parameter	Donor group			Disease group		
Hb(gm/dl)	Pre op	1 month	After 6 month	Pre op	1 month	After 6 month
8-10%	-	-	-	5(25%)	2(10%)	2(10%)
10-12%	11(55%)	6(30%)	8(40%)	11(55%)	13(65%)	15(75%)
12-14%	8(40%)	13(65%)	11(55%)	2(10%)	5(25%)	3(15%)
14-16%	1(5%)	1(5%)	1(5%)	2(10%)	-	-
Grand Total	20	20	20	20	20	20

Table 8: Hemoglobin level pre and post operatively in both groups

In the donor group mean urine specific gravity pre operatively, at 1 month and after 6 month of nephrectomy 1.019±0.006, 1.018±.005, 1.024±.0004 respectively. In the disease group mean urine specific gravity pre operatively, at 1 month and after 6 month of nephrectomy were 1.015 ±.006, 1.019±.005, 1.02±.007 respectively. [Table 9]. In donor group mean 24- hour urinary protein pre operatively, at 1 month and after 6 month of nephrectomy was 68.8± 6.8,75.7±11.9, 76±7.1 mg/day respectively. In disease group mean 24- hour urinary protein pre operatively, at 1 month and after 6 month of nephrectomy was 70.6±11.9, 81.8±11.6 and 84.1±13.5 mg/day respectively. [Table 10]

Parameter	Donor Group			Disease Group		
Urine sp. Gravity	Pre op	1 month	After 6 months	Pre op	1 month	After 6 months
Mean±SD	1.019±0.006	1.018 ±0.006	1.024±0.004	1.015±0.006	1.019±0.005	1.02±0.007

Table 9: Urine specific gravity pre and post operatively in both groups

Parameter	Donor Group			Disease Group		
24 hr Urinary protein(mg/day)	Pre op	1 month	After 6 months	pre op	1 month	After 6 months
Mean±SD	68.8±6.8	75.7±11.9	76±7.1	70.6±8.13	81.8±11.6	84.1±13.5

Table 10: 24 hour urinary protein pre and post operatively in both groups

In the donor group mean 24-hour urinary protein from baseline 68.6 mg/day preoperatively, increased upto 10% at 1 month and 11.3 % after 6 month of kidney donation. In the disease group mean 24-hour urinary protein from baseline 70.6 mg/day preoperatively, increased upto 15.8% at 1 month and 17.1 % after 6 month of nephrectomy. [Table 11]., in the donor group mean 24-hour urinary protein from baseline 68.6 mg/day preoperatively, increased upto 10% at 1 month and 11.3 % after 6 month of kidney donation. In the disease group mean 24-hour urinary protein from baseline 70.6 mg/day preoperatively, increased upto 15.8% at 1 month and 17.1% after 6 month of nephrectomy.

Parameter	Donor Group			Disease Group		
24 hr Urinary protein (mg/day)	Pre-op	1 month	After 6 month	Pre-op	1 month	After 6 month
% increase	68.8 mg/dl	10%	11.3%	70.6 mg/dl	15.8%	17.1%

Table 11: 24 hour urinary protein pre and post operatively in both groups

In the study, in donor group mean serum creatinine pre operatively was 0.85±0.12mg/dl, at 1 month of donation 1.05±0.14 (p<.001) mg/dl and after 6 month of donation 0.98±0.17 (p<.001) mg/dl. In disease group mean serum creatinine pre operatively was 1.05±0.2mg/dl, at 1 month of nephrectomy 1.02±0.15 (p<.001) mg/dl and after 6 month 1.01 ± 0.09(p<.001) mg/dl. [Table 12] In the donor group preoperative mean sr. creatinine was 0.78 mg/dl it increased up to 23.5% at 1 month of donation and it remained up to 15.2% of preoperative serum creatinine after nephrectomy. In the disease group from preoperative mean sr. creatinine 1.01mg/dl it increased up to 18.8% at 1 month and after 6 month of nephrectomy it remained up to 14.3% of preoperative serum creatinine.

Parameter	Donor Group			Disease Group		
sr. creatinine (mg/dl)	Pre op	1 month	After 6 months	pre op	1 month	After 6 months
Mean±SD	0.85±0.12	1.05±0.14	0.98±0.17	1.01±0.2	1.21±0.15	1.14±0.09
p value		<.001	<.001		<.001	<.001

Table 12: Mean serum creatinine pre and post operatively in both groups

In our study the mean GFR measured by DTPA scan in donor group pre operatively was 49.33±4.39 ml/min, at 1 month and after 6 month of kidney donation it was 64.69± 4.85 (p<.001)ml/min and 66.23±5.03 (p<.001)ml/min respectively. In disease group mean GFR measured pre operatively was 54.94 ± 8.25 ml/min, at 1 month and after 6 month of nephrectomy it was 63.78±6.14 (p<.001)ml/min and 63.88±5.81 (p<.001)ml/min respectively.[Table 13]. In the donor group preoperative mean GFR was 49.33±4.39 ml/min which increased upto 29.4 % at 1 month of donation and 31.5% after 6 month of donation. In the disease group preoperative mean GFR was 54.94±8.25 ml/min, which increased upto 16.1% at 1 month of nephrectomy it and 17.2% after 6 month of nephrectomy.

Parameter	Donor Group			Disease Group		
DTPA ScanGFR(ml/min)	Pre op	1 month	After 6 months	Pre op	1 month	After 6 months
Mean±SD	49.33±4.39	64.69±4.85	66.23±5.03	54.94±8.25	63.78±6.14	63.88±5.81
P value		<.001	<.001		<.001	<.001

Table 13: Mean GFR by DTPA scan pre and post operatively in both groups

In present study, in donor group USG measured preoperative mean kidney volume was 115.3 cm3 which increased upto 21.5% at 1 month and after 6 month of post donation it increased upto 22.3%. In disease group USG measures preoperative kidney mean volume was 124.8 cm3 which increased upto 13.3% at 1 month and after 6 month of nephrectomy it increased upto 14.8%.[Table 14]. In the donor group USG measured preoperative mean kidney volume was 115.3 cm3 which increased upto 21.5% at 1 month and after 6 month of post donation it increased upto 22.3%. In the disease group USG measures preoperative kidney mean volume was 124.8 cm3 which increased upto 13.3% at 1 month and after 6 month of nephrectomy it increased upto 14.8%.

Parameter	Donor Group		Disease Group	
USG Kidney size	1 month	After 6 month	1 month	After 6 month
% increase	21.5%	22.3%	13.3%	14.8%

Table 14: USG volume of retained kidney pre and post operatively in both groups

In the donor group 12 patients were of below 50 years of age, their GFR increased to 35.6% at 1 month and upto 38.4% after 6 month, 8 patients were of age more than 50 years and there GFR increased to 26.9% at 1 month and 28.2% after 6 month of donation. In disease group 9 patients were of below 50 years of age, their GFR increased to 11.9% at 1 month and upto 14.1% after 6 month. 11 patients were of age more than 50 years and there GFR increased to 8.6% at 1 month and upto 10.1% after 6 month of nephrectomy. In d present study, in donor group 12 patients were below age of 50 years and there serum creatinine pre-operative was 0.8±0.12 mg/dl which changed to 1±0.12 mg/dl (25% increase) at 1 month and 0.91±0.09mg/dl (13.75% increase) after 6 month postoperatively.

Number of patients above age of 50 years were 8 and there serum creatinine pre-operative was 0.92±0.11 mg/dl which changed to 1.1±0.16 mg/dl (22% increase) at 1 month and 1.14±0.11 mg/dl (24% increase) after 6 month postoperatively.

In present study, in donor group no. of female patients were 16 and there GFR increased upto 31% at 1 month and 33.4% after 6 month, no. of Male patients were 4 and there GFR increased upto 33.2% at 1 month and 35.5% after 6 month of donation.

In present study, in donor group no. of patients with BMI <25 were 12 and there preoperative mean GFR was 48.1±3.7 ml/min which changed to 64.2± 5.3 (33.4% increase) and 66.5± 5.6 ml/min (36%increase) at 1 month and after 6 month of kidney donation.

Number of patients with BMI>25 were 8 and there preoperative mean GFR was 49.7±4.5 ml/min which changed to 63.9±4.4 (31.8% increase) and 65.9±4.4ml/min(35.5% increase) at 1 month and after 6 month after kidney donation.

DISCUSSION: To identify factors determining the risk of renal failure after unilateral nephrectomy, it is necessary to correctly estimate the individual function of each of the kidneys before and after surgery. In a previous study, the GFR of each kidney in binephric individuals was expressed as half of the corresponding two-kidney value.[7,8] However, this method does not accurately reflect the individual function of each of the kidneys because creatinine clearance determines the total GFR rather than the individual kidney function. On the other hand, the Tc-99m DTPA scan has been validated and accepted as a method for determining the GFR as a measure of both the overall renal function and the individual function of each of the kidneys.

A number of western studies have reviewed the changes in renal function and blood pressure post-nephrectomy. There is no data on Indian donors in literature. It is

documented that Indians differ in presentation and progression of diseases from their Western counterparts. Given this unique genetic background, ethnicity and environmental factors, there is every reason to believe that the effects of nephrectomy could be different in Indians as compared to what is reported from the west.

Gjertson DW et al[9] in 2000 did one of the largest series in the United States, wives as renal donors were twice as common compared with husbands. Higher incidence of kidney disease in men, fear of losing the earning male member, and perception of renal donation as an extension of responsibility toward family in females have been suggested as reasons for female preponderance among living donors. In our study in donor group, female contributed about 80% of the kidney donation group. 55% of the kidney donation was mother and wives. This trend is also evident in data from other centers in India. In nephrectomy group majority of cases were male (75%) who had to undergo nephrectomy. As non-functioning kidney and RCC were main reason for nephrectomy, in which NFK was mainly due to Nephrolithiasis and various studies showed same epidemiology as found in our study.

Turun Song et al[10] studied 55 live donors and mean age of 48.24±8.14 and age range 40-80 yrs. Artur A. Antoniewicz et al[2] studied 51 patients with mean age 62.2 and age range 45-75 years who underwent nephrectomy for RCC. In our study, in donor group maximum no. of cases (40%) was in age range 50-60 years with mean age 44.8± 6.7 years. As majority of the kidney donors in our study were parents. In Nephrectomy group majority of cases (60%) were in age range of 50-60 years with mean age of 48.7± 5.5 years. This is due to higher incidence of RCC in older age group.

A.B. Ochwila et al[11] studied renal function of 52 living kidney donors with mean BMI of 23.6 ± 4.13 and BMI ranging from 17.4 to 34.9. Hye Ok Kim et al[12] studied factors affecting changes in the glomerular filtration rate after unilateral nephrectomy in living kidney donors and patients with renal disease. In this study mean BMI in donor group was 24.1±3.5 and in nephrectomy group 24.3±3.4. In our study mean BMI in donor group was 24.1±. In our study mean BMI in disease group was 24.5±2.1.

Glazier et al[13] in 1997 reported a 12 years' experience with 347 nephrectomy and found renal tumours is the most frequent condition requiring nephrectomy. Bertram et al[14] in 2013 published the historical series of 20 years with 646 consecutive nephrectomy performed between1978-1997. Of these 209 (33% of total) nephrectomy were performed for benign conditions and malignant disease led to operation in 437 cases (67.7%). In our study in disease group 50% of nephrectomy were done for malignant condition and 45% nephrectomy were done for benign condition (NFK). Our results are similar with that of other studies.

Z. Chen et al[15] in 2012 did a study on 136 live donors who were studied for compensatory changes in the retained kidney after nephrectomy. Follow up study was done after 1 month and 1 year. Hye Ok Kim et al[12] in 2010 did his first study 13.7±3.1 days (range: 1 to 174 days) before nephrectomy for the donor nephrectomy group and 16.7±1.7 days (range: 1 to 54 days) before nephrectomy for the disease nephrectomy group. The second study was performed 6.7±0.2 months (range:5 to 13 months) after surgery for the donor nephrectomy group and 7.9±0.52 months (range: 3 to 18 months). In our study donor group second follow up study was done at 8.05±1.2 months (6-12months) and in nephrectomy group at 7.65±1.06 months (6-12months).

In a meta-analysis by Kasiske et al[16] in 1995 found that there was no increase in BP in 3100 nephrectomized patients. TJ. Watnick et al[17] found that prevalence of hypertension in donors was significantly increased. Donor nephrectomy is associated with hyper filtration in the remnant kidney and one of the markers of hyper filtration damage is systemic hypertension. It is logical to presume that donors may have a slight rise in BP post -nephrectomy. On the other hand it is an established fact that the kidney has an enormous functional reserve and loss of upto 50% nephron mass does not have any ill effects. The studies on post nephrectomy increase in blood pressure have also not shown consistent results. In our study one patient developed pre-hypertension at 1 month and the same patient was hypertensive after 6 month of follow up and there was no significant change in mean systolic B.P (117.1±6.2 vs 118.9±7.1mm of hg) and mean diastolic B.P(77.5±4.4 vs 78.6±4.5 mm of hg) pre and post operatively. No significant change in mean systolic (135.3±11.6 vs 136±11.4 mm of hg) and mean diastolic B.P (84.6±4.6 vs 83.7±3.9 mm of hg) pre and post operatively.

Hassan N. Ibrahim et al[18] in 2009 studied 3698 donor he found no significant change in mean RBS. Preoperatively RBS was 90.9±9.8mg/dl and post operatively it was 100.6±25.9mg/dl with p value <.001. In our study, in donor group, preoperatively none had high blood glucose level and which remained unchanged after nephrectomy at 1 month and after 6 month. In the nephrectomy group 20% cases were diabetic and took hypoglycaemic drug before surgery and after nephrectomy, after 6 months 3 had blood glucose >120mg/dl.

D. Andualem et al[19] in 2012 founded 46(63%) patients underwent nephrectomy for benign conditions, which is comparable with the series reported from developing countries like Pakistan, India, Jordan and Saudi Arabia. Most of his patients had non-functioning kidney secondary to obstruction due to stone disease. In our study, in donor group, right kidney GFR was more then left in 45% cases, less than left in 30% cases and equal in 25% cases. In the nephrectomy group 45% cases underwent surgery for non-functional kidney, 50% cases for renal cell carcinoma and 5% cases for renal vein thrombosis.

Bertram L. and Kasiske et al[14,16] in 2013 did a Prospective, controlled, observational cohort study and compared donor with control group(eligible to donate kidney) and found that donor group had 3.7% less haemoglobin then the control after 6 month of nephrectomy. In our study there was no significant change in mean Hb. level pre and post operatively in both groups. There was no

significant change in urinary and specific gravity pre and post operatively in both groups.

Three studies D'Almeida et al,[20] Williams et al[21] and Mathillas et al[22] compared a total of 129 donors to 59 controls on 24-h urine protein, to determine if increases in proteinuria after donation were possibly attributable to normal aging. Proteinuria appeared to be increased after donation in each of these three studies, although the confidence interval (CIs) was wide. The 24-h urine protein was higher in donors compared to controls an average of 11 years after donation (controls 83 mg/day, donors 147 mg/day, weighted mean difference 66 mg/day, and 95% CI 24-108). This difference increased with the time from donation (P<0.001).In our study, the increase in 24 hour urinary protein is more in disease group as compared to donor can be attributed to older age and pre-existing comorbidities.

Z. Chen et al[15] in 2012 studied 136 living related kidney donors underwent assessments before surgery as well as at 1 and 12 months, postoperatively the donors GFR was 59.00±19.55 ml/min at 1 month after surgery; it was 48.10±14.03 ml/min before surgery. The 22% average increase was significant (P<.01). The GFR at 1 year after surgery was 59.42±16.06 ml/min versus 48.10±14.03ml/min, 23.5% average increase which was significant (P <.01). The GFR values were not significantly different at 1 and 12 months after surgery (P>.01). Hye Ok Kim et al[12] in 2010 studied GFR and factors affecting changes in the postoperative glomerular filtration rate (GFR) after unilateral nephrectomy in living kidney donors and patients with renal disease. The mean change in GFR was significantly greater in the donor nephrectomy group than in the disease nephrectomy group (11.1±8.5 ml/min vs. 5.6±7.2ml/min, p<0.05). The mean change in GFR was significantly greater in the donor nephrectomy group than in the disease nephrectomy group (11.1±8.5ml/min vs. 5.6±7.2ml/min, p<0.05).In his study the disease nephrectomy group showed fewer compensatory changes in GFR than the donor nephrectomy group. This effect was attributed to the higher number of older patients in the disease nephrectomy group. Further, a compensatory reaction may have already occurred in the contralateral kidney before nephrectomy. In this study, patients exhibited a compensatory change in GFR in the remaining kidney after nephrectomy. However, the compensatory hyperfunction declined with increasing age in both the donor nephrectomy and disease nephrectomy groups. Yoshinori Shirasaki et al[23] in 2004 found that the mean preoperative MAG3 clearance of the remaining kidney of the 30 patients was 155.4ml/min/1.73m2. The mean MAG3 clearance of the remaining kidney had increased to 209.2ml/min/1.73 m2 by 1 month after nephrectomy, and the average percentage increase was 39.5%. After 1 year, it had increased to 211.3 ml/min/1.73 m2, with a 40.5% average percentage increase.

SimonaBen-Haim et al[24] in 1999 studied 30 consecutive patients (18 men, 12 women; average age, 67y) who were undergoing unilateral radical nephrectomy were evaluated by sequential quantitative 99mTc-dimercaptosucciancicid (DMSA) SPECT (QDMSA) studies. The first study was done before surgery. Follow-up studies were performed 2-23 months after surgery. The relative function of the remaining kidney increased from 56.8%±7.1% to 79.1%±23.6% (t= 4.9; P<0.0001) of the global renal function before nephrectomy. He concluded that adaptive changes occur soon after surgery; persist for at least 1 year. In our study, in donor group mean GFR pre operatively was 49.33±4.39ml/min, it increased after 1 month of kidney donation to mean GFR 64.69±4.85 ml/min (p<.001, 29.4% increase), after 6 month it was 66.23±5.03 ml/min (p<.001, 31.5% increase) with no significant difference between 1month and after 6 month (p>.005). As shown by the data GFR increases initially till 1 month and then tends to stabilize over time. Our results are similar with that of other studies.

Z. Chen et al[15] in 2012 found that the length, width, and short diameters of 136 retained kidneys were measured using colour Doppler ultrasound, showing approximately 6% increases at postoperative 1 month compared with the presurgical values, a significant difference. The length, width, and short diameter of each retained kidney at postoperative months 1 and 12 were similar, indicating that the compensatory hypertrophy had stabilized within 1 month and did not increase with time. Funahashi et al[25] observed a change in retained kidney size after unilateral nephrectomy, reporting that renal hypertrophy that occurred within 1 week after surgery stabilized after 6 months or later. In the present study, in donor group pre operatively USG measured mean kidney volume was 115.3±13.2cm3, at 1 month it increased to 140.2±13.7cm3 (p<.001, 21.5% increase) and increased after 6 month post donation upto 141.5±13.6 cm3 (p<.001, 22.3% increase). The change in volume of retained kidney at 1 month and after 6 month were not significant post operatively (140.2±13.7cm3 vs 141.5±13.6, p >.005).

In disease group pre operatively USG measured mean kidney volume was 124.8±17.7 cm3, at 1 month it increased up to 142.8±18.3 cm3(p<.001,13.3% increase) and after 6 months it increased upto 143.8±18.4cm3 (p<.001, 14.8% increase). Change in mean kidney volume at 1 month and after 6 months was not significant (142.8±18.3 vs 143.8± 18.4cm3, p>.005), but the percentage increase in volume was less than that of donor group (22.3%vs13.3%), that is due to the fact that renal hypertrophy and hyperplasia occurred prior to surgery in the disease group.

Hye Ok Kim et al[12] in 2010 did a regression analysis of his data and which shows that at the time of nephrectomy, the compensatory change in the GFR of the remaining kidney is less in older subjects. GFR estimated that for a 55-year-old individual undergoing nephrectomy, the change in GFR will be about 9 ml/min less than that for a 25-year-old individual after unilateral nephrectomy. Lindeman RD et al [26] stated that in the general population, the GFR decreases with age and begins to fall at the age of 40. After 50 years of age, the GFR declines more rapidly. The decline in GFR between the age of 35 and 55 years is approximately 1 ml/(min/year), and it accelerates to approximately 1.4

ml/(min/year) beyond 55 years of age. So it is evident from data that there is age related decline in the GFR in both groups which is similar to the other studies.

CONCLUSION: After unilateral nephrectomy, the morphology, structure function, and hemodynamic parameters of the retained kidney show adaptive compensatory changes, that stabilized by 6 months. The compensatory changes included elevated GFR and ERPF in the retained kidney, increased kidney volume. Age, preoperative creatinine level, and HTN were statistically significant predictive factors affecting the change in GFR after unilateral nephrectomy. In present study showed that the compensatory change in the GFR of the remaining kidney declined with increasing age in both the younger donors and older nephrectomy groups. Although the follow-up period in this study was limited to 1 year after nephrectomy, the results reveal that even patients with normal GFR levels should be followed for more than 1 year to determine the fate of renal function after nephrectomy.

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