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Research Article

The Incidence And Risk Factors Of Chronic Kidney Disease After Tumor (Radical/Partial) And Simple Nephrectomy - A Retrospective Observational Study.

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Abstract

Introduction : Nephrectomy inevitably reduces the functional renal parenchyma, resulting in loss of renal function[1]. Nephrons decrease with the nephrectomy procedure, and it leads to a decline in eGFR values. eGFR < 60 is associated with increased cardiovascular events, death, and hospitalization [3,4]. Under these circumstances, it is important for the preservation of renal function not only in healthy subjects but also in populations at risk. Patients who underwent tumor nephrectomy had a higher incidence of CKD compared to patients who underwent simple nephrectomy [1,5,6]. We designed a study to compare the incidence rate of CKD between tumor nephrectomy patients and simple nephrectomy patients and to evaluate predictive factors of CKD. Our objective is to compare the incidence of CKD in patients of radical, partial, and simple nephrectomy.

Material And Methods : We retrospectively examined the patients who underwent RN (n-57), PN(n-10), and simple nephrectomy (n-17) between January 2019 to June 2023. All operations are performed by an expert surgeon. Demographic profile age, sex, laterality, comorbidity (hypertension, diabetes), addiction (smoking, alcohol), and preoperative proteinuria were collected. Serum creatinine results within one week, one month, three months, and six months postoperative follow-up were collected. Patients with eGFR above 60 were included in the study. Those who had an abnormal renal function before surgery or were lost to follow-up were excluded.

Discussion : Radical nephrectomy is an independent risk factor for the development of CKD, so the preservation of a maximum renal reserve should be pursued in case of partial nephrectomy. Age is a prognostic factor for CKD development. The major reason is that as age increases, nephron atrophy occurs and eGFR decreases. HTN and DM have been identified as predictors of renal impairment in individuals undergoing nephrectomy. Tumour size and preoperative proteinuria are risk factors for CKD development. According to our study, gender, BMI, laterality, and smoking are not prognostic factors for CKD.

Conclusion : Age, Co-morbidity, pre-operative proteinuria, type of surgery, immediate postoperative eGFR value, and tumor size are useful predictors of developing CKD after surgery. Therefore, More attention should be given to patients with decreased renal function during postoperative follow-up. PN should be strongly considered for the prevention of postoperative CKD.

Keywords: CKD, radical nephrectomy, simple nephrectomy.

BACKGROUND

Nephrectomy inevitably reduces the functional renal parenchyma, resulting in loss of renal function[1]. Renal cell carcinoma (RCC) is one of the most fatal diseases in urology. It constitutes 3% of adult cancers and is the third most common urological malignancy[2]. Stage of the disease, tumour size, and comorbidities are the most important factors influencing the choice of treatment, radical nephrectomy (RN) or partial nephrectomy (PN). Nephrons decrease with the nephrectomy procedure, and it leads to a decline in eGFR values. eGFR < 60 is associated with increased cardiovascular events, death, and hospitalisation [3,4]. Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function, present for > 3 months, and it is classified based on GFR category. Stage 1 is normal when the eGFR value is≥ 90 ml/min/1.73m^2. Stage 2 means eGFR value between 60ml/min/1.73m^2 and 89ml/min/1.73m^2, Stage 3 is 30 ml/min/1.73m^2 and 59ml/min/1.73m^2, and Stage 4 indicates 15 ml/min/1.73m^2 and 29ml/min/1.73m^2. Patients with < 15 ml/min/1.73 m^2 eGFR are accepted end-stage kidney disease [5]. CKD has a high global prevalence of approximately 11–13%, with stage 3 being the most prevalent. The first impaired stage of the estimated glomerular filtration rate (eGFR) is defined as less than 90

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ml/min/1.73m^2 [6]. Simple Nephrectomy has traditionally been assumed to have few adverse consequences, based on favorable outcomes[6]. Because patients who develop RCC are more likely to be older and have a greater number of comorbidities compared with benign disease,[8] patients who underwent tumor nephrectomy had a higher incidence of CKD compared to patients who underwent simple nephrectomy[1,5,6]. Observing and recording changes in patients' eGFR after nephrectomy is crucial, and early measures should be taken to prevent CKD. Moreover, these findings can help improve our understanding of the changes in renal function in patients after surgery and explore the indicators related to the progression of renal function impairment. We designed a study to compare the incidence rate of CKD between tumor nephrectomy patients and simple nephrectomy patients and to evaluate predictive factors of CKD. Our objective is to compare the incidence of CKD in patients of radical, partial, and simple nephrectomy.

MATERIAL AND METHOD

We retrospectively examined the patients who underwent RN, PN, and simple nephrectomy between January 2019 to June 2023. All operations are performed by an expert surgeon. Demographic profile age, sex, laterality, comorbidity (hypertension, diabetes) addiction (smoking, alcohol)were collected. Preoperative proteinuria was assessed according to urinalysis. Preoperative and postoperative eGFR were calculated using the abbreviated Modification of Diet in Renal Disease (MDRD) equation recommended in the K/DOQI guideline [7]. Serum creatinine one week, one month, three months, and six months postoperative follow-up were collected. chronic kidney dysfunction was defined as a eGFR of <60ml/min/1.73m^2 for more than 6 months.

Inclusion and exclusion criteria

All patients >18 years with a preoperative eGFR value of above 60 ml/min/1.73m^2 who underwent partial/radical/simple nephrectomy were included in the study. Patients who had been diagnosed with CKD preoperatively, patients with unknown eGFR, Incomplete clinical records, and those who had preoperative metastatic disease were excluded from the study.

Statistical method

Statistical analysis was done by using descriptive and inferential statistics using Chisquare test and Student's paired and unpaired t test and software used in the analysis were SPSS 27.0 version and GraphPad Prism 7.0 version and p<0.05 is considered as level of significance(p<0.05).

Ethical

Ethical approval was granted by the Father Muller Institutional Ethics Committee (ref no.-FMIEC/CCM/304/2024).

RESULT

A total of 84 patients were enrolled in our study group. CKD developed in 25 patients (eGFR < 60), and postoperative eGFR was above 60 in 59 patients. Among these, 10 patients underwent PN, 57 patients underwent RN due to RCC, and 17 patients underwent simple nephrectomy due to a non-functioning kidney during the period, and fulfilled the inclusion criteria. The demographics and clinical characteristics of the study participants are given in **Table 1**. The mean age of the CKD group was 61.64 ± 9.52, and the non-CKD group was 51.25 ± 13.42 (p < 0.0001). In both groups, male preponderance was observed, 16(64%) in the CKD group and 34(57.63%) in non non-CKD group. There is no statistically significant difference between the groups according to gender (p = 0.58). The most affected side of the kidney was the right in the CKD group 13 (52%) and left in non non-CKD group 32 (54.24%). there was statistically significant fall in GFR in patients with co-morbidity(HTN,DM,IHD)(p=0.0018).There was no significant difference with respect to addiction (p = 0.07).

Table 1. Distribution of CKD patients according to their demographic characteristics

	CKD(n=25)	No CKD(n=59)	Total(n=84)	p-value
Age in years	61.64±9.52	51.25±13.42	54.34±13.22	12.29 p=0.0001,S
Range	42-78 yrs	20-80 yrs	20-80 yrs	
Gender				
Male	16(64%)	34(57.63%)	50(59.52%)	0.29 p=0.58,NS
Female	9(36%)	25(42.37%)	34(40.48%)	
Co-morbidity				
DM	7(28%)	7(11.86%)	14(16.67%)	10.08 p=0.018,S
HTN	9(36%)	12(20.34%)	21(25%)	
IHD	4(16%)	1(1.69%)	5(5.95%)	
Not Any	14(56%)	46(77.97%)	60(71.43%)	
Additions				

Alcohol	2(8%)	2(3.39%)	4(4.76%)	5.13 p=0.07,NS
Smoking	3(12%)	1(1.69%)	4(4.76%)	
Not Any	20(80%)	56(94.92%)	76(90.48%)	
Laterality				
Right Side	13(52%)	27(45.76%)	40(47.62%)	0.27 p=0.70,NS
Left Side	12(48%)	32(54.24%)	44(52.38%)	

preoperative proteinuria present in 7(28%) of CKD group patients which was statistically significant (p=0.0001)

Table 2. Distribution of CKD patients according to Proteinuria

Proteinurea	CKD(n=25)	No CKD(n=59)	Total(n=84)	p-value
Present	7(28%)	0(0%)	7(8.33%)	18.02 p=0.0001,S
Absent	18(72%)	59(100%)	77(91.67%)	
Total	25(100%)	59(100%)	84(100%)	

The mean tumour size was 7.3 ± 3.3 cm in the CKD group and 3.57 ± 3.1 cm in the non-CKD group. Which is statistically significantly lower in the non-CKD group (p = 0.0001)

Table 3. Distribution of CKD patients according to preoperative and postoperative eGFR

eGFR	Preoperative	Postoperative	Total
CKD			
≤60	0(0%)	25(100%)	25(100%)
>60	25(100%)	0(0%)	25(100%)
No CKD			
≤60	0(0%)	0(0%)	0(0%)
>60	59(100%)	59(100%)	118(100%)

In our study, we found that age, co-morbidity (HTN, DM), preoperative proteinuria, type of surgery (RN), and tumor size were found to be predictors for the development of CKD.

Table 4. Distribution of CKD patients according to Tumor Size(cm)

Tumor Size(cm)	CKD(n=25)	No CKD(n=59)	Total(n=84)	p-value
0-3 cm	4(16%)	28(47.46%)	32(38.10%)	20.84 p=0.0001,S
3.1 to 6 cm	5(20%)	21(35.59%)	26(30.95%)	
6.1 to 9 cm	9(36%)	8(13.56%)	17(20.24%)	
9.1 to 12 cm	5(20%)	2(3.39%)	7(8.33%)	
12.1 to 15 cm	2(8%)	0(0%)	2(2.38%)	
Total	25(100%)	59(100%)	84(100%)	
Mean ±SD	7.30±3.37	3.57±3	4.68±3.54	

This study included 56(66.67%) cases of clear cell carcinoma, 7(8.33%) cases of papillary cell carcinoma, 3(3.57%) cases of chromophobe cell carcinoma, 1 (1.19%) case of sarcomatoid, and 17(20.24%) cases of other pathology types. In our study, we compare CKD and non-CKD patients with respect to Tumor size and tumor biopsy in patients who underwent radical and partial nephrectomy.

Table 5. Distribution of CKD patients according to Procedure

Procedure	CKD(n=25)	No CKD(n=59)	Total(n=84)	p-value
Partial Nephrectomy	1(4%)	9(15.25%)	10(11.90%)	13.02 p=0.001,S
Radical Nephrectomy	23(92%)	33(55.93%)	57(67.86%)	
Simple Nephrectomy	1(4%)	16(27.12%)	17(20.24%)	
Total	25(100%)	59(100%)	84(100%)	

Our CKD rates were 1/10 (4%)in PN, 23/57 (96%) in RN, and 1/17(4%) in simple nephrectomy according to the type of surgery. CKD rate was statistically significantly higher in patients with radical nephrectomy (p = 0.001).

Graph 1. Distribution of CKD patients according to Procedure.

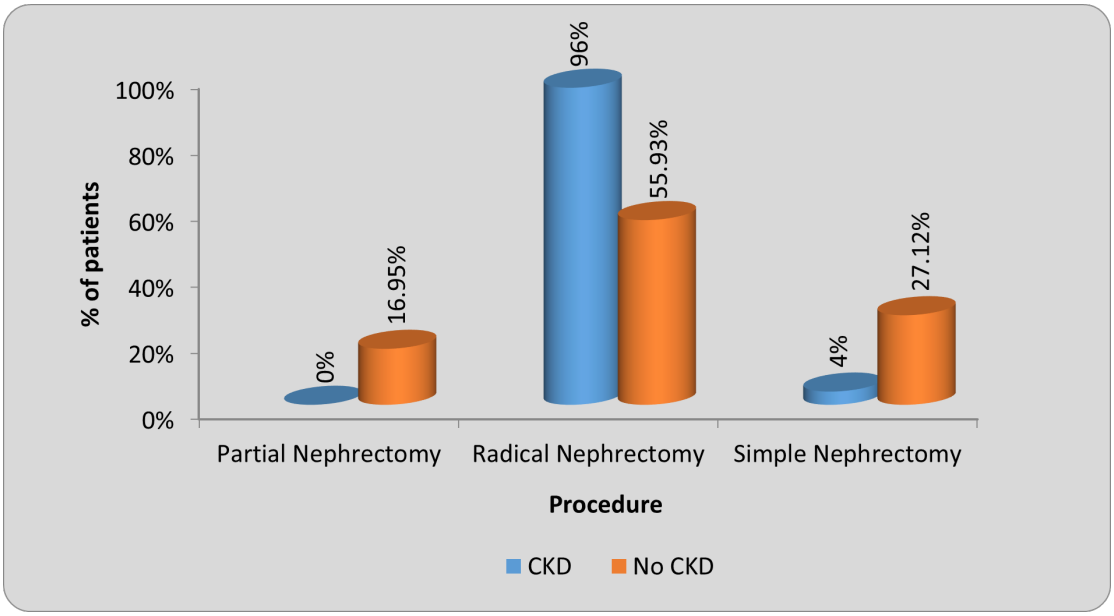


Table 6. Distribution of CKD patients according to Biopsy

Biopsy	CKD(n=25)	No CKD(n=59)	Total(n=84)	p-value
Chromophobe	2(8%)	1(1.69%)	3(3.57%)	10.70 p=0.030,S
Clear Cell	20(80%)	36(61.02%)	56(66.67%)	
Papillary	1(4%)	6(10.17%)	7(8.33%)	
Sarcamatoid	1(4%)	0(0%)	1(1.19%)	
Not Any	1(4%)	16(27.12%)	17(20.24%)	
Total	25(100%)	59(100%)	84(100%)	

Patients were followed up for 6 months. A total of 25 patients developed postoperative CKD. We found that the mean rate of creatinine of patients who develop CKD is 1.66±0.35 at 1 month,1.61±0.28 at 3 months, and 1.63±0.28at 6 months. A total of 30 patients were found to have raised creatinine at the first follow-up visit (1 month after surgery). We found out that in around 5 patients, Gradual improvement in renal function was observed.

Table 7. Comparison of Serum Creatinine level at baseline, week 1, 1 month, 3 months, and 6 months in two groups (Student's unpaired t-test)

Time Period	CKD	No CKD	t-value	p-value
Baseline	1.08±0.21	0.93±0.23	2.64	0.010, S
Week 1	1.50±0.29	1.01±0.30	6.91	0.0001, S
1 month	1.66±0.35	1±0.29	8.77	0.0001, S
3 months	1.61±0.28	1.01±0.33	7.80	0.0001, S
6 months	1.63±0.28	1.01±0.30	8.59	0.0001, S

Graph 2. Comparison of Serum Creatinine levels at baseline, week 1, 1 month, 3 months, and 6 months in two groups

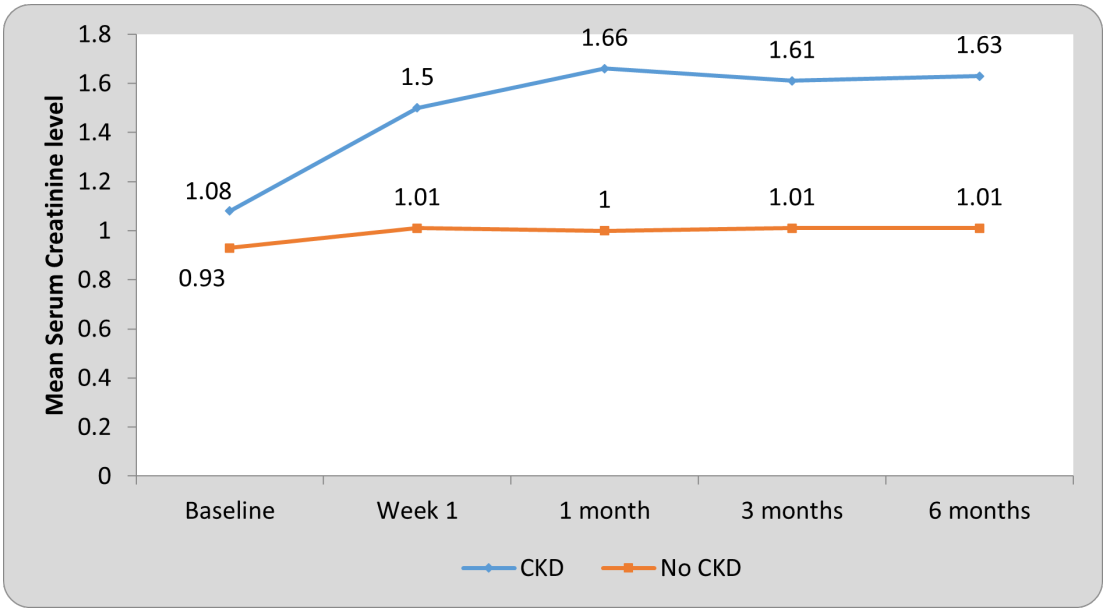


Table 8. Comparison of Serum Creatinine levels at week 1, 1 month, 3 months, and 6 months with baseline in two groups (Student's paired t-test)

Time Period	CKD	t-value	No CKD	t-value
Baseline	1.08±0.21	-	0.93±0.23	-
Week 1	1.50±0.29	7.96,p=0.0001,S	1.01±0.30	2.37,p=0.006,S
1 month	1.66±0.35	7.56,p=0.0001,S	1±0.29	2.00,p=0.049,S
3 months	1.61±0.28	8.61,p=0.0001,S	1.01±0.33	2.36,p=0.029,S
6 months	1.63±0.28	8.12,p=0.0001,S	1.01±0.30	2.44,p=0.017,S

17 of these 25 patients' eGFR values were above 50 ml/min/1.73m^2 when CKD was observed during the 6 months of follow-up, and only 8 patients' eGFR dropped to the level of 40-50 ml/min/1.73m^2. 59 patients with >60 ml/min/1.73m^2 at 6 months of follow-up. Gradual improvement in eGFR value was observed in 5 patients.

DISCUSSION

The likelihood of a decline in kidney function after kidney surgery is an important consideration when treating patients. Ideally, nephrectomy should not cause CKD if the contralateral kidney is well preserved, since the good renal function can be maintained by the remaining kidney. Over time, kidney function will deteriorate due to underlying chronic disease[6]. Following unilateral nephrectomy, some adaptation mechanisms, such as hyperfiltration and hypertrophy, take place.

In our study, we found that older age is an independent risk factor for developing CKD. There are studies that show that age is an important determinant for the development of CKD[8,9].

We believe that the main cause is nephron atrophy and a decline in eGFR with age. Our study indicates that BMI is not a predictor of CKD. In contrast, Reinstatler et al. discovered a correlation between BMI and a postoperative deterioration in kidney function [10,11].

HTN and DM have been identified as predictors of renal impairment in individuals undergoing nephrectomy. Satasivam et al.found that patients with HTN and DM had a significantly higher percentage of reduction in postoperative GFR[12]. A study by Ito et al. identified HTN, DM, and proteinuria as significant predictors of long-term renal impairment [13]. In our study, we found out that patients with a history of HTN, DM are more prone to decline in renal function after unilateral nephrectomy.

In our study, we found out that preoperative proteinuria is predictive factor for CKD development. Similarly, another study showed that preoperative proteinuria is related to poor postoperative renal function [14]. Takagi et al. found there is no relationship between proteinuria with postoperative deterioration in renal function [15].

Tumour size and location are the important factors when deciding on the type of surgery. As per recent guidelines, partial nephrectomy is a standard treatment in patients with less than 4 cm tumor size [16,17]. Lane et al. showed that tumour size predicts postoperative eGFR after surgery [18]. Conversely,

Kong et al.found that tumour size is not a clinical factor for CKD development. We found a statistically significant difference in tumour size between groups ($p < 0.0001$, significant).

In our study, Patients were followed up for 6 months. A total of 25 patients developed postoperative CKD. We found that the mean rate of creatinine of patients who develop CKD is 1.66±0.35 at 1 month,1.61±0.28 at 3 months, and 1.63±0.28at 6 months. A total of 30 patients were found to have raised creatinine at the first follow-up visit (1 month after surgery). We found out that in around 5 patients, Gradual improvement in renal function was observed. In a recent study, it was shown that renal functions are not stable immediately post operative which were recover with time after stabilizing acute changes in renal function. We evaluated the eGFR values at the end of 6 months. In this study, we included patients with preoperative eGFR > 60; other studies, also shown that lower preoperative eGFR is a predictor for CKD [18,19]. This study shows that a fall in GFR was statistically significant after RN.

Partial nephrectomy is the mainstay of treatment of small renal masses with similar oncological outcome [20,21]. The main superiority of partial nephrectomy over radical nephrectomy is preservation of renal function [22]. In our study, it was found that patients who underwent radical nephrectomy had higher CKD rates and risk factors for CKD development. Other studies demonstrate that partial nephrectomy reduces CKD rates and postoperative complications in comparison with radical nephrectomy [23]. It should be considered that the type of surgery affects the probability of CKD, so preservation of a maximum renal reserve should be pursued.

Development of CKD related to Cardiovascular problems, hospitalization, and death [24]. Therefore, it is important to analyse risk factors responsible for CKD following nephrectomy. This allows the clinician to identify those patients who would benefit from early intervention, such as dietary changes, weight loss, and control of DM and HTN.

LIMITATIONS

This is a retrospective study, and a relatively small number of patients are the limiting factor of this study. The study was conducted in a single institution, which may limit the generalizability of the findings. Another limitation is that the short duration of follow-up may have limited insights into the long-term progression and natural course of the disease.

CONCLUSIONS

Our study showed a significantly increased risk of CKD post RN. Age, Co-morbidity, pre-operative proteinuria, and type of surgery are the most important factors affecting CKD development after surgery. The immediate postoperative eGFR value may be useful in evaluating the risk of developing postoperative CKD in nephrectomy patients. More attention should be given to patients with decreased renal function during postoperative follow-up. The implementation of appropriate measures is very important for the recovery of patients with long-term renal function impairment.

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