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Incidence of Contrast-Induced Nephropathy in Post-Renal Transplant Recipients

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ABSTRACT

Contrast-induced nephropathy (CIN) is a widely occurring, although possibly preventable, complication after the use of iodinated contrast media. **Objectives:** To identify CIN incidence in patients who have undergone renal transplants and also to see the risk factors involved. **Methods:** The cross-sectional research was carried out at the Sindh Institute of Urology and Transplantation (SIUT), Karachi, within six months after ethical consent of the College of Physicians and Surgeons Pakistan (CPSP). The sample size was 174 renal transplant recipients (aged 18 years and above) with an estimated glomerular filtration rate (eGFR) of over 20 ml/min, and these individuals were pre-exposed to 50 ml of iodinated contrast. Data analysis was done by use of SPSS version 25.0. Associations were evaluated using the chi-square test and multivariate logistic regression, with p≤0.005 being taken as statistically significant. **Results:** The average age of the interviewees was 44.2 ± 11.6 years old. The mean serum creatinine increased to 1.76 ± 0.49 mg/dl at the end of the experiment and correspondingly decreased to 55.6 ± 12.3 ml/min to 49.8 ± 13.1 ml/min. CIN appeared in 26 patients (14.9%). Its occurrence was much higher among those patients who had diabetes mellitus (23.8%, p=0.021) and hypertension (19.2%, p=0.045). On multivariate analysis, independent predictors of CIN were diabetes mellitus and contrast volume more than 100 ml (p<0.001). **Conclusions:** CIN is very prevalent among the post-renal transplant recipients. Higher contrast volume and diabetes mellitus are the best independent predictors.

INTRODUCTION

Contrast-induced nephropathy (CIN), also known as contrast-induced acute kidney injury (CI-AKI), is a major cause of iatrogenic kidney dysfunction, especially in individuals who have underlying kidney dysfunction, including renal transplant recipients. Even though iodinated contrast agents have significantly improved diagnostic and interventional radiology, their usage is linked with the high likelihood of acute kidney injury, even when the kidney is transplanted and is thought to be in stable baseline performance [1, 2]. Kidney transplant recipients (KTRs) could be a unique population vulnerable to CIN since a combination of several factors can increase their vulnerability to the condition, such as dependence on one functioning kidney, persistent exposure to immunosuppressive agents, which can be nephrotoxic, and changes in renal hemodynamics [3]. There is some inconsistent evidence on contrast exposure in this population, though. Chotkan *et al.* showed that pre-transplant contrast administration to deceased kidney donors did not have a significant effect on the long-term graft survival, but transient impairment of early renal functioning was reported [1]. However, other reports have indicated quantifiable incidence of CIN after exposure to contrast in transplant patients, which demands close observation and preventive measures in this high-risk patient population [4, 5]. There is a wide range of reported incidence of CIN, with much of the variation being a result of heterogeneity in patient populations, diagnostic criteria, and preventive protocols. A huge meta-analysis found a combined worldwide incidence of 2-30 percent, with most of the cases found in persons who have already had dysfunction of the kidney [6]. There are no particular data

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on renal transplant groups, but argue in favor of a clinically important risk as potentially negative outcomes on graft functionality and patient outcome [7]. Pathophysiology of CIN comprises of renal vasoconstriction, medullary hypoxia, and direct tubular toxicity induced by oxidative stress and inflammatory mechanisms [8]. Increase in molecular knowledge has led to possible preventive measures, such as optimized hydration, antioxidant therapy, and pharmacologic vasodilation, but CIN remains a clinical problem, especially in cases where contrast-enhanced imaging is inevitable in transplant recipients [9]. The recent activities have been aimed at minimizing contrast-associated nephrotoxicity in the use of alternative imaging modalities and risk stratification. Contrast-enhanced ultrasound (CEUS) has become a safer imaging tool to assess kidney transplant complications without making use of the iodinated contrast media [4]. Also, recent recommendations by the American College of Radiology support the customized risk evaluation and preventive actions in case of necessity of contrast administration in patients with kidney disease [10].

Although there has been an increased awareness and preventive strategies developed, their use in daily clinical practice has been inconsistent. Timely intervention and early detection of the risk of CIN are thus important, especially in the transplant population. This study hypothesized that contrast-induced nephropathy events are clinically significantly frequent in post-renal transplant recipients and that the risk of it is related to certain clinical factors, such as comorbidities and contrast volume. This study aimed to establish the occurrence of CIN and determine the predictors of CIN among post-renal transplant individuals who are exposed to contrast.

METHODS

The study is cross-sectional research done with a group of patients visiting the outpatient and inpatient department of the Transplant Unit of the Sindh Institute of Urology and Transplantation (SIUT), Karachi, between 6 months of August 2025 and January 2026. The research began following ethical consent of the College of Physicians and Surgeons Pakistan (CPSP) (CPSP/REU/NEP-2023-198-1082; dated 28th June 2025) and permission of its Research Evaluation Unit (REU) (IRB approval number: SIUT-ERC-2025/A-563; dated 22nd May 2025). All participants had given informed consent in written form before enrolling. The sample size was estimated with the help of the Open Epi software, whose assumptions were based on the predicted incidence of a contrast-induced nephropathy (CIN) of 13 percent in post-renal transplant recipients, according to Abu Jawdeh *et al.* [11]. The sample size of 174 was determined by using a 95% confidence interval and a 5 percent margin of error. A non-probability consecutive sampling method was used in the recruitment. Included were patients who had a history of renal transplant, whose estimated glomerular filtration rate (eGFR) was stable (over 20 ml/min/1.73 m 2 when calculated according to the CKD-EPI equation), and had received at least 50 ml of intravenous iodinated contrast media during diagnostic or interventional procedures. Patients would not be included in the study if they had any dialysis within the previous week before contrast exposure, had suffered an acute rejection episode within the past week, were on inotropic or ventilatory support, or were undergoing acute rejection or active infection at the time of contrast. Age, gender, medical record number, education level, residence, and monthly income were all collected by use of a pre-designed proforma. Body mass index (BMI) was calculated by dividing the weight of a person in kilograms by height in meters squared, and anthropometric measurements were taken with the help of a calibrated digital weighing scale and a standard height chart. The time taken after renal transplantation and comorbid conditions like diabetes mellitus, hypertension, obesity, anemia, coronary artery disease, congestive heart failure, and smoking status were recorded and confirmed with the help of medical records. The kind of contrast media used and the amount of the media used were noted in relation to each participant. Baseline (day 1) and repeated (72-96 hours, day 4) serum creatinine were determined after exposure to the contrast. The level of hemoglobin and HbA1c was also recorded. All laboratory values were recorded by the investigator with the help of an estimation of glomerular filtration rate before and after contrast exposure. The definition of contrast-induced nephropathy was a 25% increase in serum creatinine relative to baseline during 72-96 hours of exposure to contrast without any other known etiologies of acute kidney injury.

The Statistical Package of Social Sciences (SPSS) version 25.0 was used in the analysis of the data. Mean and standard deviation were used to represent quantitative variables, whereas frequencies and percentages were used to represent qualitative variables. They stratified to adjust for potential effect modifiers, including age, gender, BMI categories, socioeconomic variables, and comorbid conditions. Categorical variables were compared using the chi-square test, and those variables that were statistically significant on univariate analysis were included in a multivariate logistic regression model to determine independent predictors of CIN. The p-value of less than 0.005 was taken to have been statistically significant.

RESULTS

The final analysis had 174 post-renal transplant recipients who received contrast-enhanced imaging. Continuous variables were described in terms of mean ± standard deviation; this was done by ensuring that there was

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approximate normality, and categorical variables were stated in terms of frequencies and percentages. Categorical variable associations were evaluated with the Chi-square test, and continuous variable comparisons across groups were evaluated with independent-sample tests in situations where normality and homogeneity of variance conditions were satisfied. This study provides a summary of the baseline demographic, anthropometric, and renal function traits of the participants in the study. The average age of the participants was 44.211.6 (19-70 years). 112 (64.4%) of the cohort were males. The average serum creatinine was raised to 1.76 ± 0.49 mg/dl at 72-96 hours after contrast exposure, and the mean eGFR was reduced to 49.8 ± 13.1 ml/min/1.73 m2. The volume of contrast that was administered was 92.6 ± 21.8 ml (Table 1).

Table 1: Baseline Demographic, Anthropometric, and Renal Function Characteristics of Post-Renal Transplant Recipients (n=174)

Variables	Mean ± SD / n (%)
Age (years)	44.2 ± 11.6
Gender (Male/Female)	112 (64.4%) / 62 (35.6%)
BMI (kg/m^2)	25.7 ± 3.9
Duration Since Transplantation (months)	38.5 ± 22.4
Baseline Serum Creatinine (mg/dl)	1.48 ± 0.37
Post-Contrast Serum Creatinine (mg/dl)	1.76 ± 0.49
Baseline eGFR (ml/min)	55.6 ± 12.3
Post-contrast eGFR (ml/min)	49.8 ± 13.1
Contrast Volume (ml)	92.6 ± 21.8

The study gives the prevalence of comorbid conditions in the study population. The most common comorbidities included hypertension and diabetes mellitus (Table 2).

Table 2: Frequency of Comorbid Conditions among Post-Renal Transplant Recipients (n=174)

Comorbidity	n (%)
Hypertension	78 (44.8%)
Diabetes Mellitus	63 (36.2%)
Anemia	24 (13.8%)
Coronary Artery Disease	16 (9.2%)
Congestive Heart Failure	10 (5.7%)
Smoking	27 (15.5%)

A 25% increase in serum creatinine levels compared to baseline (contrast-induced nephropathy, CIN) was noted in 26 patients (14.9%), 72 to 96 hours after the exposure to contrast. Within a week, renal function came back to normal in 22 of them (84.6%). None of the patients needed renal replacement therapy, and it was considered to be an observed clinical outcome in the course of follow-up. The results demonstrate the correlation between CIN and the possible risk variables. The prevalence of CIN was much higher among diabetes mellitus patients than among non-diabetic patients (23.8% vs. 9.8%; p=0.021). Similarly, hypertensive patients were found to have a greater incidence of CIN when compared to non-hypertensive patients (19.2% vs. 10.2; p=0.045). There was a significantly greater incidence of CIN in patients who were given a contrast volume more than 100 ml (26.1% vs. 9.8; p=0.008). Statistically significant correlation between CIN and gender/BMI category was not found (Table 3).

Table 3: Association of Contrast-Induced Nephropathy with Demographic and Clinical Risk Factors

Variables	Total (n)	CIN Present, n (%)	CIN Absent, n (%)	p-value
Male	112	18 (16.1%)	94 (83.9%)	0.570
Female	62	8 (12.9%)	54 (87.1%)	
Diabetes Mellitus	63	15 (23.8%)	48 (76.2%)	0.021*
Hypertension	78	15 (19.2%)	63 (80.8%)	0.045*
Contrast Volume >100 ml	69	18 (26.1%)	51 (73.9%)	0.008*
BMI >25 kg/m^2	98	13 (13.3%)	85 (86.7%)	0.310

*p≤0.005 is considered statistically significant

The study provides a comparison of the continuous variables in the patients who succumbed to CIN and those who did not. CIN patients possessed much higher post-contrast serum creatinine values and were administered much more contrast media. There was no statistically significant difference in the age, BMI, or baseline serum creatinine between the two groups. In the multivariate logistic regression analysis, diabetes mellitus and contrast volume over 100 ml were independent predictors of CIN (p<0.001) (Table 4).

Table 4: Comparison of Continuous Variables Between CIN and Non-CIN Groups

Variables	CIN Present (n= 26), Mean ± SD	CIN Absent (n= 148), Mean ± SD	p-value
Age (years)	46.5 ± 12.3	43.8 ± 11.5	0.290
BMI (kg/m^2)	26.2 ± 4.1	25.6 ± 3.8	0.480
Baseline Serum Creatinine (mg/dl)	1.56 ± 0.39	1.47 ± 0.36	0.330
Post-contrast Serum Creatinine (mg/dl)	2.02 ± 0.41	1.71 ± 0.45	0.001*
Contrast Volume (ml)	103.1 ± 18.5	90.7 ± 22.1	0.008*

*p≤0.005 is considered statistically significant

DISCUSSION

The current paper assessed this incidence and the determinants of contrast-induced nephropathy (CIN) in post-renal transplant patients receiving contrast-enhanced imaging and showed the overall incidence of 14.9%. This observation is in line with already established rates in transplant populations and supports the increased vulnerability of renal allografts to contrast-related renal injury despite the increased safety of imaging methods and preventive measures. Contrast-enhanced imaging continues to play a vital role in post-transplant care, especially in evaluating vascular patency, graft perfusion, and post-operative complications. Nevertheless, the problem of the safety of iodinated contrast agents in such a

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high-risk population remains a significant issue. Fernández *et al.* stressed that modern contrast agents are comparatively safer, but the renal transplant patients are still at risk because of low renal reserve and due to the exposure to nephrotoxic immunosuppressive agents [12]. This issue can be justified by the baseline and renal function alterations that were experienced by our cohort, where the decrease in renal functioning was measurably observed after the exposure to contrast. Recent studies have also paid more attention to the early diagnosis of CIN by other types of biochemical markers. Zywno *et al.* have mentioned the importance of biomarkers like neutrophil gelatinase-associated lipocalin (NGAL), cystatin C, and interleukin-18 that can identify the presence of acute kidney injury earlier than serum creatinine [13]. In the present case, even though the serum creatinine-based definitions were applied, the temporary rise of creatinine levels in the vast majority of affected patients indicates that the introduction of new biomarkers into the post-contrast monitoring regimens can enable the timely detection and treatment of transplant recipients. The stratification of risks and personal contrast control is highly promoted in modern guidelines. In a collaborative statement of the Polish Society of Nephrology and Radiology, Chmielewski *et al.* suggested risk evaluation and cautious contrast application in patients with defective renal function should be personalized [14]. These recommendations are consistent with our findings, with diabetes mellitus, hypertension, and greater contrast volume being significantly related to CIN, and diabetes mellitus and contrast volume >100 ml continuing to be independent predictors on multivariate analysis. Other imaging modalities are also being considered as a way of minimizing contrast-induced nephrotoxicity in patients who have undergone renal transplants. David *et al.* proved that contrast-enhanced ultrasound (CEUS) provides better evaluation of graft perfusion, and no patients are exposed to iodinated contrast agents [15]. Further implementation of CEUS in the follow-up of routine transplantation would have the potential to decrease the incidence of CIN among this at-risk group. Preventative measures remain critical in reducing the risk of CIN. Kellum focused on the fact that acute kidney injury, such as CIN, can be prevented in most cases by proper hydration, careful use of contrast doses, and close observation after the procedure [16]. The lack of dialysis-inducing CIN in our cohort refers to the efficiency of such preventive interventions and indicates that the contrast-related renal damage in transplant patients is often mild and reversible if the relevant precautions are taken. The incidence of CIN that was observed during our study is very similar to that of the study by Abu Jawdeh *et al.* who described the incidence of CIN at around 13% in their study population of post-transplant patients [11]. Likewise, Fananapazir *et al.* reported temporary elevations of serum creatinine in cases of intra-arterial contrast administration without irreversible graft dysfunction [17], which were observed to match current findings that 84.6% of patients returned to baseline renal functioning within one week. Image practices quality assurance is also of great essence. Research by Roohi *et al.* Taher *et al.* and Owusu-Banahene *et al.* have demonstrated that improper use of imaging and repeat exposure are some of the reasons leading to avoidable radiation and contrast utilization [18-20]. The application of standardized imaging protocols and personnel education in the transplant radiology services can further help to decrease preventable cases of CIN.

There are some limitations of this study. It has a cross-sectional design that restricts causal determination between observed risk factors and the development of CIN. It was based on serum creatinine-based definitions without any additions of early kidney injury biomarkers, which could not have given an accurate picture of subclinical renal injury. Also, the study was carried out in one center, and this might limit the extrapolation of the research to other transplant populations that have different clinical practices.

CONCLUSIONS

To sum up, it was found that contrast-induced nephropathy was present in 14.9% of those who have undergone post-renal transplant, which proves that the incidence of CIN is clinically significant in this group. The best independent predictors of CIN were diabetes mellitus and increased contrast volume. These findings highlighted the necessity of personalized risk evaluation, the reduction of contrasts, and the need to consider other imaging modalities in order to maintain long-term graft function in recipients of renal transplants despite mildly adverse cases.

Authors' Contribution

Conceptualization: AN
Methodology: AN, A, AK
Formal analysis: AN, A
Writing and Drafting: AN, EA, AK
Review and Editing: AN, EA, A, AK

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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