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Impact of Chronic Kidney Disease on Outcomes in Non-ST Elevation Myocardial Infarction.

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ABSTRACT:

Background: Chronic kidney disease (CKD) significantly increases the risk of cardiovascular complications, particularly in patients with non-ST segment elevation myocardial infarction (NSTEMI). However, the effects of revascularization procedures on these patients remain under-explored.

Objective: This study evaluates outcomes in CKD patients presenting with NSTEMI, focusing on major adverse cardiovascular events (MACE) and renal function.

Methods: A prospective study was conducted at Alexandria University Hospital from December 2022 to June 2023, involving 50 NSTEMI patients, categorized into CKD (Group 1) and non-CKD (Group 2). We analyzed demographic data, revascularization rates, complications during hospitalization and at three months post-discharge, and changes in renal function.

Results: CKD patients showed higher rates of renal deterioration and adverse cardiovascular outcomes. Revascularization significantly improved both renal and cardiovascular outcomes for CKD patients, mitigating renal function decline compared to those who did not undergo revascularization.

Conclusion: CKD patients with NSTEMI face a greater risk of in-hospital complications, including heart failure and mortality. Nonetheless, revascularization is vital for enhancing cardiovascular and renal outcomes in this high-risk group.

Keywords: Chronic Kidney Disease, Non-ST Elevation Myocardial Infarction, Revascularization, Major Adverse Cardiovascular Events, Renal Function

INTRODUCTION

Chronic kidney disease (CKD) is a critical independent risk factor for cardiovascular disease, significantly increasing the likelihood of coronary heart disease and myocardial infarction **(Anavekar et al., 2004; Herzog et al., 2011; Mehran et al., 2009).** Patients with CKD experience accelerated atherosclerosis, contributing to the high prevalence of cardiovascular complications, which remains the leading cause of death in this population **(Anavekar et al., 2004; Herzog et al., 2011).** Notably, about 40% of patients with acute coronary syndrome (ACS) present with renal dysfunction, with CKD nearly doubling the mortality risk in these patients **(Hanna et al., 2012; Lawesson et al., 2015).** The increased burden of comorbidities and risk factors in CKD patients is compounded by the underutilization of guideline-recommended medical and reperfusion therapies, such as coronary angiography (CAG) and percutaneous coronary intervention (PCI) **(Nicola et al., 2015; Szummer et al., 2009).** Additionally, CKD patients are at heightened risk for contrast-induced nephropathy (CIN), acute kidney injury (AKI), and major bleeding events **(Turan et al., 2015).** The necessity and optimal timing of invasive strategies in NSTEMI patients with CKD remain under-researched, making it imperative to address these gaps to improve individualized patient care **(Members et al., 2022).** The primary aim of this study is to evaluate the outcomes of patients with CKD presenting with non-ST elevation myocardial infarction (NSTEMI) concerning major adverse cardiovascular events (MACE) and renal function and the effect of revascularization on these outcomes

Patients and Methods:

This prospective study included patients diagnosed with NSTEMI admitted to Alexandria University Hospital between December 2022 and June 2023. The participants were divided into two groups: Group 1, patients with chronic kidney disease (CKD) and NSTEMI, and Group 2, patients without CKD and NSTEMI. Patients with CKD on dialysis and congenital heart disease were excluded. CKD was defined by an estimated glomerular filtration rate (eGFR) below 60 ml/min/1.73 m^2 or evidence of kidney damage.

Data collection involved detailed demographic information, clinical history, vital signs, and laboratory tests, including cardiac enzymes and renal function markers. Imaging studies, such as echocardiography and abdominal ultrasound, were performed to assess cardiac and renal function.

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Follow-up occurred immediately post-NSTEMI and three months later, focusing on major adverse cardiovascular events (MACE) and renal function. Data were analyzed using IBM SPSS Statistics version 20.0. Qualitative data were presented as numbers and percentages, while quantitative data were described using the range, mean, standard deviation, median, and interquartile range. Normality of the data was assessed using the Shapiro-Wilk test.

For **statistical analysis**, the Chi-square test was applied to compare categorical variables between the CKD and non-CKD groups, and Fisher's Exact test was used when the Chi-square test's assumptions were violated (i.e., small expected frequencies). Continuous variables were compared using Student's t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Statistical significance was set at $p < 0.05$.

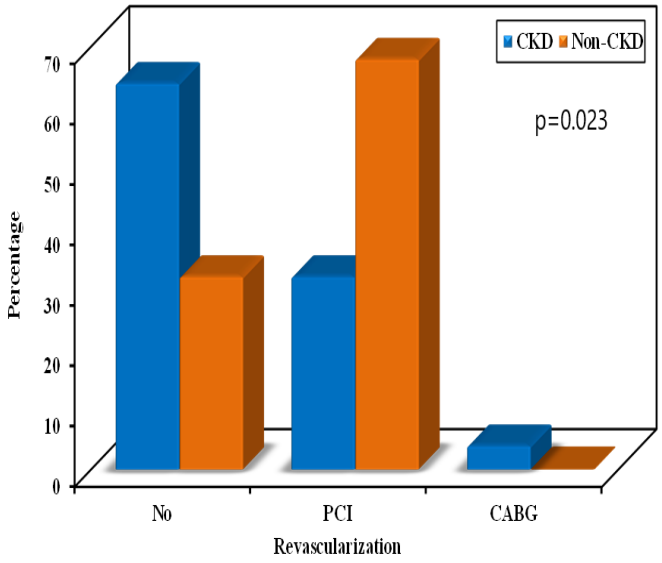
Ethical approval was obtained, and informed consent was secured from all participants, ensuring strict adherence to ethical research guidelines.

Results:

The demographic data comparison revealed no statistically significant differences between the two groups. Group I consisted of 13 males and 12 females, aged 48 to 80 years, with a mean age of 62.68 ± 6.98 years. Group II included 17 males and 8 females, aged 35 to 86 years, with a mean age of 60.76 ± 12.63 years. Both groups had similar rates of diabetes, hypertension, and ischemic history. Additionally, most patients in both groups had preserved ejection fractions, and no significant differences in cardiac function were observed between the groups.

Regarding the revascularization procedures, a significant difference was observed in revascularization rates between CKD and non-CKD patients (p=0.023). In Group I, 64% of patients did not undergo any revascularization, while 32% underwent percutaneous coronary intervention (PCI) and 4% received coronary artery bypass grafting (CABG). Conversely, Group II exhibited a higher PCI rate of 68%, with no patients undergoing CABG and 32% receiving no revascularization (Figure 1)

Figure (1):Comparison between the two studied groups according to revascularization



The in-hospital complications for both groups showed that there was higher incidence of heart failure and in hospital mortality among the CKD group patients. Heart failure occurred in 24% of CKD patients compared to 20% of non-CKD patients. Cardiovascular mortality was observed in 4% of CKD patients, with no cases in the non-CKD group. In terms of stroke, none of the CKD patients experienced a stroke, while one patient in the non-CKD group did, although this difference was not statistically significant (Table 1)

Table (1):Comparison between in-hospital complications and after 3 Months complications according to complications in each group

		In hospital complications		After 3 month		McN p
		No.	%	No.	%	
CKD group	**Total**					
	Stroke	0/25	0.0	2/24	8.3	0.500
	Heart failure	6/25	24.0	8/24	33.3	0.453
	Cardiovascular mortality	1/25	4.0	1/24	4.2	1.000
	No Revascularization					
	Stroke	0/16	0.0	1/15	6.7	1.000
	Heart failure	5/16	31.3	7/15	46.7	0.375
	Cardiovascular mortality	1/16	6.3	1/15	6.7	1.000
	Revascularization (PCI/ CABG)					
	Stroke	0/9	0.0	1/9	11.1	1.000
	Heart failure	1/9	11.1	1/9	11.1	1.000
	Cardiovascular mortality	0/9	0.0	0/9	0.0	–
Non-CKD group	**Total**					
	Stroke	1/25	4.0	0/25	0.0	1.000
	Heart failure	5/25	20.0	7/25	28.0	0.727
	Cardiovascular mortality	0/25	0.0	0/25	0.0	–
	No Revascularization					
	Stroke	1/8	12.5	0/8	0.0	1.000
	Heart failure	2/8	25.0	7/8	87.5	0.063
	Cardiovascular mortality	0/8	0.0	0/8	0.0	–
	Revascularization (PCI/ CABG)					
	Stroke	0/17	0.0	0/17	0.0	–
	Heart failure	3/17	17.6	0/17	0.0	0.250
	Cardiovascular mortality	0/17	0.0	0/17	0.0	–

McN: McNemar test

p: p value for comparing between **In hospital** and **After 3 month**

Three months post-discharge, patients in the CKD group exhibited higher rates of complications compared to the non-CKD group. Recurrent myocardial infarction occurred in 16.7% of CKD patients versus 12% in the non-CKD group. Stroke was reported in 8.3% of CKD patients, while no cases were observed in the non-CKD group. Heart failure was the most common complication, affecting 33.3% of CKD patients compared to 28% in the non-CKD group. Cardiovascular mortality was slightly higher in the CKD group (4.2%), although this difference was not statistically significant. Additionally, contrast-induced nephropathy was seen in 2 CKD patients who underwent contrast procedures, with no cases in the non-CKD group

Renal function deterioration between the two groups showed a significantly higher proportion of CKD patients who experienced deterioration (48%) compared to non-CKD patients (16%), with a p-value of 0.015 (Figure 2)

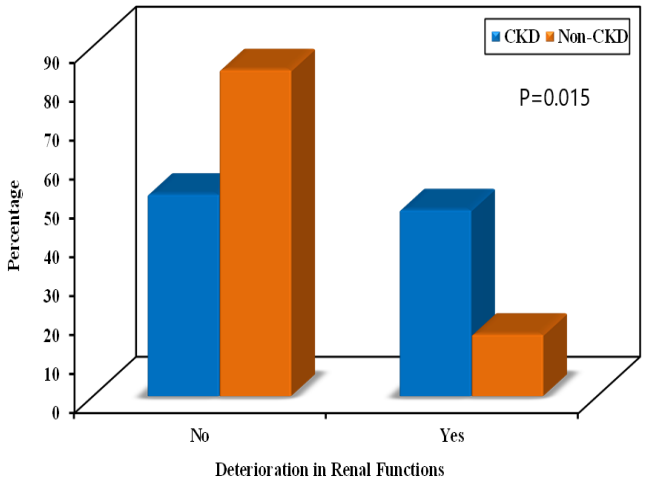


Figure (2):Comparison between the two studied groups according to deterioration in renal functions

The comparison of revascularization outcomes between CKD and non-CKD groups shows significant protective effects in preventing heart failure. In the CKD group, heart failure was more common in non-revascularized patients (46.7%) versus only 11.1% in those revascularized. Cardiovascular mortality was also exclusive to the non-revascularized group (6.7%). Similarly, in the non-CKD group, none of the revascularized patients developed heart failure, while 87.5% of those without revascularization did (Table 2)

Table (2): Relation between complications and revascularization After 3-month in CKD and non-CKD group (n = 25)

CKD group	Revascularization No (n = 15)		Yes (n = 9)		χ^2	^{FE}p
	No.	%	No.	%		
Heart failure						
No	8	53.3	8	88.9	3.200	0.178
Yes	7	46.7	1	11.1		
Stroke						
No	14	93.3	8	88.9	0.145	1.000
Yes	1	6.7	1	11.1		
Cardiovascular mortality						
No	14	93.3	9	100.0	0.626	1.000
Yes	1	6.7	0	0.0		
Non-CKD group	**Revascularization No (n = 8)**		**Yes (n = 17)**		χ^2	^{FE}p
	No.	**%**	**No.**	**%**		
Heart failure						
No	1	12.5	17	100.0	20.660*	<0.001*
Yes	7	87.5	0	0.0		
Stroke						
No	8	100.0	17	100.0	–	–
Yes	0	0.0	0	0.0		
Cardiovascular mortality						
No	8	100.0	17	100.0	–	–
Yes	0	0.0	0	0.0		

χ^2: **Chi square test** **FET: Fisher Exact test**

p: p value for Relation between Heart failure and revascularization

Renal function deterioration, measured by a 0.3 mg/dL rise in creatinine, showed that non-revascularized CKD patients had a much higher deterioration rate (91.7%) compared to only 8.3% in the revascularized group. In non-CKD patients, although there was a trend toward higher deterioration in non-revascularized patients (75% vs. 23.8%), the difference did not reach statistical significance (p=0.081). These findings highlight revascularization's role in protecting against both heart failure and renal decline (Table 3)

Table (3):Relation between deterioration in renal functions and revascularization in CKD group and non-CKD group (n = 24)

CKD group	Deterioration in Renal Functions No (n = 13)		Yes (n = 12)		χ^2	^{FE}p
	No.	%	No.	%		
Revascularization						
No	5	38.5	11	91.7	7.667*	0.011*
PCI	7	53.8	1	8.3	5.940*	0.030*
CABG	1	7.7	0	0.0	0.962	1.000
Non-CKD group	**Deterioration in Renal Functions No (n = 21)**		**Yes (n = 4)**		χ^2	^{FE}p
	No.	**%**	**No.**	**%**		
Revascularization						
No	5	23.8	3	75.0	4.046	0.081
PCI	16	76.2	1	25.0	4.046	0.081
CABG	0	0.0	0	0.0	–	–

FET: Fisher Exact test

p: p value for Relation between deterioration in renal functions and revascularization

*: Statistically significant at $p \leq 0.05$

Discussion

Revascularization rates differed significantly; 64% of CKD patients did not undergo revascularization compared to 32% of non-CKD patients. Murray et al. reported similar findings, noting lower use of coronary angiography (CAG) and percutaneous coronary interventions (PCI) in CKD patients **(Murray et al., 2018).** Other studies found that CKD patients were less likely to receive invasive treatments **(Holzmann & Siddiqui, 2020; Scott et al., 2023; Smilowitz et al., 2017).** Concerns about adverse events, acute kidney injury, and bleeding risks contribute to these lower rates **(Isaac et al., 2022; Moscucci et al., 2003).**

In-hospital complications were more frequent in CKD patients, with higher rates of heart failure (24% vs. 20%) and cardiovascular mortality (4% vs. 0%). Although stroke was rare in both groups, CKD patients had a higher incidence. Previous research indicates worse in-hospital outcomes for CKD patients with NSTEMI, attributed to lower adherence to guideline-recommended therapies **(Fox et al., 2010; Hanna et al., 2012; Hanna et al., 2011).** Januszek et al. found that impaired renal function correlates with increased in-hospital adverse events, including pulmonary edema, cardiogenic shock, and resuscitated cardiac arrest. Severe renal impairment is also associated with acute kidney injury and major bleeding **(Januszek et al., 2024).**

At the three-month follow-up, CKD patients had higher rates of recurrent myocardial infarction (16.7% vs. 12%), stroke (8.3% vs. 0%), and heart failure (33.3% vs. 28%). Cardiovascular mortality was higher in the CKD group (4.2%), though not statistically significant. These findings align with Wang et al., who observed more frequent MACE in advanced CKD patients **(Wang et al., 2016).** Mueller et al. and subsequent studies confirmed that initial renal function is a significant predictor of both in-hospital and long-term mortality **(Bonello et al., 2008; Mueller et al., 2004; Rhee et al., 2014).**

Contrast-induced nephropathy was observed in 2 CKD patients, but not in non-CKD patients. Murray et al. highlighted increased awareness and preventive measures for contrast-induced nephropathy, such as using low-osmolar contrast agents and improving hydration protocols **(Murray et al., 2018).** Tomey & Chyou emphasized the importance of evolving predictive tools for acute kidney injury **(Tomey & Chyou, 2024).**

Revascularization showed beneficial effects in both groups. In CKD patients, those who did not undergo revascularization experienced significantly more heart failure (46.7% vs. 11.1%) and cardiovascular mortality (6.7%). Non-CKD patients also showed significant benefits from revascularization, with none experiencing heart failure compared to 87.5% of non-revascularized patients. These results echo Hanna et al., who found high in-hospital mortality among non-revascularized patients, particularly those with CKD **(Hanna et al., 2012).** Subsequent studies supported the efficacy of early invasive strategies for CKD patients with NSTEMI, though severe CKD patients may benefit less **(Fong et al., 2023; Sharon et al., 2022; Wang et al., 2016).** Smilowitz et al. and Dégano et al. also reported lower in-hospital mortality with invasive management but noted higher complication rates in CKD patients **(Dégano et al., 2017; Smilowitz et al., 2017).**

Deterioration in renal function was more common in CKD patients (48% vs. 16%), with revascularization showing a protective effect. In CKD patients, deterioration was less frequent among those who underwent PCI (11% vs. 68.7%). Non-CKD patients also showed improved outcomes with revascularization (93% with stable renal function). this comes in the same line with Damman et al. and Di Lullo et al., study results. They demonstrated that acute coronary syndrome (ACS) can exacerbate cardiac and renal dysfunction, leading to cardiorenal syndrome. Renal dysfunction in ACS patients is linked to decreased cardiac output, renal perfusion, and increased renal vein pressure **(Damman et al., 2014; Di Lullo et al., 2017; Matsushita, 2016).** Additionally, dysregulated apoptosis and inflammation also contribute to renal injury **(Colombo et al., 2012).**

Our study comes with its **limitations.** The relatively small sample size, the short follow-up period, and the single-center design may limit generalizability and hinder the assessment of long-term outcomes.

Conclusion

This study found that revascularization procedures significantly improve both cardiovascular and renal outcomes for patients with and without chronic kidney disease (CKD) presenting with non-ST segment elevation myocardial infarction (NSTEMI). Specifically, CKD patients who underwent revascularization had a notable reduction in renal function deterioration compared to those who did not receive the procedure.

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