Identifying Risk Factors for The Development of Contrast-Induced Nephropathy in Patients Undergoing Coronary Angiography Developing Renal Insufficiency

Dr. Jaghat Ram* Dr. Muhammad Assa Baloch, Dr. Samiullah***, Dr. Mashooque Ali Dasti ****, Dr. Shahbaz Ali Shaikh****, Dr. Ghulam Mahdi Jamro*****

*National institute of Cardiovascular Disease Satellite Centre Larkana Sindh Pakistan
** Sheikh Mohammad Bin Zayed Al. Nayhan institute of Cardiology, Quetta Pakistan
***Hayatabad Medical Complex Peshawar Pakistan
****National Institute of Cardiovascular Diseases (NICVD), Karachi Sindh Pakistan
*****Muhammad Medical College (MMC) Mirpur khas

***Abstract*-**

Objective/Aim: The objective of this research was to evaluate the potential reasons of CI-AKI among individuals who are receiving coronary angiography.

Background: The occurrence of acute renal failure after coronary angiography and percutaneous coronary intervention (PCI), known as contrast induced nephropathy, often leads to extended hospital stays and poorer outcomes. This investigation aimed to identify the multiple risk factors contributing to contrast induced nephropathy among patients receiving PCI.

Materials and Methods: The investigation was a prospective, descriptive analysis that took place at the Sheikh Mohammad Bin Zayed Al Nayhan Institute of Cardiology Quetta, focusing on 210 patients who underwent coronary angiography. The study employed a checklist to gather information, and Chi-square and regression analyses were employed to identify the risk factors associated with CI AKI.

Results: Regarding the gender of the patients, 141 (67.1%) were male and 69 (32.8%) were female. In terms of age, the majority of patients were in the 40-60 age group, accounting for 172 (81.9%) patients. The mean age of the patients was 61.6 ± 11.6 years. The use of nephrotoxic drugs was common among the patients, with 202 (96.1%) using NSAIDs, 138 (65.7%) using ACEIs, 34 (16.1%) using ARBs, and 30 (14.2%) using diuretics.

The results suggest that Diabetes has a strong positive association with the outcome (OR=16.158), while Type of coronary angiography and Volume of contrast media also appear to have significant positive associations with the outcome (OR=2.281 and OR=2.086, respectively).

Conclusion: Patients undergoing coronary angiography are considered to have the main risk factors for developing CI AKI.

Keywords: Coronary angiography, contrast-induced nephropathy, renal insufficiency

I. Introduction

Coronary artery disease (CAD) is a health condition marked by obstruction of the blood flow to the heart as a result of plaque buildup, blood clots, or constriction of the arteries. This can result in a reduction in the quantity of oxygenated blood that reaches the heart tissue, leading to myocardial ischemia. If not addressed and worsens or continues for an extended period, it may lead to the demise of heart muscle cells.[1]

Chronic Kidney Disease (CKD) is strongly linked to Coronary Artery Disease (CAD), with a prevalence that ranges from 23% to 46%.[2,3]Patients with CKD are at a heightened risk of developing CAD compared to the general population.[4,5] CAD is also responsible for over 50% of deaths that result from end-stage renal disease (ESRD).[6] Poor kidney function is associated with an increased likelihood of premature death, cardiac events, and hospital admissions.[7] Contrast induced nephropathy (CIN) is a type of acute kidney failure that can occur following coronary angiography and percutaneous coronary intervention (PCI), leading to prolonged hospital stays and worse outcomes.[8] CIN is identified by the sudden occurrence of kidney dysfunction within one to three days following the introduction of iodinated contrast agent, and typically resolves on its own, though certain individuals may necessitate dialysis.[9] With the emergence of coronary angioplasty, there has been a growing inclination toward PCI, leading to a reduction in CABG. Around 1.4 million catheterization interventions are conducted in the United States annually.[10] Both coronary angiography and PCI require the use of contrast agent during the procedure, which is a frequent trigger for CIN.[11]

The CIN factor is frequently accountable for AKI acquired within hospital premises, and leads to a higher incidence of cardiac events such as myocardial infarction and coronary interventions.[12] Additionally, it contributes to various complications within the hospital setting, including bleeding, transfusions, vascular issues, and increased rates of morbidity and mortality.[13]

Coronary artery disease (CAD) is a major cause of death on a global scale and continues to significantly impact morbidity, mortality, and healthcare expenses.[14] CAD is currently categorized into two types: chronic coronary syndrome (CCS) also known as stable angina, and acute coronary syndrome (ACS), which is further subcategorized into non-ST segment elevation ACS (NSTACS) and ST-segment elevation ACS (STACS).[15] Treatment of CAD varies depending on several factors, including the type of ACS or CCS, the extent of coronary obstruction, and

the onset of symptoms. Treatment options may involve immediate reperfusion through thrombolytic therapy or percutaneous coronary intervention (PCI), antiplatelet and anticoagulant medications, and in some cases, coronary artery bypass grafting surgery may be considered as a viable treatment option.[16] Coronary angiography entails injecting contrast medium intravascularly to inspect blood flow in the coronary arteries. Contrast medium usage can result in severe acute kidney injury (AKI), referred to as contrast-induced AKI (CI-AKI).[17] CI-AKI is the third most prevalent cause of iatrogenic AKI and has been linked to an elevated risk of grave adverse events like renal failure, stroke,[18] myocardial infarctions, and death. Even slight increases in serum creatinine have been associated with more extended hospital stays and higher expenses. According to records, CI-AKI occurrences vary between 3% and 50%, based on demographics and risk factors.[19] The risk of CI-AKI is lower in people with normal renal function, but it rises in those with one or more risk factors.[20] Currently, no research has been conducted to investigate the incidence and risk factors of CI-AKI in Pakistani patients. Thus, this study is aimed at evaluating CI-AKI in our population that undergoes coronary angiography.

II. MATERIAL AND METHODS

The investigation was a prospective and descriptive study that took place at the Sheikh Mohammad Bin Zayed Al Nayhan Institute of Cardiology in Quetta for six months, focusing on patients receiving percutaneous coronary angiography (PCA).

The individuals involved in the research underwent PCA at Sheikh Mohammad Bin Zayed Al Nayhan Hospital throughout the study period. A comprehensive coverage method was employed, considering the inclusion and exclusion parameters. All patients admitted for a solitary coronary angiography were incorporated, but those undergoing multiple coronary angiographies were omitted from this study.

A predetermined list was utilized to collect information, which included details about patients' demographics like their age and sex. The next part covered clinical features, such as the type of other illnesses and medications given to the patient at the same time. The third section focused on the kind of coronary angiography that was performed (either for diagnosis or intervention) and the type and amount of dye used. The fourth segment was concerned with measuring serum creatinine (SCr) levels upon admission and for three consecutive days after the coronary angiography to establish a baseline.

Statistical Analysis

The information was analyzed utilizing IBM's Statistical Package for the Social Sciences (SPSS), version 23.0. The frequency tables displayed the amounts and proportions of the research factors. The statistical differences were assessed using the Chi square examination, and a logistic regression study was conducted to establish the risks associated with the development of CI-AKI. A P-value of ≤ 0.05 was regarded as a signal of statistical importance.

III. RESULTS

Table 1 provides information about the demographic profile, patient presentation, comorbid diseases, and the use of nephrotoxic drugs in a group of patients. The data are presented in number and percentage format, which allows for easy interpretation of the information.

Regarding the gender of the patients, 141 (67.1%) were male and 69 (32.8%) were female. In terms of age, the majority of patients were in the 40-60 age group, accounting for 172 (81.9%) patients. The mean age of the patients was 61.6 ± 11.6 years.

In terms of patient presentation, 108 (51.4%) had STEMI, 91 (43.3%) had NSTEMI, and 11 (5.2%) had unstable angina. The most common comorbid disease was hypertension, accounting for 101 (48.0%) patients, followed by diabetes mellitus, accounting for 75 (35.7%) patients.

Regarding baseline serum creatinine levels, 141 (67.1%) patients had levels in the range of 0-1.3 mg/dl, while 56 (26.6%) had levels in the range of 1.4-1.9 mg/dl, and 13 (6.2%) had levels of ≥2 mg/dl. The mean baseline serum creatinine level was 1.34 ± 0.41 mg/dl.

The use of nephrotoxic drugs was common among the patients, with 202 (96.1%) using NSAIDs, 138 (65.7%) using ACEIs, 34 (16.1%) using ARBs, and 30 (14.2%) using diuretics.

Finally, the development of CI-AKI occurred in 65 (30.9%) patients, while 145 (69.0%) did not develop CI-AKI.

Overall, this information can provide valuable insights into the patient population and their risk factors for developing CI-AKI.

Table 1: The study sample's usage of kidney-damaging drugs, as well as their sociological, demographic, and medical features, were examined. (n = 210)

Demographic profile	Number	Percentage
Gender		
Male	141	(67.1%)
Female	69	(32.8%)
Age (Years)		
≤40	4	(1.9%)
40-60	172	(81.9%)
61-70	23	(10.9%)
≥70	11	(5.2%)
Age, mean ± SD (years	61.6 ± 11.6	
Patient presentation (CAD)		
ST-segment elevation myocardial infarction	108	(51.4%)
non-ST-segment myocardial infarction	91	(43.3)
Unstable angina	11	(5.2)
Comorbid diseases		
Diabetes mellitus	75	(35.7)
Hypertension	101	(48.0)
Baseline serum creatinine (mg/dl)		
0-1.3	141	(67.1)

1.4-1.9	56	(26.6)
≥2	13	(6.2)
serum creatinine, mean ± SD (mg/dl)	1.34 ± 0.41	
Use of nephrotoxic drugs		
non-steroidal anti-inflammatory drugs	202	(96.1)
angiotensin-converting enzyme inhibitors	138	(65.7)
angiotensin receptor blockers	34	(16.1)
Diuretics	30	(14.2)
Development of CI-AKI		
Yes	65	(30.9)
No	145	(69.0)

Table 2 provides the frequency and percentages of different variables related to coronary angiography.

Regarding the "Type of coronary angiography," out of the total sample of 210 patients who underwent angiography, the majority (123, 58.5%) received percutaneous coronary intervention, while the remaining 87 (41.4%) underwent diagnostic angiography.

For the variable "Type of contrast media," all 210 patients received Iohexol as the contrast media. Therefore, the percentage for this variable is 100%.

Finally, the "Volume of injected contrast media" variable shows that the majority of patients (80, 38.0%) received a volume of 100-199 ml, followed by 56 patients (26.6%) who received a volume of 200-299 ml. A total of 46 patients (21.9%) received less than 100 ml, and 28 patients (13.3%) received a volume of 300 ml or more.

Table 2: Varieties of coronary angiography and the kind and amount of infused contrasting agents (n = 210).

Characteristics	Number	Percentages
Type of coronary angiography		
Diagnostic	87	(41.4)
Percutaneous coronary intervention	123	(58.5)
Type of contrast media		
Iohexol	210	(100)
Volume of injected contrast media (ml)		
<100	46	(21.9)
100-199	80	(38.0)
200-299	56	(26.6)
≥300	28	(13.3)

The results suggest that Diabetes has a strong positive association with the outcome (OR=16.158), while Type of coronary angiography and Volume of contrast media also appear to have significant positive associations with the outcome (OR=2.281 and OR=2.086, respectively).

In contrast, Gender, Age, Use of NSAIDs, Use of ACEIs, Use of ARBs, and Use of diuretics do not appear to be significantly associated with the outcome.

It is important to note that p-values and CIs should be interpreted in conjunction with the estimated coefficients and ORs to understand the magnitude and direction of the associations. Additionally, these results are based on the specific sample and population used in the analysis and may not be generalizable to other settings. (Table 3)

Table 3 Foreseeing the likelihood of contrast-induced acute kidney injury in the patient via a binary logistic regression examination, which examines their risk factors. (n = 210).

Characteristics	Coefficient	P-value	OR	95% CI for OR	
				Lower	Upper
Gender	−0.242	0.416	0.426	0.300	1.487
Age	−0.386	0.231	0.646	0.314	1.387
Diabetes	2.627	0.001	16.158	5.661	32.854
Patient presentation (CAD)	0.331	0.330	1.336	0.613	2.19
Hypertension	0.412	0.226	1.546	0.725	2.310
Baseline serum creatinine	0.235	0.120	0.607	0.514	1.301
Use of NSAIDs	−0.382	0.672	0.418	0.513	2.721
Use of ARBs	0.546	0.325	0.172	0.5471	2.617
Use of ACEIs	−0.175	0.241	0.507	0.735	1.542
Use of diuretics	0.181	0.350	0.534	1.230	3.187
Type of coronary angiography	0.761	0.026	2.281	1.157	4.701
Volume of contrast media	0.631	0.001	2.086	1.230	3.063

IV. DISCUSSION

CI-AKI has gained more attention since angiography technology has been widely used to manage CAD patients due to its link to increased morbidity and mortality.[17] According to the present investigation, the frequency of CI-AKI (31.9%) was greater in individuals who received coronary angiography compared to earlier research conducted in China (7.2%), Austria (10.2%), and Canada (12.7%).[21,22] In this study, 67.1% of patients were male, and men are known to have a higher incidence of cardiovascular disease than women of similar age.[23] However, previous research has reported that women with CAD have poor prognoses and higher cardiovascular risk factors.[24] Surprisingly, this study found no significant association between gender or age and AKI development,[25] which contradicts previous studies that reported a significantly higher incidence of CI-AKI in females and elderly

patients (age ≥70 years).[13] The reason for this dispute could be attributed to the limited sample size in contrast to other research or may be linked to genetic diversity. The precise process underlying CI AKI is not entirely comprehended. Numerous processes could be implicated in the development of kidney injury, such as constriction of renal arteries, renal ischemia, obstruction of tubules, inflammation, and initiation of oxidative stress.[26] Numerous clinical features, such as diabetes mellitus, high blood pressure, and STEMI manifestation, have been associated with the development of CI-AKI.[27]

In individuals with diabetic nephropathy, the occurrence of AKI episodes is correlated with an increased probability of developing serious chronic kidney ailments.[28] Furthermore, these patients are more susceptible to tubular damage resulting from iohexol.[29] Our research indicates a notable connection between diabetes mellitus and the emergence of CI-AKI, which is consistent with previous investigations.[14,30] Nevertheless, hypertension and CAD display are not related to the emergence of CI-AKI, which goes against prior research where STEMI presentation was the most strongly associated factor with CI-AKI development.[31] The simultaneous use of medications can be linked to the development of CI-AKI by causing harm to the renal tubules and disrupting blood flow in the kidneys due to the contrast agent.[32] Certain drugs like ACEIs, ARBs, diuretics, NSAIDs, and metformin have been shown to heighten the risk of CI-AKI in individuals undergoing coronary angiography, and it may be beneficial to stop taking these medications before receiving the contrast medium to prevent CI-AKI.[33]

Nevertheless, the current study discovered no notable correlation between the usage of NSAIDs, renin-angiotensin system inhibitors, and water pills and CI-AKI. In opposition to prior investigations that proposed ACEIs may add to CI-AKI, especially in individuals with pre-existing renal issues,[14,34] a recent research conducted by Abdalla and colleagues in 2022 demonstrated that diuretics may elevate the risk of CI-AKI by diminishing renal blood flow and amplifying the toxicity caused by the contrast agent.[35] Coronary angiography can serve both diagnostic and therapeutic purposes, such as PCI.36 In this research, the utilization of coronary angiography for PCI was linked to a higher incidence of CI-AKI,[13,37] which is similar to findings from other studies that suggest a PCI-related risk for CI-AKI. This could be attributed to variations in procedure-specific features, such as the type of catheter, stent, and intra-aortic balloon pump.[38] Furthermore, because preventive measures are limited, CI-AKI was predominantly observed in patients undergoing emergency PCI procedures, rather than selective PCI procedures.[25] The hospital solely has Iohexol as the available contrast agent, hence all subjects of the research were administered with it. Iohexol is a contrast agent with three iodine atoms and is non-ionic. It has a vast distribution volume, and over 90% of it is expelled unchanged via the glomerular filtration in the initial 24 hours. Thus, extreme caution must be taken while administering Iohexol to patients with severe renal dysfunction.[29] Furthermore, dehydration is hazardous and may lead to acute renal failure in vulnerable nondiabetic patients, diabetic patients, and patients with advanced vascular disease. Consequently, it is crucial for patients to be adequately hydrated prior to and following the administration of any contrast agent, such as iohexol.[29] The latest research demonstrated variations in the quantity of iohexol injected. We observed that in hospital settings, the determination of the amount of contrast agent used during angiography is reliant on the experience of the performing physicians, which could contribute to the occurrence of CI-AKI in some patients. The amount of contrast agent administered is significantly related to the development of CI-AKI according to statistical data, which is consistent with a study that identified high doses of contrast media as a risk factor for CI-AKI,[13] which is correlated with the severity of kidney damage and mortality.[39] In contrast, another study revealed no statistically significant connection between the quantity of contrast agent used and the incidence of CI-AKI.[25] The present investigation is subject to certain constraints. Firstly, it was conducted at a solitary medical facility, implying that its findings cannot be extrapolated to other hospitals. Secondly, we were unable to determine the estimated glomerular filtration rate (eGFR) for the patients, since we did not have access to data regarding their body weight. Thirdly, we did not explore the treatment and preventative measures for CI-AKI or the clinical implications after hospital discharge. Nonetheless, this study represents the first attempt to determine the frequency and risk factors of CI-AKI in our patients.

V. CONCLUSION

The research findings indicated a substantial prevalence (30.9%) of CI AKI in individuals who received coronary angiography. There was a significant correlation ($p < 0.05$) between CI-AKI and diabetes mellitus, PCI, and a large quantity of contrast medium. Patients who undergo coronary angiography are identified as the primary high-risk group for developing CI AKI. To improve renal safeguarding during coronary angiography, particularly for high-risk patients, more efficient approaches are imperative.

REFERENCES

1. Abdalla MA, Ahmed KO, Yousef BA. Incidence and Risk Factors of Contrast-Induced Acute Kidney Injury in Sudanese Patients Undergoing Coronary Angiography: A Descriptive Prospective Study. Cureus [Internet]. 2022 Feb 3; Available from: https://www.cureus.com/articles/83385-incidence-and-risk-factors-of-contrast-induced-acute-kidney-injury-in-sudanese-patients-undergoing-coronary-angiography-a-descriptive-prospective-study

2. Ix JH, Shlipak MG, Liu HH, Schiller NB, Whooley MA. Association between Renal Insufficiency and Inducible Ischemia in Patients with Coronary Artery Disease. J Am Soc Nephrol [Internet]. 2003 Dec;14(12):3233–8. Available from: https://journals.lww.com/00001751-200312000-00023

3. Anavekar NS, McMurray JJV, Velazquez EJ, Solomon SD, Kober L, Rouleau JL, et al. Relation between Renal Dysfunction and Cardiovascular Outcomes after Myocardial Infarction. N Engl J Med [Internet]. 2004 Sep 23;351(13):1285–95. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMoa041365

4. Ohtake T, Kobayashi S, Moriya H, Negishi K, Okamoto K,

Maesato K, et al. High Prevalence of Occult Coronary Artery Stenosis in Patients with Chronic Kidney Disease at the Initiation of Renal Replacement Therapy. J Am Soc Nephrol [Internet]. 2005 Apr;16(4):1141–8. Available from: https://journals.lww.com/00001751-200504000-00042

5. Levin A. THE CLINICAL EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES IN CHRONIC KIDNEY DISEASE: Clinical Epidemiology of Cardiovascular Disease in Chronic Kidney Disease Prior to Dialysis. Semin Dial [Internet]. 2003 Mar 28;16(2):101–5. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1046/j.1525-139X.2003.16025.x

6. Collins AJ. Cardiovascular Mortality in End-Stage Renal Disease. Am J Med Sci [Internet]. 2003 Apr;325(4):163–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0002962915342920

7. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu C yuan. Chronic Kidney Disease and the Risks of Death, Cardiovascular Events, and Hospitalization. N Engl J Med [Internet]. 2004 Sep 23;351(13):1296–305. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMoa041031

8. Park K, Chung WY, Seo JB, Kim SH, Zo JH, Kim MA, et al. The prevention of contrast induced nephropathy by sarpogrelate in patients with chronic kidney disease: a study protocol for a prospective randomized controlled clinical trial. Trials [Internet]. 2010 Dec 20;11(1):122. Available from: https://trialsjournal.biomedcentral.com/articles/10.1186/1745-6215-11-122

9. Wood SP. Contrast-Induced Nephropathy in Critical Care. Crit Care Nurse [Internet]. 2012 Dec 1;32(6):15–24. Available from: https://aacnjournals.org/ccnonline/article/32/6/15/3265/Contrast-Induced-Nephropathy-in-Critical-Care

10. Riley RF, Don CW, Powell W, Maynard C, Dean LS. Trends in Coronary Revascularization in the United States From 2001 to 2009. Circ Cardiovasc Qual Outcomes [Internet]. 2011 Mar;4(2):193–7. Available from: https://www.ahajournals.org/doi/10.1161/CIRCOUTCOMES.110.958744

11. McCullough PA. Contrast-Induced Acute Kidney Injury. J Am Coll Cardiol [Internet]. 2008 Apr;51(15):1419–28. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0735109708003537

12. Dangas G, Iakovou I, Nikolsky E, Aymong ED, Mintz GS, Kipshidze NN, et al. Contrast-Induced nephropathy after percutaneous coronary interventions in relation to chronic kidney disease and hemodynamic variables. Am J Cardiol [Internet]. 2005 Jan;95(1):13–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0002914904014407

13. Marenzi G, Lauri G, Assanelli E, Campodonico J, De Metrio M, Marana I, et al. Contrast-induced nephropathy in patients undergoing primary angioplasty for acute myocardial infarction. J Am Coll Cardiol [Internet]. 2004 Nov;44(9):1780–5. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0735109704016110

14. Tehrani S, Laing C, Yellon DM, Hausenloy DJ. Contrast-induced acute kidney injury following PCI. Eur J Clin Invest [Internet]. 2013 May;43(5):483–90. Available from: https://onlinelibrary.wiley.com/doi/10.1111/eci.12061

15. Knuuti J, Wijns W, Saraste A, Capodanno D, Barbato E, Funck-Brentano C, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J [Internet]. 2020 Jan 14;41(3):407–77. Available from: https://academic.oup.com/eurheartj/article/41/3/407/5556137

16. Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. Eur Heart J [Internet]. 2019 Jan 7;40(2):87–165. Available from: https://academic.oup.com/eurheartj/article/40/2/87/5079120

17. McCullough PA, Choi JP, Feghali GA, Schussler JM, Stoler RM, Vallabahn RC, et al. Contrast-Induced Acute Kidney Injury. J Am Coll Cardiol [Internet]. 2016 Sep;68(13):1465–73. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0735109716347179

18. Gleeson TG, Bulugahapitiya S. Contrast-Induced Nephropathy. Am J Roentgenol [Internet]. 2004 Dec;183(6):1673–89. Available from: https://www.ajronline.org/doi/10.2214/ajr.183.6.01831673

19. James MT, Samuel SM, Manning MA, Tonelli M, Ghali WA, Faris P, et al. Contrast-Induced Acute Kidney Injury and Risk of Adverse Clinical Outcomes After Coronary Angiography. Circ Cardiovasc Interv [Internet]. 2013 Feb;6(1):37–43. Available from: https://www.ahajournals.org/doi/10.1161/CIRCINTERVENTIONS.112.974493

20. Gopalan P. Contrast-induced acute kidney injury. South African J Anaesth Analg [Internet]. 2011 Mar 12;17(2):193–5. Available from: https://www.tandfonline.com/doi/full/10.1080/22201173.2011.10872776

21. Lei L, Xue Y, Guo Z, Liu B, He Y, Song F, et al. Population attributable risk estimates of risk factors for contrast-induced acute kidney injury following coronary angiography: a cohort study. BMC Cardiovasc Disord [Internet]. 2020 Dec 12;20(1):289. Available from: https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01570-6

22. Ribitsch W, Horina JH, Quehenberger F, Rosenkranz AR, Schilcher G. Contrast Induced Acute Kidney Injury and its Impact on Mid-Term Kidney Function, Cardiovascular Events and Mortality. Sci Rep [Internet]. 2019 Nov 15;9(1):16896. Available from: https://www.nature.com/articles/s41598-019-53040-5

23. Wakabayashi I. Gender differences in cardiovascular risk factors in patients with coronary artery disease and those with type 2 diabetes. J Thorac Dis [Internet]. 2017 May;9(5):E503–6. Available from: http://jtd.amegroups.com/article/view/13405/11370

24. Gao Z, Chen Z, Sun A, Deng X. Gender differences in cardiovascular disease. Med Nov Technol Devices [Internet]. 2019 Dec;4:100025. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2590093519300256

25. Yuan Y, Qiu H, Hu XY, Luo T, Gao XJ, Zhao XY, et al. Risk Factors of Contrast-induced Acute Kidney Injury in Patients Undergoing Emergency Percutaneous Coronary Intervention. Chin Med J (Engl) [Internet]. 2017 Jan 5;130(1):45–50. Available from: https://journals.lww.com/00029330-201701050-00008

26. Bansal S, Patel RN. Pathophysiology of Contrast-Induced Acute Kidney Injury. Interv Cardiol Clin [Internet]. 2020 Jul;9(3):293–8. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2211745820300250

27. Bartholomew BA, Harjai KJ, Dukkipati S, Boura JA, Yerkey MW, Glazier S, et al. Impact of nephropathy after percutaneous coronary intervention and a method for risk stratification. Am J Cardiol [Internet]. 2004 Jun;93(12):1515–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0002914904003595

28. Thakar C V., Christianson A, Himmelfarb J, Leonard AC. Acute Kidney Injury Episodes and Chronic Kidney Disease Risk in Diabetes Mellitus. Clin J Am Soc Nephrol [Internet]. 2011 Nov;6(11):2567–72. Available from: https://journals.lww.com/01277230-201111000-00005

29. Delanaye P, Ebert N, Melsom T, Gaspari F, Mariat C, Cavalier E, et al. Iohexol plasma clearance for measuring glomerular filtration rate in clinical practice and research: a review. Part 1: How to measure glomerular filtration rate with iohexol? Clin Kidney J [Internet]. 2016 Oct;9(5):682–99. Available from: https://academic.oup.com/ckj/article-lookup/doi/10.1093/ckj/sfw070

30. Rihal CS, Textor SC, Grill DE, Berger PB, Ting HH, Best PJ, et al. Incidence and Prognostic Importance of Acute Renal Failure After Percutaneous Coronary Intervention. Circulation [Internet]. 2002 May 14;105(19):2259–64. Available from: https://www.ahajournals.org/doi/10.1161/01.CIR.0000016043.87291.33

31. Tsai TT, Patel UD, Chang TI, Kennedy KF, Masoudi FA, Matheny ME, et al. Contemporary Incidence, Predictors, and Outcomes of Acute Kidney Injury in Patients Undergoing Percutaneous Coronary Interventions. JACC Cardiovasc Interv [Internet]. 2014 Jan;7(1):1–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1936879813015604

32. Andreucci M, Faga T, Serra R, De Sarro G, Michael A. Update on the renal toxicity of iodinated contrast drugs used in clinical medicine. Drug Healthc Patient Saf [Internet]. 2017 May;Volume 9:25–37. Available from: https://www.dovepress.com/update-on-the-renal-toxicity-of-iodinated-contrast-drugs-used-in-clini-peer-reviewed-article-DHPS

33. Hiremath S, Kayibanda JF, Chow BJW, Fergusson D, Knoll GA, Shabana W, et al. Drug discontinuation before contrast procedures and the effect on acute kidney injury and other clinical outcomes: a systematic review protocol. Syst Rev [Internet]. 2018 Dec 21;7(1):34. Available from: https://systematicreviewsjournal.biomedcentral.com/articles/10.1186/s13643-018-0701-1

34. Ma M, Wan X, Gao M, Pan B, Chen D, Sun Q, et al. Renin-angiotensin-aldosterone system blockade is associated with higher risk of contrast-induced acute kidney injury in patients with diabetes. Aging (Albany NY) [Internet]. 2020 Apr 2;12(7):5858–77. Available from: https://www.aging-us.com/lookup/doi/10.18632/aging.102982

35. Solomon R, Werner C, Mann D, D'Elia J, Silva P. Effects of Saline, Mannitol, and Furosemide on Acute Decreases in

Renal Function Induced by Radiocontrast Agents. N Engl J Med [Internet]. 1994 Nov 24;331(21):1416–20. Available from: http://www.nejm.org/doi/abs/10.1056/NEJM199411243312104

36. Kolkailah AA, Alreshq RS, Muhammed AM, Zahran ME, Anas El-Wegoud M, Nabhan AF. Transradial versus transfemoral approach for diagnostic coronary angiography and percutaneous coronary intervention in people with coronary artery disease. Cochrane Database Syst Rev [Internet]. 2018 Apr 18;2018(4). Available from: https://doi.wiley.com/10.1002/14651858.CD012318.pub2

37. Pyxaras SA, Sinagra G, Mangiacapra F, Perkan A, Di Serafino L, Vitrella G, et al. Contrast-Induced Nephropathy in Patients Undergoing Primary Percutaneous Coronary Intervention Without Acute Left Ventricular Ejection Fraction Impairment. Am J Cardiol [Internet]. 2013 Mar;111(5):684–8. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0002914912024514

38. Haq MFU, Yip CS, Arora P. The conundrum of contrast-induced acute kidney injury. J Thorac Dis [Internet]. 2020 Apr;12(4):1721–7. Available from: http://jtd.amegroups.com/article/view/38687/html

39. Marenzi G. Contrast Volume During Primary Percutaneous Coronary Intervention and Subsequent Contrast-Induced Nephropathy and Mortality. Ann Intern Med [Internet]. 2009 Feb 3;150(3):170. Available from: http://annals.org/article.aspx?doi=10.7326/0003-4819-150-3-200902030-00006

AUTHORS

First Author – Dr. Jaghat Ram
MBBS, FCPS,
Assistant Professor Cardiology
Cardiology Post Fellowship in Interventional Cardiology
National institute of Cardiovascular Disease Satellite Centre Larkana Sindh Pakistan

Second Author – Dr. Muhammad Assa Baloch,
MBBS, FCPS Cardiology, Senior Registrar Cardiology,
Department: Cardiology,
Sheikh Mohammad Bin Zayed Al. Nayhan institute of Cardiology Quetta, Quetta Pakistan,

Third Author – Dr. Samiullah
FCPS Cardiology
Assistant Professor Interventional Cardiology Hayatabad Medical Complex Peshawar

Fourth Author – Dr. Mashooque Ali Dasti
MBBS. DIP CARD. MD (Cardiology). Fellowship Interventional Cardiology
Associate Professor of Cardiology
National Institute of Cardiovascular Diseases (NICVD) Karachi, Sindh Pakistan

Fifth Author – Dr. Shahbaz Ali Shaikh
MBBS, FCPS (Cardiology)
Assistant Professor
National Institute of Cardiovascular Diseases (NICVD), Karachi

Sixth Author – Dr. Ghulam Mahdi Jamro
MBBS, MRCP (UK), FRCP(Glasgow)
Postgraduate Diploma Endocrinology (USW-UK)
Specialist physician Internal Medicine-Oman
Visiting Consultant Medicine
Muhammad Medical College (MMC) Mirpur khas

Correspondence Author Dr. Samiullah
FCPS Cardiology
Assistant Professor Interventional Cardiology
Hayatabad Medical Complex Peshawar