Ukrainian Journal of Nephrology and Dialysis
Scientific and Practical, Medical Journal

Founder:
- National Kidney Foundation of Ukraine

ISSN 2304-0238;
eISSN 2616-7352

Journal homepage: https://ukrjnd.com.ua

Research Article

doi: 10.31450/ukrjnd.1(81).2024.03

Hayder Abdulateef Zghair Nassir[1], Laith Falah Hassan[2]

Risk of acute kidney injury in elective percutaneous coronary intervention: A comparative study of radial and femoral access

[1]Department of Medicine, College of Medicine, University of Basrah, Basrah, Iraq
[2]Al-Karkh Health Directorate, Yarmouk Teaching Hospital, Baghdad, Iraq

Citation: Nassir HAZ, Hassan LF. Risk of acute kidney injury in elective percutaneous coronary intervention: A comparative study of radial and femoral access. Ukr J Nephr Dial. 2024;1(81):18-26. doi: 10.31450/ukrjnd.1(81).2024.03.

Abstract. *The impact of vascular access type, specifically transradial versus transfemoral, on the occurrence of acute kidney injury (AKI) in patients undergoing percutaneous coronary intervention (PCI) remains uncertain. In this study, we aimed to compare the incidence of AKI between the two access groups.*
Methods. This prospective observational study involved 164 adult patients undergoing elective PCI. Patients were categorized into transfemoral (n = 100) and transradial (n = 64) groups. Demographic data, including age, sex, body surface area, and preoperative glomerular filtration rate, as well as clinical information such as the presence of baseline ventricular dysfunction, diabetes mellitus, hypertension, postoperative blood loss, and transfusion volume, were recorded. Serum creatinine levels within the first 48-72 hours postoperatively were also documented.
Results. Out of 100 patients in the transfemoral group, 12 (12%) developed AKI compared with 2 patients out of 64 (3.13%) in the transradial group. In the logistic multivariate analysis, several independent risk factors for AKI in patients undergoing PCI were identified. These factors included age >55 years (OR 2.88, 95% CI 1.09; 11.97, p = 0.046), diabetes (OR 4.82, 95% CI 1.12; 31.65, p = 0.039), preprocedural creatinine levels > 0.85 mg/dL (OR 3.17, 95% CI 1.54; 17.96, p = 0.019), fluoroscopy time > 10 min (OR 6.55, 95% CI 1.65; 26.03, p = 0.008), Mehran score indicating a risk of contrast-induced nephropathy >8 (OR 4.23, 95% CI 1.25; 14.3, p = 0.020), and transfemoral access (OR 3.22, 95% CI 1.08; 18.54, p = 0.044).
Conclusions. Transradial access is associated with a significant independent reduction in the incidence of post-PCI AKI compared with transfemoral access. Age >55 years, diabetes, preprocedural creatinine > 0.85 mg/dL, fluoroscopy time > 10 min, Mehran score >8, and transfemoral access were identified as independent risk factors for AKI in patients undergoing PCI.

Keywords: *elective percutaneous coronary intervention, radial access, femoral access, acute kidney injury.*

Article history:
Received December 05, 2023
Received in revised form January 18, 2024
Accepted January 20, 2024

Conflict of interest statement. The authors declare no competing interest.

Correspondence should be addressed to Hayder Abdulateef Zghair Nassir:
hayder.zghair@uobasrah.edu.iq

УДК: 616.132.2–089.843:616-06:616.61-008.6-036.11

Хайдер Абдулатеф Згаір Насір[1], Лайт Фалах Хассан[2]

Ризик гострого пошкодження нирок у пацієнтів з плановим черезшкірним коронарним втручанням: порівняльне дослідження трансрадіального та трансфеморального доступу

1Кафедра медицини, Медичний коледж, Університет Басри, Басра, Ірак
2Управління охорони здоров я Аль-Карх, навчальна лікарня Ярмук, Багдад, Ірак

Резюме. *Вплив судинного доступу, зокрема трансрадіального проти трансфеморального, на розвиток гострого пошкодження нирок (ГПН) у пацієнтів з плановим черезшкірним коронарним втручанням (ЧКВ), залишається невизначеним. У цьому дослідженні ми мали на меті порівняти захворюваність на ГПН між двома групами доступу.*

Методи. У цьому проспективному обсерваційному дослідженні взяли участь 164 дорослих пацієнти, яким було виконано планове ЧКВ. Пацієнти були розділені на 2 групи: група трансфеморального (n = 100) та группа трансрадіального (n = 64) доступу. Аналізували демографічні дані, включаючи вік, стать, площу поверхні тіла та передопераційну швидкість клубочкової фільтрації, а також клінічну інформацію, таку як наявність базової шлуночкової дисфункції, цукрового діабету, гіпертензії, післяопераційної крововтрати та обсягу трансфузії. Рівні сироваткового креатиніну протягом перших 48-72 годин після операції також були задокументовані.

Результати. ГПН розвинулось у 12/100 (12%) пацієнтів групи трансфеморального доступу та у 2/64 (3,13%) пацієнтів групи трансрадіального доступу. У логістичному багатофакторному аналізі вік >55 років (OR 2,88; 95% CI 1,09; 11,97, p = 0,046), діабет (OR 4,82; 95% CI 1,12; 31,65, p = 0,039), рівень креатиніну до процедури > 0,85 мг/дл (ВШ 3,17; 95% ДІ 1,54; 17,96, p = 0,019), час флюорографії > 10 хв (ВШ 6,55; 95% ДІ 1,65; 26,03, p = 0,008), ризик контраст-індукованої нефропатії за шкалою Мехрана >8 (ВШ 4,23; 95% ДІ 1,25; 14,3, p = 0,020) і трансфеморальний доступ (OR 3,22; 95% ДІ 1,08; 18,54, p = 0,044) були ідентифіковані як незалежні фактори ризику ГПН у пацієнтів з плановим ЧКВ.

Висновки. Трансрадіальний доступ асоціюється зі статистично значущим зниженням частоти ГПН після ЧКВ порівняно з трансфеморальним доступом. Вік понад 55 років, цукровий діабет, рівень креатиніну >0,85 мг/дл перед процедурою, час флюорографії >10 хв, ризик контраст-індукованої нефропатії за шкалою Мехрана >8 і трансфеморальний доступ були визначені як незалежні фактори ризику ГПН у пацієнтів, які перенесли ЧКВ.

Ключові слова: *планове черезшкірне коронарне втручання, трансрадіальний доступ, трансфеморальний доступ, гостре пошкодженн нирок.*

Introduction. Morbidity, and mortality from ischemic heart disease (IHD) rank first in the current noninfectious diseases [1]. With the advent of the era of medical reperfusion, percutaneous coronary intervention (PCI) has been an effective treatment among patients with IHD. Acute kidney injury (AKI) is one of the common complications after PCI. A large-sample retrospective cohort study showed that the incidence of AKI after PCI was 9%. In PCI patients with AKI, the length of hospital stay was prolonged, the survival rate decreased, and the incidence of cardiovascular events and end-stage renal diseases (ESRD) also increased [2]. It has been reported that even mild deterioration of renal function after PCI that does not meet the criteria for AKI was associated with increased long-term mortality [3].

Studies have shown that one of the important causes of AKI after PCI is the nephrotoxicity of iodine contrast agents [2]. It is reported that the incidence of contrast agent-induced AKI is as high as 10–30%, which has become the third major inducement of iatrogenic AKI [4]. The pathogenesis of contrast-induced nephropathy (CIN) is complex and has not been fully elucidated.

The main mechanisms known include direct damage of contrast media (CM) to renal tubular epithelial cells, ischemia and hypoxia of renal medulla, release of oxygen free radicals, and inflammatory response [5]. Contrast media can decrease the activity of renal tubular epithelial cells by activating a series of ion channels, and activate a variety of apoptosis pathways to induce apoptosis of renal tubular epithelial cells [6]; the use of CM causes transient increase and then continuous decrease of renal blood flow, resulting in insufficient medullary perfusion. The osmotic diuretic effect of contrast agents leads to a decrease in blood circulation and the aggravation of renal ischemia. Furthermore,

Hayder Abdulateef Zghair Nassir
hayder.zghair@uobasrah.edu.iq

contrast agents may increase the pressure and liquid viscosity in renal tubules, and then lead to high quantity oxygen consumption of renal tubules. It also aggravates the ischemia and hypoxia of the medulla by renal vasoconstriction on account of reducing the production of nitric oxide (NO) [7].

The cardiac function may deteriorate in patients with IHD, manifesting as heart failure. The process of kidney injury caused by heart failure is consistent with the manifestations of type I cardiorenal syndrome. The incidence of renal dysfunction in patients with acute and chronic heart failure was 23% and 25%, respectively [8]. The decrease in cardiac output caused by IHD leads to the insufficiency of renal artery perfusion, the increase of renal vein pressure, and the decrease in glomerular filtration rate (GFR), which eventually causes kidney injury [9]. With the neurohumoral feedback systems, as sympathetic nervous system and renin angiotensin aldosterone system (RAAS) are overactivated, which can cause vasoconstriction and further kidney injury [10]. Also, ACS patients usually suffer from defects in the regulation of apoptosis and inflammatory pathway activation during the onset of the disease, and the overactivation of monocytes and the direct effect of pro-inflammatory factors can also cause renal tissue injury [11].

IHD patients suffer from obvious atherosclerosis. Cholesterol crystals in the plaques released into blood circulation may lead to embolism of multiple arterioles (including renal arterioles) when atherosclerotic plaques rupture. Meanwhile, platelets are activated by substances released from the vascular wall cells and secrete pro-inflammatory chemokines and cytokines, which participate in vascular inflammation, thus aggravating the disease [12].

Cholesterol crystal embolization can cause damage to renal parenchyma in a short period of time when multiple tiny blood vessels of the kidney are involved. The pathogenesis includes cholesterol embolism and inflammatory reaction. which later turn into megakaryocytes and then phagocytize cholesterol crystals. At the same time, thrombosis occurs in the microvasculature followed by angiointimal hyperplasia, and subsequently develops into vascular fibrosis, which eventually results in complete occlusion of the vascular lumens [13-16].

Transradial access (TRA) is the preferred choice for patients at a heightened risk of complications associated with femoral vascular access. Such high-risk patients encompass those with morbid obesity, severe lower extremity peripheral vascular disease, abdominal aortic aneurysm with thrombus, individuals on anticoagulation therapy, those unable to lie flat, and patients with bleeding diathesis [17]. While TRA has been increasingly adopted for PCI due to its association with reduced bleeding and vascular complications, its impact on AKI remains less clear. Retrospective analyses, including a large-scale study of over 80,000 patients, have suggested that TRA may confer a lower risk of AKI compared to transfemoral access (TFA), even after adjusting for periprocedural bleeding (OR 0.76, P=0.03) [18]. Similarly, in high-risk patients undergoing primary PCI for ST-elevation myocardial infarction (STEMI) at high-volume centers, TFA was linked to a higher incidence of AKI (OR 1.65; CI [1.084-2.524]; p=0.02) [19]. Furthermore, a prospective study indicated a trend toward reduced AKI with TRA [20]. Despite these findings, there remains a knowledge gap regarding the definitive impact of vascular access on AKI incidence in the PCI patient population, particularly when considering various patient risk profiles and procedural contexts.

The present study aims to address this gap by comparing the effects of TRA versus TFA vascular access on the development of AKI in patients undergoing PCI.

Patients and methods. ***Study Design and Setting.*** This was a prospective observational study including 164 consecutive adult patients undergoing PCI in Ibn Albaitar Center, Iraqi Center for Heart Disease, Baghdad Cardiac Center, and Al Najaf Cardiac Center. Patients were categorized according to vascular access into TFA (n = 100) and TRA (n = 64) groups. The study protocol was approved by the Iraqi Council of Medical Specializations. Prior to data collection, explicit consent was obtained from each participant after providing a comprehensive explanation of the study's objectives. Each patient was afforded the unrestricted option to withdraw at any point. The study ensured strict confidentiality of all data, assuring participants that the information would solely be utilized for research purposes.

Inclusion criteria: all adult consecutive patients undergoing non-emergency PCI. Exclusion criteria: patients Exclusion criteria: patients with left ventricular ejection fraction (EF) less than 50%, those undergoing complex PCI, and individuals requiring emergency operations.

Data Collection. Demographic information includes age, sex, height, weight, and body surface area. Investigations involve preoperative glomerular filtration rate (GFR) and serum creatinine. Clinical data encompass the presence of baseline ventricular dysfunction (ejection fraction <50%), diabetes mellitus, peripheral vascular disease, hypertension, postoperative blood loss, and transfusion volume requirements. Serum creatinine levels 48-72 hours postoperatively will also be recorded. The Cath Lab systems utilized are from Philips and Siemens.

Endpoints and follow-up period. The main outcomes assessed in the study included AKI, characterized by a rise in serum creatinine exceeding 25% or an increase of 0.5 mg from baseline within 48-72 hours postoperatively, kidney failure necessitating the initiation of dialysis, and overall hospital mortality. We closely monitored patients for three months post-procedure, and no significant complications were observed, as all patients were categorized as Type A lesions, irrespective of radial or femoral access. The patient's disposition after the PCI procedure is outlined as follows:

- Cases discharged on the day of the procedure with no complications (n=88).
- Cases were kept under observation for 2 days before discharge with no complications (n=76).

Post-procedural care involved a comprehensive reassessment and evaluation, including complete blood count (CBC), renal function tests (RFT), thyroid function tests (TFT), liver function tests (LFT), GFR, troponin, abdominal ultrasound, and chest x-ray. No cases required readmission. Follow-up was conducted regularly, either weekly or monthly as needed, at both the private outpatient clinic and the Ibn Albaitar Center, Iraqi Center for Heart Disease, Baghdad Cardiac Center, and Al Najaf Cardiac Center.

All discharged cases exhibited no minor or major complications during follow-up post-PCI. Renal indices were monitored, and there were no reported cases of microvascular obstruction. The administration of a low osmolar iodinated contrast agent, specifically iopromide (Ultravist 370), was uniform at 100-150 ml per patient, ensuring consistency in care.

Statistical analysis. All data were recorded using Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 24.0. Continuous variables were presented as mean and standard deviation (M±SD) and assessed with an independent t-test, while categorical variables were expressed as frequency and percentage and analyzed using the Chi-square test. Logistic regression analysis was conducted through a multivariate model to identify factors significantly associated with AKI, building upon the findings of the univariate model. This analysis yielded odds ratios (OR) and their corresponding 95% confidence intervals (CI). A p-value equal to or less than 0.05 was considered statistically significant.

Results. ***Baseline characteristics of the patients.*** The mean age of the patients in the TRA group was higher than that of the TFA group (p = 0.016). However, both groups were comparable in terms of sex, body weight, and smoking status with no significant differences. In contrast, patients in the TFA group demonstrated lower BMI than those in the TRA group (p = 0.019). Diabetes and hypertension were very common comorbidities in both groups. Although DM was more common among patients in the TFA than the TRA groups (74% vs. 67.19%), the difference was not significant. The mean level of creatinine was slightly higher in the TFA group than TRA group with no significant differences. Preprocedural Hb concentration was very close between the two groups with no significant difference (Table 1).

Table 1

Demographic and clinical characteristics of the study population

Variables	Transfemoral Group (n=100)	Transradial Group (n=64)	p-value
Age (years)	54.35±9.44	58.07±9.53	0.016
Sex			
Male Female	79 (79%) 21 (21%)	49 (76.56%) 15 (23.44%)	0.623
Body mass (kg)	74.47±13.83	78.45±13.95	0.076
BMI (k/m^2)	26.14 ± 3.8	27.98 ± 4.64	0.019
Smoking			
Never Ex/current	89 (89%) 11 (11%)	52 (81.25%) 12 (18.75%)	0.163
Comorbidity			
DM HTN	74 (74%) 55 (55%)	43 (67.19%) 33 (51.56%)	0.482 0.667
Creatinine (mg/dL)	0.90 ±0.23	0.81±0.22	0.205
Hb (g/dL)	13.34±1.64	13.51±1.65	0.535

Abbreviations: BMI; body mass index, DM; diabetes mellitus, Hb; hemoglobin, HTN; hypertension.

Procedural characteristics of the patients. Both groups were comparable regarding the frequency of cardiogenic shock with no significant differences. However, the mean fluoroscopy time in the TRA group was significantly higher than in the TFA group (Table 2).

Table 2

Procedural characteristics of the included patients

Features	Transfemoral Group (n=100)	Transradial Group (n=64)	p-value
Cardiogenic shock No Yes	 93 (93%) 7 (7%)	 60 (93.75%) 4 (6.25%)	0.851
Fluoroscopy time (min)	8.59±3.88	10.62±5.3	0.011
Contrast volume (ml3)	141.35±54.38	163.54±52.15	0.009
Mehran Score	8.39±3.1	7.17±2.1	0.071

Moreover, the TRA group had a significantly higher contrast volume compared with the TRA group. Finally, the mean Mehran score in TFA and TRA was 8.39±3.1 and 7.17±2.1, respectively with no significant difference.

Post-PCI AKI incidence and its association with Baseline patient characteristics. Out of 100 patients in the TFA group, 12 (12%) developed AKI compared with 2 patients out of 64 (3.13%) in the TRA group. Statistically, there was a significant difference between TFA and TRA in the incidence of AKI. Patients in both groups were categorized into two categories: with and without AKI (Table 3).

Table 3

Association of the patient's baseline characteristics with the development of post-PCI AKI

Variables	Patients without AKI (n=150)	Patients with AKI (n=14)	p-value
Age (years)	55.85±9.2	62.23±12.47	0.022
Gender Male Female	 117 (78%) 32 (22%)	 11 (78.57%) 3 (21.43%)	0.997
Body mass (kg)	75.18±13.84	77.19±14.0	0.386
BMI (k/m^2)	27.36±4.32	26.33±5.41	0.405
Smoking Never Ex/current	 129 (86%) 21 (14%)	 12 (85.71%) 2 (14.29%)	0.977
Comorbidity DM HTN	 103 (68.67%) 78 (52%)	 14 (100%) 10 (71.43%)	 0.013 0.163
Creatinine (mg/dL)	0.85±0.23	1.04±0.22	0.004
Hb (g/dL)	13.48±1.64	12.76±1.54	0.120

Abbreviations: BMI; body mass index, DM; diabetes mellitus, Hb; hemoglobin, HTN; hypertension.

As presented in Table 3, the patients with AKI were younger and had a higher prevalence of diabetes and serum creatinine levels compared with the patients without AKI.

Risk factors for post-PCI AKI development. Firstly, we compared the procedural characteristics studied between the patients with and without AKI. Two procedural characteristics were found to be significantly associated with the development of post-PCI AKI: the fluoroscopy time and the Mehran score (Table 4).

Table 4

Association of procedural characteristics with development of post-PCI AKI

Characteristics	Patients without AKI (n=150)	Patients with AKI (n=14)	p-value
Cardiogenic shock No Yes	 140 (93.33%) 10 (6.67%)	 13 (92.86%) 1 (7.14%)	0.946
Fluoroscopy time, (min)	9.52±4.5	12.95±6.82	0.010
Contrast volume (mL3)	154.24±54.11 50-	160±54.35	0.704
Mehran Score	7.75±2.6	10.57±4.0	<0.001

Abbreviation: AKI; acute kidney injury.

Secondly, a logistic regression analysis was conducted to assess whether the type of vascular access serves as an independent risk factor for the development of AKI in patients undergoing PCI, irrespective of other confounding variables. All baseline and procedural factors that exhibited significant associations with AKI were included. Numeric variables were categorized into two groups using appropriate cutoff values. The results of the multivariate model are presented in Table 5.

Table 5

Risk factors for post-PCI AKI development in the multivariate logistic regression analysis

Variables	Patients without AKI (n=150)	Patients with AKI (n=14)	p-value	OR(95%CI)
Age, (years) ≤55 >55	77 (51.33%) 73 (48.67%)	3 (21.43%) 11 (78.57%)	0.046	1.0 2.88(1.09-11.97)
DM No Yes	47 (31.33%) 103 (68.67%)	0 14 (100%)	0.039	1.0 4.82(1.12-31.65)
Creatinine (mg/dL) ≤0.85 >0.85	84 (56%) 66 (44%)	2 (14.29%) 12 (85.71%)	0.019	1.0 3.17(1.54-17.96)
Fluoroscopy time, (minute) ≤10 >10	98 (65.33%) 52 (34.67%)	3 (21.43%) 11 (78.57%)	0.008	1.0 6.55(1.65-26.03)
Mehran Score ≤8 >8	98 (65.33%) 52 (34.67%)	4 (28.57%) 10 (71.43%)	0.020	1.0 4.23(1.25-14.3)
Vascular access Transradial Transfemoral	62 (41.33%) 88 (58.67%)	2 (14.29%) 12 (85.71%)	0.044	1.0 3.22(1.08-18.54)

Abbreviations: AKI; acute kidney injury, CI; confidence interval, DM; diabetes mellitus, OR; odds ratio.

As shown in Table 5, age >55 years, diabetes, preprocedural creatinine > 0.85 mg/dL, fluoroscopy time > 10 min, Mehran score >8, and transfemoral access were identified as independent risk factors for the development of AKI following PCI.

Discussion. Over 60 years back radial arterial access was described, but it was not favored due to equipment and technical limitations. Then, successful interventional procedures through the radial route were introduced. Since then, transradial catheterization has gained widespread adoption in many parts of the world [21]. In the present study, patients in the TFA group had significantly older ages and lower BMIs than those in the TRA group. This is almost in agreement with an American study including 7,529 patients, 5,353 (71%) in the TFA group and 2,176 (29%) in the TRA group [22]. Patients in the TFA Group were older than those in the TRA group. This difference may arise from operator selection bias, where operators tend to opt for radial access when performing coronary angiography on older and heavier patients [22].

Furthermore, patients in the TRA group had significantly higher fluoroscopy time and contrast volume (10.62±5.3 min and 163.54±52.15 ml, respectively than TFA group (8.59±3.88 min and 141.35±54.38 ml, respectively). These results are in accordance with a Pakistani study including 1016 adult patients undergoing PCI [23]. The mean fluoroscopy time in the TRA group was 6.3±3.0 min compared with 4.0±2.9 ml in the TFA group, while the median contrast volume was 221 ml and 81 ml in the TRA and TFA groups, respectively. This observation mainly referred to the complexity of radial anatomy and the technical difficulties that a radial operator has to face while performing the transradial procedure [23].

The key finding in the present study was that 12% of patients in the TFA group developed AKI compared with 3.13% in the TRA group. This finding significantly extends previous work in this field. In fact, many previous studies have also demonstrated similar findings although with different rates of AKI in each group. Among 8404 patients enrolled in the MATRIX-Access trial [24] from 78 centers. AKI occurred in significantly fewer patients with TRA compared with TFA. AKI occurred in 15.4% with TRA and 17.4% with TFA (p = 0.018). A propensity-matched analysis of 17,714 patients who received urgent or elective PCI showed a 24% reduction in the risk of AKI, defined as an absolute increase in serum creatinine of >0.5 mg/dL in patients who underwent TRA compared with those who underwent TFA. In a STEMI population that underwent primary PCI, TFA compared with RA was associated with a 56% greater risk of AKI [25].

Pancholy et al. demonstrated that the primary endpoint of post-PCI AKI was significantly less frequent in the TRA group compared with the TFA Group (1.1% vs 2.4%, p = 0.001). TRA was independently associated with a lower incidence of post-PCI AKI (OR 0.57, 95% confidence interval 0.35 to 0.91, p = 0.018) [26]. A comparison of the data of 21,479 patients in the radial group and 25,337 patients in the femoral group indicated a reduced incidence of AKI with the radial route [OR=0.66, 95% CI: 0.54-0.81, p<0.0001 [27]. However, several studies did not confirm such an association. A study randomly assigned 8404 patients with acute coronary syndrome, with or without STsegment elevation, to radial (4197) or femoral (4207) access for coronary angiography and percutaneous coronary intervention. Kidney failure was reported in 1.1 and 1.4% in radial and femoral access respectively with no significant difference [28]. In an Egyptian study, the incidence of AKI was 16.67% and 13.33% in TFA and TRA, respectively without statistically significant difference between the two approaches [29]. These variations between different studies could be attributed to several factors, the most important of which are the variation in the definition of AKI in different studies, variation in demographic characteristics of the patients, and variation in contrast volume and fluoroscopy time. Interestingly not all studies conducted a multivariate analysis or used propensity-matched methods, which implies the effects of some confounding factors.

According to multivariate analysis in the present study, besides vascular access, age >55 years, diabetes, preprocedural creatinine > 0.85 mg/dL, fluoroscopy time > 10 min, and Mehran score >8 were independent risk factors for the development of AKI following PCI. Several studies worldwide indicated the importance of these factors in the incidence of AKI post-PCI. In the Egyptian study [29], the authors noticed that there was a direct relation between the development of AKI and old age and the presence of diabetes. Also, AKI was strongly related to longer fluoroscopy time and the amount of contrast media. In a large cohort including 9512 patients undergoing PCI, Giacoppo et al. [30] found that patients who developed AKI had a higher prevalence of comorbidities. After multivariable analysis, established risk factors for AKI, diabetes mellitus, and increased contrast volume, were found to be independently associated with AKI.

Our study has several limitations that warrant acknowledgment. Firstly, the sample size is relatively small, limiting the generalizability of the results. Secondly, there was a lack of standardization in the type of contrast media used and the implementation of AKI preventive treatments across all patients. Additionally, the variability in Cath Lab Machine systems resulted in different radiation exposures, preventing the collection of consistent radiation doses for equivalent fluoroscopy times. Finally, the study did not include all possible confounders that could influence post-PCI AKI, which may affect the comprehensive understanding of the observed outcomes.

Conclusions. Transradial PCI access demonstrates a notable independent reduction in the incidence of post-PCI AKI compared with TFA. Independent risk factors for the development of post-PCI AKI include older age (>55 years), the presence of

diabetes, preprocedural creatinine > 0.85 mg/dL, fluoroscopy time > 10 min, and a Mehran score >8. Given that many risk factors for post-PCI AKI are nonmodifiable, the utilization of TRA offers operators an additional opportunity to mitigate the risk. The use of non-ionic low osmolar contrast media is recommended. Further studies with larger sample sizes and propensity-score-matched designs are advised for more robust and reliable results.

Conflict of interest. The authors declare no conflict of interest.

Funding source. The authors declare that they did not receive any financial support from any organization for the submitted paper.

Data availability. The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' contribution.

H. A. Z. Nassir: conceptualization, investigation, resources, data curation, writing - original draft;

L. F. Hassan: conceptualization; data curation; writing – reviewing.

References:

1. World Health Organization. [Internet]. Global status report on noncommunicable diseases, 2023. [accessed 2023 Nov 2]. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.
2. *Brown JR, Rezaee ME, Nichols EL, Marshall EJ, Siew ED, Matheny ME.* Incidence and In-Hospital Mortality of Acute Kidney Injury (AKI) and Dialysis-Requiring AKI (AKI-D) After Cardiac Catheterization in the National Inpatient Sample. J Am Heart Assoc. 2016;5(3):e002739. doi: 10.1161/JAHA.115.002739.
3. *Kanic V, Suran D, Vollrath M, Tapajner A, Kompara G.* Influence of minor deterioration of renal function after PCI on outcome in patients with ST-elevation myocardial infarction. J Interv Cardiol. 2017;30(5):473-479. doi: 10.1111/joic.12407.
4. *Mohammed NM, Mahfouz A, Achkar K, Rafie IM, Hajar R.* Contrast-induced Nephropathy. Heart Views. 2013;14(3):106-16. doi: 10.4103/1995-705X.125926.
5. *Ozkok S, Ozkok A.* Contrast-induced acute kidney injury: A review of practical points. World J Nephrol. 2017;6(3):86-99. doi: 10.5527/wjn.v6.i3.86.
6. *Andreucci M, Faga T, Russo D, Bertucci B, Tamburrini O, Pisani A, et al.* Differential activation of signaling pathways by low-osmolar and iso-osmolar radiocontrast agents in human renal tubular cells. J Cell Biochem. 2014;115(2):281-9. doi: 10.1002/jcb.24662.
7. *Liu ZZ, Schmerbach K, Lu Y, Perlewitz A, Nikitina T, Cantow K, et al.* Iodinated contrast media cause direct tubular cell damage, leading to oxidative stress, low nitric oxide, and impairment of tubuloglomerular feedback. Am J Physiol Renal Physiol. 2014 Apr 15;306(8):F864-72. doi: 10.1152/ajprenal.00302.2013.
8. *Shirakabe A, Hata N, Kobayashi N, Okazaki H, Matsushita M, Shibata Y, et al.* Worsening renal failure in patients with acute heart failure: the importance of cardiac biomarkers. ESC Heart Fail. 2019;6(2):416-427. doi: 10.1002/ehf2.12414.
9. *Di Lullo L, Bellasi A, Barbera V, Russo D, Russo L, Di Iorio B, et al.* Pathophysiology of the cardiorenal syndromes types 1-5: An uptodate. Indian Heart J. 2017;69(2):255-265. doi: 10.1016/j.ihj.2017.01.005.
10. *Matsushita K.* Pathogenetic Pathways of Cardiorenal Syndrome and their Possible Therapeutic Implications. Curr Pharm Des. 2016;22(30):4629-4637. doi: 10.2174/1381612822666160510125057.
11. *Kumar U, Wettersten N, Garimella PS.* Cardiorenal Syndrome: Pathophysiology. Cardiol Clin. 2019;37(3):251-265. doi: 10.1016/j.ccl.2019.04.001.
12. *Ozkok A.* Cholesterol-embolization syndrome: current perspectives. Vasc Health Risk Manag. 2019;15:209-220. doi: 10.2147/VHRM.S175150.
13. *Ghanem F, Vodnala D, K Kalavakunta J, Durga S, Thormeier N, Subramaniyam P, et al.* Cholesterol crystal embolization following plaque rupture: a systemic disease with unusual features. J Biomed Res. 2017;31(2):82-94. doi: 10.7555/JBR.31.20160100.
14. *Ortega-Loubon C, Fern ndez-Molina M, Carrascal-Hinojal Y, Fulquet-Carreras E.* Cardiac surgery-associated acute kidney injury. Ann Card Anaesth. 2016;19(4):687-698. doi: 10.4103/0971-9784.191578.
15. *Raso Vasquez AO, Kertai MD, Fontes ML.* Postoperative thrombocytopenia: why you should consider antiplatelet therapy? Curr Opin Anaesthesiol. 2018;31(1):61-66. doi: 10.1097/ACO.0000000000000551.
16. *Brodsky S, Eikelboom J, Hebert LA.* Anticoagulant-Related Nephropathy. J Am Soc Nephrol. 2018;29(12):2787-2793. doi: 10.1681/ASN.2018070741.
17. *Anjum I, Khan MA, Aadil M, Faraz A, Farooqui M, Hashmi A.* Transradial vs. Transfemoral Approach in Cardiac Catheterization: A Literature Review. Cureus. 2017;9(6):e1309. doi: 10.7759/cureus.1309.
18. *Kooiman J, Seth M, Dixon S, Wohns D, LaLonde T, Rao SV, et al.* Risk of acute kidney injury after percutaneous coronary interven-

tions using radial versus femoral vascular access: insights from the Blue Cross Blue Shield of Michigan Cardiovascular Consortium. Circ Cardiovasc Interv. 2014;7(2):190-8. doi: 10.1161/CIRCINTERVENTIONS.113.000778.

19. *Cortese B, Sciahbasi A, Sebik R, Rigattieri S, Alonzo A, Silva-Orrego P, et al.* Comparison of risk of acute kidney injury after primary percutaneous coronary interventions with the transradial approach versus the transfemoral approach (from the PRIPITENA urban registry). Am J Cardiol. 2014;114(6):820-5. doi: 10.1016/j.amjcard.2014.06.010.
20. *Damluji A, Cohen MG, Smairat R, Steckbeck R, Moscucci M, Gilchrist IC.* The incidence of acute kidney injury after cardiac catheterization or PCI: a comparison of radial vs. femoral approach. Int J Cardiol. 2014;173(3):595-7. doi: 10.1016/j.ijcard.2014.03.092.
21. *Piers LH, Vink MA, Amoroso G.* Transradial Approach in Primary Percutaneous Coronary Intervention: Lessons from a High-volume Centre. Interv Cardiol. 2016;11(2):88-92. doi: 10.15420/icr.2016:21:3.
22. *Pancholy MS, Skelding K, Scott T, Blankenship J, Pancholy SB.* Effect of Access Site Choice on Acute Kidney Injury After Percutaneous Coronary Intervention. Am J Cardiol. 2017;120(12):2141-2145. doi: 10.1016/j.amjcard.2017.08.039.
23. *Farman MT, Khan NU, Sial JA, Saghir T, Rizvi SN, Zaman KS.* Comparison of fluoroscopy time during coronary angiography and interventions by radial and femoral routes- can we decrease the fluoroscopy time with increased experience? An observational study. Anadolu Kardiyol Derg. 2011;11(7):607-12. doi: 10.5152/akd.2011.163.
24. *Valgimigli M, Gagnor A, Calabr P, Frigoli E, Leonardi S, Zaro T, et al;* MATRIX Investigators. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. Lancet. 2015;385(9986):2465-76. doi: 10.1016/S0140-6736(15)60292-6.
25. *Le May M, Wells G, So D, Chong AY, Dick A, Froeschl M, et al.* Safety and Efficacy of Femoral Access vs Radial Access in ST-Segment Elevation Myocardial Infarction: The SAFARI-STEMI Randomized Clinical Trial. JAMA Cardiol. 2020;5(2):126-134. doi: 10.1001/jamacardio.2019.4852.
26. *Pancholy MS, Skelding K, Scott T, Blankenship J, Pancholy SB.* Effect of Access Site Choice on Acute Kidney Injury After Percutaneous Coronary Intervention. Am J Cardiol. 2017;120(12):2141-2145. doi: 10.1016/j.amjcard.2017.08.039.
27. *Wang C, Chen W, Yu M, Yang P.* Comparison of acute kidney injury with radial vs. femoral access for patients undergoing coronary catheterization: An updated meta-analysis of 46,816 patients. Exp Ther Med. 2020;20(5):42. doi: 10.3892/etm.2020.9170.
28. *Jolly SS, Yusuf S, Cairns J, Niemel K, Xavier D, Widimsky P, et al;* RIVAL trial group. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet. 2011;377(9775):1409-20. doi: 10.1016/S0140-6736(11)60404-2.
29. *Samy N, Ahmed A. Osama M.* Contrast Induced Nephropathy after Radial or Femoral Access for Invasive Management of Acute Coronary Syndrome. World J Cardiovasc Dis. 2019;9:572-583. doi: 10.4236/wjcd.2019.98050.
30. *Giacoppo D, Madhavan MV, Baber U, Warren J, Bansilal S, Witzenbichler B, et al.* Impact of Contrast-Induced Acute Kidney Injury After Percutaneous Coronary Intervention on Short- and Long-Term Outcomes: Pooled Analysis From the HORIZONS-AMI and ACUITY Trials. Circ Cardiovasc Interv. 2015;8(8):e002475. doi: 10.1161/CIRCINTERVENTIONS.114.002475.