Cardiology and Angiology: An International Journal

Volume 12, Issue 4, Page 154-161, 2023; Article no.CA.100819
ISSN: 2347-520X, NLM ID: 101658392

Predictors of Bleeding after Percutaneous Coronary Intervention

Kerols Safwat Ayob Esa [a*], Ibtsam Khairat Abdelhayi [a], Yasser El Barbary [a] and Mai Mohamed Salama [a]

[a] Cardiovascular Medicine Department, Faculty of Medicine, Tanta University, Tanta, Egypt.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CA/2023/v12i4354

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100819

Original Research Article

Received: 04/05/2023
Accepted: 05/07/2023
Published: 11/07/2023

ABSTRACT

Background: Acute coronary syndrome patient outcomes have been improved using early invasive techniques. The aim of this study was to investigate the incidence, location, and severity of bleeding in PCI-treated cases to identify patient risk profiles and increased bleeding occurrences.
Methods: This prospective observational study evaluated percutaneous coronary angiography in 80 patients with hypertension and diabetes mellitus who planned to undergo primary or elective PCI. The cases were separated into 2 groups; those who reported bleeding (n=11) and those who did not (n=69). All patients underwent physical examination, laboratory evaluation, 12-lead electrocardiography, and PCI.
Results: In univariate regression analysis, age (OR: 1.09, 95% CI: 1.009 – 1.192), female gender (OR: 4.32, 95% CI: 1.157 – 16.131), history of peripheral arterial disease (OR: 7.31, 95% CI: 1.585 – 33.742), and femoral site of vascular access (OR: 9.6, 95% CI: 2.263 – 40.721) were independent predictors of major bleeding after PCI. In multivariate regression analysis, age (OR: 1.12, 95% CI:1.014 – 1.269), female gender (OR: 13.75, 95% CI: 1.983 – 161.2), history of peripheral arterial disease (OR: 43.38, 95% CI: 3.754 - 1042) and femoral site of vascular access (OR: 13.29, 95% CI: 2.233 – 128.5) were independent predictors of major bleeding after PCI.

**Corresponding author;*

Conclusions: Patients who reported bleeding after PCI had a significantly higher age, prevalence of female sex, serum creatinine, and transfemoral intervention before and after intervention compared to patients who did not report bleeding, while haemoglobin and transradial intervention before and after intervention were significantly lower in the bleeding cases than in the non-bleeding cases.

Keywords: Acute coronary syndrome; bleeding; percutaneous coronary intervention.

1. INTRODUCTION

Acute coronary syndrome (ACS) patient outcomes have been improved by the use of early invasive techniques. Cases undergoing primary percutaneous coronary intervention (PCI) have an enhanced risk for bleeding occurrences, with these events affecting morbidity and mortality significantly [1,2].

Prior to selecting a therapeutic plan for PCI patients with a high risk of bleeding, international guidelines encourage weighing the bleeding risk. Although the causes and outcomes of hemorrhagic events after primary PCI have been investigated, their absolute and relative rates over time remain unclear [1,3].

According to research, the incidence of substantial bleeding in ACS ranges from 0.8% to 11.5% and is the most prominent non-cardiac morbidity in these instances [4,5].

There are many factors that act as predictors of bleeding, among these factors: age, sex, renal function, vascular access (femoral access versus radial access), anaemia, same clay discharge versus delayed day discharge [2].

Depending on laboratory findings, bleeding is classified as major (intracranial bleeding or haemorrhage that causes hemodynamic instability and necessitates intervention), moderate (haemorrhage that requires blood transfusion but does not cause hemodynamic instability), or mild (bleeding that is not sever or moderate) [5,6].

The objective of this study was to investigate the incidence, location, and severity of bleeding in PCI-treated cases to identify patient risk profiles and increased bleeding occurrences.

2. PATIENTS AND METHODS

This prospective observational study evaluated percutaneous coronary angiography in 80 patients with hypertension and diabetes mellitus who planned to undergo primary or elective PCI at Cardiology Department, Tanta University hospital, and Elmokattam Insurance hospital between September 2020 and June 2021.

The research performed following approval from the Ethical Committee Tanta University. An informed written consent taken from the cases.

Exclusion criteria were patient refusal, advanced kidney disorder [7], hepatic disease [8], age less than 18 years, congenital heart disease and contraindications for catheterization (sever infections, blood diseases, malignancy, severe anemia or any hematological disorders).

The cases were separated into two groups: those who reported bleeding (n=11) and those who did not (n=69).

All patients underwent a medical history, physical examination, laboratory evaluation (complete blood count, INR, and serum creatinine), 12-lead electrocardiography, and percutaneous coronary intervention.

2.1 PCI Procedure

Coronary angioplasty and intracoronary stent implantation were done by whether primary or elective PCI via the femoral artery [9].

Prior to cardiac intervention, all patients were administered intravenous unfractionated heparin (10 000–12 000 U bolus + 12-hour heparin infusion for primary PCI and a preset dose of 5000 U for elective PCI). Modified to obtain an active clotting time of 200–250 seconds with adjunctive IIb/IIIa antagonist and 250–300 seconds without it (epifibatide 180 mcg/kg IV followed by continuous infusion 2 mcg/kg/min in primary PCI and 180 g/kg bolus + 1 g/kg/min injection in elective PCI).

Coronary angiography was performed invasively. Catheters for right and left control were inserted via the sheath in the right femoral artery (trans-

femoral approach). Evaluation of lesions from two orthogonal perspectives.

Syntax score computation (to assess the stenosis).

The syntax score recognized with >50% diameter in the coronary tree, reduction in vessels >1.5mm diameter. Based on AHA categorization, the coronary tree is subdivided into 16 parts [10].

Based on a table, this score varied from 3.5 for the proximal LAD to 5.0 for the left major and 0.5 for minor branches.

In the case of complete occlusion, additional points were granted as follows: age more than 3 months or unknown, bridging collateral image, blunt stump, and side branch with a diameter larger than 1.5 each received 1 point. One diseased segment receives 3 points, two diseased segments get 4 points, three diseased segments receive 5 points, and four diseased segments receive 6 points. One point was granted for types A, B, and C of bifurcation lesions; two points were awarded for types D, E, F, and G; and one point was awarded for an angulation more than 70 degrees [10].

Additionally, an aorto-ostial lesion was worth one-point, severe vessel tortuosity was worth two points, lesion length greater than twenty millimetres was worth one point, heavy calcification was worth one point, thrombus was worth one point, and diffuse disorder or small vessel involvement was worth one point per segment. Multiple lesions separated by fewer than three diameters of the reference vessel are evaluated as a single lesion. However, at a distance greater than three vessel diameters, these injuries were regarded separate [11].

2.2 Stent Implantation

If a coronary stent was necessary, the catheter containing the stent was carried along the guidewire and positioned appropriately in the stenotic coronary artery segment, followed by the expansion of the balloon. Positioned above the balloon, the stented device swells and deploys to alleviate stenosis.

Direct stenting or pre-dilation and stenting were the most prevalent stent placement techniques. Following balloon dilatation of the stenotic segment, the stent was implanted. During direct stenting, a low-profile stent delivery device was delivered directly to the lesion, and the stent was implanted without pre dilatation.

Following PCI, patients are advised to take aspirin indefinitely and clopidogrel for at least one year [12].

2.3 Post-discharge Bleeding

The PDB was defined as any of the following events: a significant or moderate Thrombolysis in Myocardial Infarction (TIMI) haemorrhage; a Global Use of Strategies to Open Occluded Arteries (GUSTO) [13] moderate or severe haemorrhage; an Acute Catheterization and Urgent Intervention Triage Strategy (ACUITY) [14] major haemorrhage; or any PDB event requiring therapeutic care. Based on its timing, PDB was categorised as early (30 days), late (30 days to 1 year), or extremely late. To categorise the site of bleeding, the following categories were utilised: central nervous system, gastrointestinal, arterial access-location (non-retroperitoneal), genitourinary, retroperitoneal, and other.

Among the outcomes evaluated in this investigation were all-cause mortality, cardiac death, MI, definite or potential ST, target vessel failure (TVF), and MACE [15]. MACE, which is a subset of the wider class of major adverse clinical events, refers to a combination or mixed clinical outcome used in clinical trials for cardiovascular research to assess the effectiveness of a medication. A major cardiovascular/clinical adverse event is utilised as a proxy for the safety and effectiveness of a certain intervention. MI was characterised using the ACUITY criterion [16,17].

The Academic Research Consortium's criterion of definitive or probable stent thrombosis was utilised [18]. TVF was defined as the sum of mortality, MI, and ischemia-driven revascularization of target vessels. MACE was defined as the combination of cardiac death, myocardial infarction, and ischemia-driven revascularization of a target lesion. All enrolled patients were followed for three months after discharge.

2.4 Statistical Analysis

After collecting data, a code sheet was constructed. SPSS (Statistical Package for the Social Sciences) V25 by IBM, United States was utilised for data organisation, tabulation,

presentation, and analysis. Numerical data were provided as mean and standard deviation (SD) and compared between two groups utilizing the unpaired Student's t-test. Qualitative data were provided as frequency and percentage (percent) and compared between two groups utilizing the Chi-square test. A P value of 0.05 with two tails was considered statistically significant.

3. RESULTS

Age, females, peripheral arterial disease, and previous bleeding were significantly more prevalent in the bleeding group than in the non-bleeding group (P = 0.021, 0.032, 0.018, and 0.002, respectively). Two groups did not vary substantially in terms of BMI, hypertension, diabetes, smoking status, and renal insufficiency Table 1.

The reported medications (antiplatelet, anticoagulant, or both) did not differ significantly between the two groups. Patients with haemorrhage had significantly higher serum creatinine levels than those without bleeding (P 0.001). Patients with bleeding had significantly lower Hgb levels before and after intervention than those without bleeding (P = 0.022 and 0.001, respectively). PLT and WBCs counts were not significantly different between groups before and after intervention Table 2.

ST elevation in bleeding group was significant increase than no bleeding group, and normal cases in no bleeding group was significant increase than bleeding group. ECG findings after intervention and HR before and after intervention were insignificantly different between two groups Table 3.

Table 1. Demographic characteristics and risk factors of the studied groups

		Patients with Bleeding (n =11)	Patients without bleeding (n =69)	P value
Age (years)		69 ± 7.08	61 ± 10.99	0.021*
Gender	**Male**	5 (45.45%)	54 (78.26%)	0.032*
	Female	6 (54.55%)	15 (21.74%)	
BMI (kg/m^2)		23.35 ± 3.5	25.7 ± 4.53	0.111
Risk factors				
HTN		9 (81.82%)	50 (72.74)	1
DM		6 (54.55%)	32 (46.38%)	0.749
Current Smoking		2 (18.18%)	33 (47.83%)	0.101
Renal insufficiency		3 (27.27%)	6 (8.70%)	0.103
Peripheral arterial disease		4 (36.36%)	5 (7.25%)	0.018*
Past bleeding trends		6 (54.55%)	7 (10.14%)	0.002*

*Data are represented as mean ± SD or frequency (%), *: statically significant as P value ≤ 0.05, BMI: Body mass index, HTN: Hypertension, DM: Diabetes mellitus*

Table 2. Medication reported in the studied groups

		Patient with Bleeding (n =11)	Patient without bleeding (n =69)	P value
Previous used medications	**Antiplatelet**	6 (54.55%)	27 (39.13%)	0.347
	Anticoagulant	2 (18.18%)	19 (27.54%)	0.718
	Both	3 (27.27%)	23 (33.33%)	1.000
Serum creatinine (mg/dL)		1.53 ± 0.27	1.24 ± 0.25	<0.001*
CBC before intervention	**Hgb (g/dL)**	12.35 ± 2.08	13.88 ± 2.00	0.022*
	PLT (10^3 cells/µL)	214.82 ± 89.81	231.42 ± 77.97	0.522
	WBCs (10^3 cells/µL)	8.31 ± 3.47	7.69 ± 2.98	0.528
CBC After intervention	**Hgb (g/dL)**	11.11 ± 2.02	13.42 ± 2.00	< 0.001*
	PLT (10^3 cells/µL)	198.73 ± 89.70	220.12 ±77.66	0.409
	WBCs (10^3 cells/µL)	7.68 ±3.53	7.20 ± 2.99	0.635

*Data are represented as mean ± SD or frequency (%), CBC: complete blood count, Hgb: hemoglobin, PLT: platelets, WBCs: white blood cells, *: statically significant as p value ≥ 0.05*

Table 3. 12-leads electrocardiogram findings before and after intervention in the studied groups

		Before intervention	After intervention
Patients with Bleeding (n=11)	**ST elevation**	5 (45.45%)	0 (0%)
	ST depression	1 (9.09%)	1 (9.09%)
	T-wave inversion	3 (27.27%)	1 (9.09%)
	Normal	2 (18.18%)	9 (81.82%)
Patients without bleeding (n=69)	**ST elevation**	9 (13.04%)	2 (2.90%)
	ST depression	7 (10.14%)	3 (4.35%)
	T-wave inversion	18 (26.09%)	5 (7.25%)
	Normal	35 (50.72%)	59 (85.51%)
P value		0.048*	0.848
HR in bleeding group (beats/min)		84 ± 9	79 ± 8
HR in no bleeding group (beats/min)		79 ± 8	75 ± 10
P value		0.064	0.214

Data are represented as mean ± SD or frequency (%),: statically significant as p value ≥ 0.05, ECG: electrocardiogram, STEMI: ST-elevation myocardial infarction*

Table 4. Percutaneous coronary intervention vascular access and used drugs in the studied groups and sites of bleeding reported in the studied patients

		Patients with Bleeding (n =11)	Patients without bleeding (n =69)	P value
Vascular access	**Trans radial intervention**	3 (27.27%)	54 (78.26%)	0.002*
	Transfemoral intervention	8 (72.73%)	15 (21.74%)	
Drugs used before discharge	**Aspirin**	5 (45.45%)	25 (36.23%)	0.739
	Clopidogrel	2 (18.18%)	12 (17.39%)	1.000
	Both	4 (36.36%)	32 (46.38%)	0.746
Drugs used after discharge	**Aspirin and Clopidogrel**	11 (100%)	69 (100%)	-
Sites of bleeding reported		**Patients who had bleeding (n =11)**		
Puncture site bleeding		4 (36.36%)		
Puncture site hematoma		6 (54.55%)		
Retroperitoneal bleeding		1 (9.09%)		
Gastrointestinal bleeding		2 (18.18%)		

*Data are presented as frequency (%), *: statically significant as p value ≥ 0.05*

Table 5. Univariate and multivariate logistic regression analysis of various risk factors for the prediction of major bleeding after PCI

	Univariate logistic regression		Multivariate logistic regression	
	OR (95% CI)	**p value**	**OR (95% CI)**	**p value**
Age (years)	1.09 (1.009 – 1.192)	**0.028***	1.12 (1.014 – 1.269)	**0.048***
Female gender	4.32 (1.157 – 16.131)	**0.029***	13.75 (1.983 – 161.2)	**0.015***
History of peripheral arterial disease	7.31 (1.585 – 33.742)	**0.011***	43.38 (3.754 - 1042)	**0.006***
Femoral site of vascular access	9.6 (2.263 – 40.721)	**0.002***	13.29 (2.233 – 128.5)	**0.009***

*OR: Odds ratio, CI: Confidence interval, *Statistically significant as p value ≤0.05*

Regarding vascular access, transradial intervention was significantly lower in the bleeding group compared to the non-bleeding group, whereas transfemoral intervention was significantly higher in the bleeding group compared to the non-bleeding group (P = 0.002). There was no significant difference between the two groups in terms of the drugs utilised before discharge Table 4.

In univariate regression analysis, age (OR: 1.09, 95% CI: 1.009 – 1.192), female gender (OR: 4.32, 95% CI: 1.157 – 16.131), history of peripheral arterial disease (OR: 7.31, 95% CI: 1.585 – 33.742), and femoral site of vascular access (OR: 9.6, 95% CI: 2.263 – 40.721) were independent predictors of major bleeding after PCI. In multivariate regression analysis, age (OR: 1.12, 95% CI:1.014 – 1.269), female gender (OR: 13.75, 95% CI: 1.983 – 161.2), history of peripheral arterial disease (OR: 43.38, 95% CI: 3.754 - 1042) and femoral site of vascular access (OR: 13.29, 95% CI: 2.233 – 128.5) were independent predictors of major bleeding after PCI Table 5.

4. DISCUSSION

Early invasive procedures have increased the risk of haemorrhage in ACS patients and PCI patients. Major bleeding is associated with a twofold to eightfold increase in mortality in patients with ACS with PCI. Significant bleeding carries a mortality risk that is comparable to or greater than that of myocardial infarction [19].

In the present study, it was found that the presence of peripheral arterial disease and past bleeding trends were significant increase in cases with bleeding group than cases without bleeding group (P value= 0.018, 0.002 respectively).

In consistent with our results, Valle et al. [20] showed that peripheral vascular disease and bleed within year preceding PCI was significantly higher in post discharge bleeding–related hospitalization than no post discharge bleeding–related hospitalization.

On contrary with our results, Sharma et al. [21] demonstrated that peripheral arterial disease was insignificantly different between BARC ≥ 1 bleeding group and no bleeding group. Their larger included sample size and classifying patients' responses were according to the BARC classification could confer a reasonable justification for this difference.

Our study reported that Hgb before and after intervention was significant decrease in bleeding group than without bleeding group (P = 0.022, < 0.001 respectively).

In agreement with our result, Généreux et al. [22] found that hemoglobin was significant decrease in PDB group than no PDB group (P <0.001).

In disagreement with our result, Sharma et al. [21] revealed that Hb was insignificant difference among two groups.

In our study, serum creatinine was significant increase in in patients with bleeding than without bleeding (P <0.001).

Compatible to our findings, Olivier et al. [23] did their investigation on 1,348 instances of ACS in which transradial PCI was performed. Before the initial balloon inflation, clopidogrel (90 percent 12 hours prior to PCI) and abciximab were administered to all patients. They demonstrated that the major bleeding group had significantly higher creatinine clearance than the non-major bleeding group (P 0.001).

In present study, vascular access, trans radial intervention was significant decrease in bleeding group than no bleeding group but transfemoral intervention was significant increase in bleeding group than without bleeding group (P = 0.002).

Similarly, Numasawa et al. [24] observed that Transradial intervention was significantly less common in the bleeding group than in the non-bleeding group, but transfemoral intervention was significantly more common in the bleeding group than in the non-bleeding group.

contradiction, Généreux et al. [22] reported the femoral and radial vascular access between two groups was not significantly different. This discrepancy could be explained by their greater sample size and their use of a different study methodology (prospective cohort) compared to our case-control sample.

According to our result, in univariate regression analysis, age (OR: 1.09, 95% CI: 1.009 – 1.192), female gender (OR: 4.32, 95% CI: 1.157 – 16.131), history of peripheral arterial disease (OR: 7.31, 95% CI: 1.585 – 33.742), femoral site of vascular access (OR: 9.6, 95% CI: 2.263 – 40.721) and baseline hemoglobin (OR:0.68, 95% CI: 0.485 – 0.961) are independent predictors for major bleeding after PCI.

Additionally, Murali et al. [25] stated Older age (OR 1.02, 95 percent CI: 1.01–1.02), female sex (OR 1.34, 95 percent CI: 1.22–1.47), fibrinolytic therapy (OR 1.77, 95 percent CI: 1.46–2.15), antiplatelet agents including GPI (OR 1.53, 95 percent CI: 1.35–1.72), and cardiogenic shock (OR 1.42, 95 percent CI: 1.10–1.82) were independently predictive of BARC-defined bleeding at baseline.

Our results were also confirmed by Jarrah et al. [26] who performed PCI in 2426 patients in succession. Using multivariate analysis, only two variables were significantly associated with serious bleeding: female gender (OR=3.7; 95% CI: 1.6, 8.5; p=0.002) and history of cardiovascular disease (OR=2.6; 95% CI: 1.1, 5.8; p=0.026).

The study cohort was rather small, and it was conducted at a single centre. Our statistical approach might not have effectively compensated for every instance of selection bias. Lack of follow-up data due to the design of the study limits our ability to precisely examine the predictors of bleeding problems.

5. CONCLUSIONS

Patients who reported bleeding after PCI had a significantly higher mean age, prevalence of female sex, serum creatinine, and transfemoral intervention before and after intervention compared to patients who did not report bleeding, while haemoglobin and transradial intervention before and after intervention were significantly lower in the bleeding cases than in the non-bleeding cases. Female gender, a history of peripheral arterial disease, the femoral site of vascular access, and haemoglobin levels at baseline are independent predictors of severe bleeding following PCI.

CONSENT AND ETHICAL APPROVAL

The research performed following approval from the Ethical Committee Tanta University. An informed written consent taken from the cases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bagai J, Little B, Banerjee S. Association between arterial access site and anticoagulation strategy on major bleeding and mortality: A historical cohort analysis in the Veteran population. Cardiovasc Revasc Med. 2018;19:95-101.
2. Pandie S, Mehta SR, Cantor WJ, Cheema AN, Gao P, Madan M, et al. Radial Versus Femoral Access for Coronary Angiography/Intervention in Women With Acute Coronary Syndromes: Insights From the RIVAL Trial (Radial Vs femorAL access for coronary intervention). JACC Cardiovasc Interv. 2015;8:505-12.
3. Udell JA, Koh M, Qiu F, Austin PC, Wijeysundera HC, Bagai A, et al. Outcomes of Women and Men With Acute Coronary Syndrome Treated With and Without Percutaneous Coronary Revascularization. J Am Heart Assoc. 2017;6.
4. Kwok CS, Sherwood MW, Watson SM, Nasir SB, Sperrin M, Nolan J, et al. Blood transfusion after percutaneous coronary intervention and risk of subsequent adverse outcomes: a systematic review and meta-analysis. JACC Cardiovasc Interv. 2015;8:436-46.
5. Kwok CS, Khan MA, Rao SV, Kinnaird T, Sperrin M, Buchan I, et al. Access and non-access site bleeding after percutaneous coronary intervention and risk of subsequent mortality and major adverse cardiovascular events: systematic review and meta-analysis. Circ Cardiovasc Interv. 2015;8.
6. Ndrepepa G, Guerra E, Schulz S, Fusaro M, Cassese S, Kastrati A. Weight of the bleeding impact on early and late mortality after percutaneous coronary intervention. J Thromb Thrombolysis. 2015;39:35-42.
7. Alcázar Arroyo R, Orte Martínez L, Otero González A. [Advanced chronic kidney disease]. Nefrologia. 2008;28 Suppl 3:3-6.
8. Sherman KE. Advanced liver disease: what every hepatitis C virus treater should know. Top Antivir Med. 2011;19:121-5.
9. Werner N, Nickenig G, Sinning J-M. Complex PCI procedures: challenges for the interventional cardiologist. Clinical Research in Cardiology. 2018;107:64-73.
10. Yadav M, Palmerini T, Caixeta A, Madhavan MV, Sanidas E, Kirtane AJ, et al. Prediction of coronary risk by SYNTAX and derived scores: synergy between percutaneous coronary intervention with taxus and cardiac surgery. J Am Coll Cardiol. 2013;62:1219-30.
11. Serruys PW, Onuma Y, Garg S, Sarno G, van den Brand M, Kappetein AP, et al.

Assessment of the SYNTAX score in the Syntax study. EuroIntervention. 2009;5: 50-6.
12. Stergiopoulos K, Brown DL. Initial coronary stent implantation with medical therapy vs medical therapy alone for stable coronary artery disease: meta-analysis of randomized controlled trials. Arch Intern Med. 2012;172:312-9.
13. Généreux P, Giustino G, Witzenbichler B, Weisz G, Stuckey TD, Rinaldi MJ, et al. Incidence, Predictors, and Impact of Post-Discharge Bleeding After Percutaneous Coronary Intervention. Journal of the American College of Cardiology. 2015;66:1036-45.
14. Stone GW, Bertrand M, Colombo A, Dangas G, Farkouh ME, Feit F, et al. Acute Catheterization and Urgent Intervention Triage strategY (ACUITY) trial: study design and rationale. Am Heart J. 2004;148:764-75.
15. Poudel I, Tejpal C, Rashid H, Jahan N. Major Adverse Cardiovascular Events: An Inevitable Outcome of ST-elevation myocardial infarction? A Literature Review. Cureus. 2019;11:e5280.
16. Stone GW, Witzenbichler B, Weisz G, Rinaldi MJ, Neumann FJ, Metzger DC, et al. Platelet reactivity and clinical outcomes after coronary artery implantation of drug-eluting stents (ADAPT-DES): a prospective multicentre registry study. Lancet. 2013; 382:614-23.
17. Stone GW, McLaurin BT, Cox DA, Bertrand ME, Lincoff AM, Moses JW, et al. Bivalirudin for patients with acute coronary syndromes. N Engl J Med. 2006;355: 2203-16.
18. Cutlip DE, Windecker S, Mehran R, Boam A, Cohen DJ, van Es GA, et al. Clinical end points in coronary stent trials: a case for standardized definitions. Circulation. 2007;115:2344-51.
19. Urban P, Mehran R, Colleran R, Angiolillo DJ, Byrne RA, Capodanno D, et al. Defining High Bleeding Risk in Patients Undergoing Percutaneous Coronary Intervention. Circulation. 2019;140:240-61.
20. Valle JA, Shetterly S, Maddox TM, Ho PM, Bradley SM, Sandhu A, et al. Postdischarge Bleeding After Percutaneous Coronary Intervention and Subsequent Mortality and Myocardial Infarction. Circ Cardiovasc Interv. 2016; 9:3519-21.
21. Sharma PK, Chhatriwalla AK, Cohen DJ, Jang J-S, Baweja P, Gosch K, et al. Predicting long-term bleeding after percutaneous coronary intervention. Catheter Cardiovasc Interv. 2017;89: 199-206.
22. Généreux P, Giustino G, Witzenbichler B, Weisz G, Stuckey TD, Rinaldi MJ, et al. Incidence, Predictors, and Impact of Post-Discharge Bleeding After Percutaneous Coronary Intervention. J Am Coll Cardiol. 2015;66:1036-45.
23. Bertrand OF, Larose É, Rodés-Cabau J, Gleeton O, Taillon I, Roy L, et al. Incidence, predictors, and clinical impact of bleeding after transradial coronary stenting and maximal antiplatelet therapy. American Heart Journal. 2009; 157:164-9.
24. Numasawa Y, Kohsaka S, Ueda I, Miyata H, Sawano M, Kawamura A, et al. Incidence and predictors of bleeding complications after percutaneous coronary intervention. J Cardiol. 2017;69: 272-9.
25. Murali S, Vogrin S, Noaman S, Dinh DT, Brennan AL, Lefkovits J, et al. Bleeding Severity in Percutaneous Coronary Intervention (PCI) and Its Impact on Short-Term Clinical Outcomes. Journal of Clinical Medicine. 2020;9:1426.
26. Jarrah M, Hammoudeh A, Okkeh O, Khader Y, Gharaibeh S, Nasser L, et al. Major bleeding events in Jordanian patients undergoing percutaneous coronary intervention (PCI): Incidence, associated factors, impact on prognosis, and predictability of the CRUSADE bleeding risk score. Results from the First Jordanian PCR (PCR1). Anatol J Cardiol. 2017;17:445-51.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/100819