e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(9); 781-786

Original Research Article

Hematocrit Values Before and after Percutaneous Coronary Intervention and its Clinical Relevance

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Received: 25-06-2023 / Revised: 28-07-2023 / Accepted: 30-08-2023
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Conflict of interest: Nil

Abstract:

Background: Both preprocedural anemia in patients undergoing percutaneous coronary intervention (PCI) as well as the occurrence and magnitude of procedure-related bleeding or anemia after PCI have been associated with late mortality and adverse cardiovascular outcomes. Reports describing these associations have not used consistent definitions for the degree of blood loss and pre-PCI anemia. Variations in the definitions of these parameters may potentially lead to confusion with regard to patient risk

Objectives: This study was undertaken to clarify the relationship between these 2 established risk factors (hematocrit at baseline and hematocrit decline after PCI) and adverse late outcomes.

Methods: A cross-sectional study was conducted in the tertiary teaching hospital from January 2010 to December 2010 was enrolled in the study. 300 consecutive patients who underwent PCI and who completed 1-year follow-up were included in this analysis without any exclusion criteria. All patients gave written consent for the PCI procedure.

Results: For description purposes, the entire population was divided with regard to hematocrit at baseline and the magnitude of hematocrit decline. The study population was composed of mostly men (65%), with a mean age of 65 years and a high prevalence of comorbidities. More than 80% were hypertensive, around one-third had a history of diabetes, close to half had previous coronary revascularization, and almost 15% had a history of congestive heart failure. The most frequent clinical presentation was either stable angina or unstable angina. The rate of drug-eluting stent use was >80%, with a high rate of angiographic success.

Conclusion: Hematocrit at baseline and the drop after PCI should be recognized as important risk factors for adverse outcomes after PCI.

Keywords: Hematocrit, PCI, anemia.

Introduction

Percutaneous coronary intervention (PCI) is the standard therapy for patients with symptomatic coronary artery disease [1,2] and hemodynamically significant coronary stenosis.[3]

The combined use of antiplatelet and antithrombin agents during and after PCI has significantly reduced the rate of stent thrombosis [4,5].

The Thrombolysis in Myocardial Infarction (TIMI) [4] and Global Utilization of Streptokinase and t-PA for Occluded Coronary Arteries (GUSTO) [5] trial groups have quantified the incidence and severity of bleeding risks after thrombolytic therapy for acute myocardial infarction (MI) [6].

Materials and Methods:

This cross-sectional study was conducted in a tertiary teaching hospital for a period of 12 months, from January 2010 to December 2010. 300 consecutive patients who underwent PCI and who completed 1-year follow-up were included in this analysis without any exclusion criteria.

All patients gave written consent for the PCI procedure, and the study was conducted under Institutional Review Board approval. Percutaneous coronary intervention was performed according to guidelines current at the time of the procedure. In all cases, the interventional strategy was at the discretion of the responsible physician.

Intraprocedural anticoagulation was ensured using unfractionated heparin to achieve an activated clotting time of >250 seconds in all patients. Glycoprotein IIb/IIIa inhibitors were used at the operator's discretion. All patients received an aspirin loading dose of 325 mg and were encouraged to continue this regimen indefinitely. After a clopidogrel loading dose of 300 to 600 mg, additional antiplatelet therapy with a 75-mg clopidogrel maintenance dose was instituted in all patients. These patients were advised to continue this regimen for at least 1 year. Clinical follow-up was done via telephone contact or office visits. The primary endpoint was the composite of all-cause mortality or nonfatal MI at 1-year follow-up.

Statistical Analysis

Continuous variables are expressed as mean ± SD. Discrete variables are presented as absolute numbers and percentages. Statistical significance was assumed at P value < .05.

Results:

Baseline characteristics

In total, 300 consecutive patients who underwent PCI from January 2010 to December 2010. and those who completed 1-year follow-up were included in this study. For description purposes, the entire population was divided with regard to hematocrit at baseline and the magnitude of hematocrit decline (Tables I-IV). The cut points were taken from previous publications [7,8,9].

The study population was composed of mostly men (65%), with a mean age of 65 years and a high prevalence of comorbidities. More than 80% were hypertensive, around one-third had a history of diabetes, close to half had previous coronary revascularization, and almost 15% had a history of congestive heart failure. The most frequent clinical presentation was either stable angina or unstable angina. Heparin was the most predominant anticoagulation method used. The majority of the population presented with multivessel disease. The rate of drug-eluting stent use was >80%, with a high rate of angiographic success.

Table 1: Baseline clinical patient characteristic regarding hematocrit at baseline

Clinical characteristics	**>39% (n = 140)**	**39%-35% (n = 90)**	**34%-30% (n = 52)**	**<30% (n = 18)**	**P-Value**
Age(yr)	62.1	61.3	64.5	64.3	0.006**
Male, n (%)	134(95.7%)	70(77.8%)	34(65.4%)	8(44.4%)	**<0.001****
Diabetes, n (%)	58(41.4%)	42(46.7%)	22(42.3%)	8(44.4%)	0.116
Hypertension, n (%)	52(37.1%)	46(51.1%)	24(46.2%)	8(44.4%)	0.048*
Current smoking, n (%)	54(38.6%)	50(55.6%)	6(11.5%)	4(22.2%)	<0.001**
Hypercholesterolemia, n (%)	92(65.7%)	46(51.1%)	28(53.8%)	4(22.2%)	0.076
Family history of CAD, n (%)	42(30%)	28(31.1%)	24(46.2%)	6(33.3%)	0.052
History of CABG or PCI, n (%)	4(2.9%)	4(4.4%)	2(3.8%)	2(11.1%)	**0.025***
History of CHF, n (%)	8(5.7%)	6(6.7%)	10(19.2%)	4(22.2%)	**<0.001****
Laboratory characteristics					
Baseline hematocrit	44.2	36.3	32.4	26.3	<0.001**
Nadir hematocrit	39.1	34.2	31.1	25.1	<0.001**
Mean hematocrit drop	5.1	2.1	1.3	1.2	**<0.001****
Baseline creatinine	1	1.2	1.1	1.4	0.168
Indication for PCI					
Acute MI, n (%)	90(64.3%)	42(46.7%)	30(57.7%)	18(100%)	**<0.001****
Cardiogenic shock, n (%)	6(4.3%)	4(4.4%)	2(3.8%)	2(11.1%)	0.162
Unstable angina, n (%)	44(31.4%)	30(33.3%)	20(38.5%)	6(33.3%)	0.839
Stable angina, n (%)	12(8.6%)	16(17.8%)	45(86.5%)	10(55.6%)	**<0.001****

Table 2: Angiographic and procedural characteristics regarding hematocrit at baseline

Procedural characteristics	**>39% (n = 140)**	**39%-35% (n = 90)**	**34%-30% (n = 52)**	**<30% (n = 18)**	**P-value**
Heparin use, n (%)	140(100%)	90(100%)	52(100%)	18(100%)	1.000
GP IIb/IIIa inhibitors, n (%)	20(14.3%)	18(20%)	14(26.9%)	10(55.6%)	**<0.001****
No. of treated lesions, median					
1 Treated lesion, n (%)	124(88.6%)	62(68.9%)	40(76.9%)	14(77.8%)	0.003**
2 Treated lesions, n (%)	14(10%)	26(28.9%)	10(19.2%)	2(11.1%)	0.003**
>2 Treated lesions, n (%)	2(1.4%)	1(1.1%)	2(3.8%)	2(11.1%)	0.053

Angiographic characteristics	>39% (n = 140)	39%-35% (n = 90)	34% 30% (n = 52)	<30% (n = 18)	P-value
Target vessel, n (%)					
LM, n (%)	2(1.4%)	2(2.2%)	6(11.5%)	2(11.1%)	**0.004****
LAD, n (%)	90(64.3%)	66(73.3%)	26(50%)	10(55.6%)	0.034*
LCx, n (%)	30(21.4%)	20(22.2%)	8(15.4%)	2(11.1%)	0.565
RCA, n (%)	38(27.1%)	36(40%)	24(46.2%)	10(55.6%)	0.013*
Type C lesion, n (%)	44(31.4%)	54(60%)	28(53.8%)	12(66.7%)	**<0.001****
DES, n	106(75.7%)	90(100%)	52(100%)	16(88.9%)	**<0.001****
Angiographic success	138(98.6%)	89(98.9%)	51(98.1%)	17(94.4%)	0.593

Table 3: Baseline clinical patient characteristics regarding the hematocrit drop

Hematocrit Drop	<5% (n=180)	5%-10% (n=88)	>10% (n=32)	P value
Clinical characteristics				
Age(yr)	62.3	63.1	65.5	0.028*
Male, n (%)	170(94.4%)	68(77.3%)	26(81.3%)	<0.001**
Diabetes, n (%)	80(44.4%)	28(31.8%)	18(56.3%)	0.032*
Hypertension, n (%)	68(37.8%)	44(50%)	16(50%)	0.111
Current smoking, n (%)	34(18.9%)	16(18.2%)	6(18.8%)	0.990
Hypercholesterolemia, n (%)	144(80%)	66(75%)	28(87.5%)	0.308
Family history of CAD, n (%)	62(34.4%)	32(36.4%)	10(31.3%)	0.869
History of CABG or PCI, n (%)	4(2.2%)	4(4.5%)	2(6.3%)	0.380
History of CHF, n (%)	20(11.1%)	14(15.9%)	8(25%)	0.094
Laboratory characteristics				
Baseline hematocrit, % ± SD	39.5	40.2	40.5	0.125
Nadir hematocrit, % ± SD	38.1	34.1	26.1	<0.001**
Mean hematocrit drop, % ± SD	1.4	6.1	14.1	**<0.001****
Indication of PCI, n (%)				
Acute MI, n (%)	108(60%)	58(65.9%)	26(81.3%)	0.063
Cardiogenic shock, n (%)	4(2.2%)	6(6.8%)	8(25%)	**<0.001****
Unstable angina, n (%)	58(32.2%)	26(29.5%)	10(31.3%)	0.906
Stable angina, n (%)	24(13.3%)	8(9.1%)	2(6.3%)	0.372

Hematocrit Drop	<5% (n=180)	5%-10% (n=88)	>10% (n=32)	P value
Procedural characteristics				
Heparin use, n (%)	180(100%)	88(100%)	32(100%)	NS
GP IIb/IIIa inhibitors, n (%)	22(12.2%)	30(34.1%)	8(25%)	**<0.001****
1 Treated lesion, n (%)	110(61.1%)	64(72.7%)	30(93.8%)	0.001**
2 Treated lesions, n (%)	20(11.1%)	24(27.3%)	8(25%)	0.002**
>2 Treated lesions, n (%)	2(1.1%)	4(4.5%)	2(6.3%)	0.108

Hematocrit Drop	<5% (n=180)	5%-10% (n=88)	>10% (n=32)	P value
Angiographic characteristics				
Target vessel, n (%)				
LM, n (%)	4(2.2%)	4(4.5%)	2(6.3%)	0.380
LAD, n (%)	112(62.2%)	58(65.9%)	24(75%)	0.363
LCx, n (%)	30(16.7%)	18(20.5%)	10(31.3%)	0.149
RCA, n (%)	60(33.3%)	36(40.9%)	8(25%)	0.226
Type C lesion, n (%)	70(38.9%)	44(50%)	22(68.8%)	**0.004****
DES, n (%)	138(76.7%)	70(79.5%)	20(62.5%)	0.146
Angiographic success, n (%)	179(99.4%)	88(100%)	30(93.8%)	**0.006****

Table 4: Hematocrit at baseline and one year outcome of death and MI

	Hematocrit at baseline			
	>39%	35% to 39%	34% to 30%	<30%
Death and MI(n)	4	5	8	10

Table 5: Hematocrit at baseline and one year outcome of death and MI

	Hematocrit drop after PCI		
	<10%	**5% to 10%**	**>10%**
Death and MI(n)	4	8	15

Table 6: Hematocrit drop and composite endpoint

	Death and MI
Hematocrit drop < 5%	14.8%
Hematocrit drop > 10%	55.5%

Tables V and VI display the 1-year unadjusted outcome risks according to hematocrit at baseline and hematocrit drop after PCI, respectively. Death and myocardial infarction were 55.5% when the hematocrit drop after PCI was more than 10% compared to 14.8% when the hematocrit drop was less than 5%. Both hematocrit at baseline (hazard ratio = 0.92, P < .001) and hematocrit drop after PCI (hazard ratio = 4.3, P < .001) strongly predicted the primary endpoint at 1-year follow-up.

The outcome difference was primarily driven by mortality in both cases and nonfatal MI for hematocrit at baseline. The frequency of the composite primary endpoint death/MI correlated oppositely to hematocrit at baseline and to the drop after PCI. For example, the higher the hematocrit at baseline, the less likely the occurrence of the composite primary endpoint at 1-year follow-up (hazard ratio [HR] 0.95 [0.9-0.98] for 1%-unit increase, P < .001); and the higher the magnitude of hematocrit drop, the higher the incidence of the composite primary endpoint at 1-year follow-up (HR 1.13 [1.09-1.15] for 1%-unit decrease, P < .001).

The expected clinical and angiographic characteristics age (HR 1.06 [1.02-1.04], P < .001), male gender (HR 1.1 [1.0-1.6], P = .04), diabetes (HR 1.9 [1.2-1.9], P < .001), chronic renal insufficiency (HR 1.8 [1.4-2.3], P < .001), congestive heart failure (HR 2.3 [1.6-2.6], P < .001), previous MI (HR 1.5 [1.1-1.7], P = .01), cardiogenic shock(HR 1.6[1.1-2.2], P = .02), the presence of at least 1 type C lesion (HR 1.3 [1.0-1.6], P = .05), and number of treated lesions (HR 1.2 [1.0-1.1], P = .03) were also associated with the 1-year composite end point of death/MI.

Table 7: Relationship between hematocrit at baseline and the 1-year outcome

Primary end point	**Hematocrit at baseline**		
	HR	**95% CI**	**P value**
Death	0.91	0.91-0.93	**<0.001**
MI	0.93	0.91-0.97	**<0.001**
Death or MI	0.92	0.91-0.93	**<0.001**

Table 8: Relationship between hematocrit drop after PCI and the 1-year outcome

Primary end point	**Hematocrit drop**		
	HR	**95% CI**	**P value**
Death	5.2	3.2-7.6	**<0.001**
MI	0.91	0.2-6.5	0.94
Death or MI	4.3	2.8-6.5	**<0.001**

Discussion:

The main finding of the present study is that both hematocrits at baseline and hematocrit drop after PCI are strongly associated with long-term mortality in patients undergoing PCI. This analysis emphasizes the close relationship between these 2 risk factors and 1-year adverse outcome. The prognostic value of the presence of anemia before PCI and severe anemia developed after PCI has been recorded [10,11]. However, the lack of consistency in the definition of severe anemia does not allow clear-cut comparisons because the chosen cutoff values differ significantly from one report to another. Importantly, these variations could potentially lead to markedly different conclusions about the safety of therapeutic regimens [12]. The need to identify antithrombotic therapies that reduce the risk of bleeding while maintaining efficacy demands a standardized bleeding definition [13]. Importantly, a recently published study from Ndrepepa et al [14] strongly supports the inclusion of periprocedural bleeding as a component of the primary endpoint in trials of post-PCI safety and efficacy. We suggest that the robust relationship between both baseline hematocrit and the hematocrit drop and the long-term mortality demonstrated to be taken into account and that a risk model be designed based on this relationship.

The underlying reasons for the higher late mortality risk in patients with baseline anemia and/or in

patients who have haemorrhagic complications of PCI are likely multifactorial. Both blood loss and anemia after PCI are associated with important comorbidities, severity of illness, and periprocedural factors that could account for the increased risk of early and late mortality. Severe anemia itself may decrease blood oxygen levels, which might be arrhythmogenic and exacerbate myocardial ischemia [15]. Differences in pharmacology treatment (especially antiplatelet therapy) may also contribute to the worse early and late prognoses in patients who present with significant bleeding or anemia after PCI [8].

Moreover, the anemic patients may represent a sicker population with a higher prevalence of comorbidities, such as diabetes or chronic renal insufficiency, which are known to reduce life expectancy [16,17,18].

In addition, the long-term effects of inflammatory modulators and cytokines associated with many types of chronic anemia may negatively influence cardiovascular disease progression [19]. Finally, a lower hemoglobin level for each level of blood loss, an inevitable accompaniment of procedure-related bleeding in anemic patients, may also contribute to the increase in adverse events.

Conclusion:

Hematocrit at baseline and the drop after PCI should be recognized as important risk factors for adverse outcomes after PCI. The inclusion of hematocrit values in a risk-stratification scheme should be strongly considered. Further studies are required to establish clear parameters for the use of RBC transfusion and to determine the maximum time of RBC storage for PCI patients.

References:

1. Antman EM, Hand M, Armstrong PW, Bates ER, Green LA, Halasyamani LK, Hochman JS, Krumholz HM, Lamas GA, Mullany CJ, Pearle DL, Sloan MA, Smith SC Jr, Anbe DT, Kushner FG, Ornato JP, Pearle DL, Sloan MA, Jacobs AK, Adams CD, Anderson JL, Buller CE, Creager MA, Ettinger SM, Halperin JL, Hunt SA, Lytle BW, Nishimura R, Page RL, Riegel B, Tarkington LG, Yancy CW. 2007 Focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2008; 51:210 – 247.
2. Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey DE Jr, Chavey WE II, Fesmire FM, Hochman JS, Levin TN, Lincoff AM, Peterson ED, Theroux P, Wenger NK, Wright RS, Smith SC Jr, Jacobs AK, Halperin JL, Hunt SA, Krumholz HM, Kushner FG, Lytle BW, Nishimura R, Ornato JP, Page RL, Riegel B. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non– ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2007; 116:e148 – e304.
3. Gibbons RJ, Abrams J, Chatterjee K, Daley J, Deedwania PC, Douglas JS, Ferguson TB Jr., Fihn SD, Fraker TD Jr, Gardin JM, O'Rourke RA, Pasternak RC, Williams SV, Gibbons RJ, Alpert JS, Antman EM, Hiratzka LF, Fuster V, Faxon DP, Gregoratos G, Jacobs AK, Smith SC Jr. ACC/AHA 2002 Guideline update for the management of patients with chronic stable angina—summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Chronic Stable Angina). Circulation 2002; 2003:149 –158.
4. Eisenstein EL, Anstrom KJ, Kong DF, Shaw LK, Tuttle RH, Mark DB, Kramer JM, Harrington RA, Matchar DB, Kandzari DE, Peterson ED, Schulman KA, Califf RM. Clopidogrel use and long-term clinical outcomes after drug-eluting stent implantation. JAMA 2007; 297: 159 – 168.
5. Kastrati A, Mehilli J, Pache J, Kaiser C, Valgimigli M, Kelbaek H, Menichelli M, Sabaté M, Suttorp MJ, Baumgart D, Seyfarth M, Pfiserer ME, Schömig A. Analysis of 14 trials comparing sirolimus-eluting stents with bare-metal stents. N Engl J Med 2007; 356:1030 – 1039.
6. Peter Kim, Simon Dixon,MB. Bradley Eisenbrey, Barbara O'Malley, Judy Boura, William O'Neill. Impact of Acute Blood Loss Anemia and Red Blood Cell Transfusion on Mortality after Percutaneous Coronary Intervention. Clin. Cardiol. 30 (Suppl. II), II-35 – II-43 (2007).
7. Dauerman HL, Lessard D, Yarzebski J, et al. Bleeding complications in patients with anemia and acute myocardial infarction. Am J Cardiol 2005; 96:1379-83.
8. Kim P, Dixon S, Eisenbrey AB, et al. Impact of acute blood loss anemia and red blood cell transfusion on mortality after percutaneous coronary intervention. Clin Cardiol 2007; 30(S2):II35-43.
9. Spencer FA, Moscucci M, Granger CB, et al. Does comorbidity account for the excess mortality in patients with major bleeding in acute myocardial infarction? Circulation 2007; 116:2793-801.
10. Nikolsky E, Aymong ED, Halkin A, et al. Impact of anemia in patients with acute

myocardial infarction undergoing primary percutaneous coronary intervention: analysis from the Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) Trial. J Am Coll Cardiol 2004; 44: 547-53.
11. Voeltz MD, Patel AD, Feit F, et al. Effect of anemia on hemorrhagic complications and mortality following percutaneous coronary intervention. Am J Cardiol 2007; 99: 1513-7.
12. Steinhubl SR, Kastrati A, Berger PB. Variation in the definitions of bleeding in clinical trials of patients with acute coronary syndromes and undergoing percutaneous coronary interventions and its impact on the apparent safety of antithrombotic drugs. Am Heart J 2007; 154:3-11.
13. Wallace TW, Rao SV. The challenge of defining bleeding among patients with acute coronary syndromes. Clin Cardiol 2007; 30(S2):II16-23.
14. Ndrepepa G, Berger PB, Mehilli J, et al. Periprocedural bleeding and 1-year outcome after percutaneous coronary interventions: appropriateness of including bleeding as a component of a quadruple endpoint. J Am Coll Cardiol 2008; 51:690-7.
15. Levy PS, Quigley RL, Gould SA. Acute dilutional anemia and critical left anterior descending coronary artery stenosis impairs end organ oxygen delivery. J Trauma 1996; 41:416-23.
16. Chesebro JH, Knatterud G, Roberts R, et al. Thrombolysis in Myocardial Infarction (TIMI) Trial, Phase I: a comparison between intravenous tissue plasminogen activator and intravenous streptokinase. Clinical findings through hospital discharge. Circulation 1987; 76:142-54.
17. Mak KH, Moliterno DJ, Granger CB, et al. Influence of diabetes mellitus on clinical outcome in the thrombolytic era of acute myocardial infarction. GUSTO-I Investigators. Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries. J Am Coll Cardiol 1997; 30:171-9.
18. Shaw JA, Andrianopoulos N, Duffy S, et al. Renal impairment is an independent predictor of adverse events post coronary intervention in patients with and without drug-eluting stents. Cardiovasc Revasc Med 2008; 9:218-23.
19. Weiss G, Goodnough LT. Anemia of chronic disease. N Engl J Med 2005; 352:1011-23.