Original Article

Comparison of the One-Year Outcome Between Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention in Patients With Multivessel Coronary Artery Disease

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ABSTRACT

Background: Our study aimed to compare the 1-year therapeutic outcome between coronary artery bypass graft surgery (CABG) and percutaneous coronary intervention (PCI) in patients with multivessel coronary artery disease (CAD).

Methods: This retrospective cohort study was conducted on 150 patients with multivessel CAD who underwent CABG or PCI in Imam Ali Cardiovascular Center, Kermanshah, Iran, between March 2017 and March 2019. Data were collected using a checklist developed based on the study objectives. Differences between subgroups were assessed by using the independent *t* test and the χ^2 test (or the Fisher exact test). A multivariate binary logistic regression model was used to determine factors associated with referral to CABG or PCI.

Results: The mean age was 63.48 (SD=9.73) years in the PCI group and 60.54 (SD=10.85) years in the CABG group (*P*=0.741). The CABG group was more likely to have left main disease (16.6% vs 0%; *P*<0.001). The PCI group was more likely to take an antiplatelet (viz, clopidogrel) and nitrates, whereas the CABG group was more likely to take antihypertensives (angiotensin receptor blockers) and anticoagulants (viz, rivaroxaban and warfarin) (*P*<0.05). The CABG had significantly higher rates of major bleeding (*P*=0.003) and arrhythmia (*P*=0.045) than the PCI group. There was a significant difference in the mortality between the 2 treatment groups (9.3% of the CABG group vs 1.3% of the PCI group; *P*=0.029). Left main disease was associated with an increased odds of referral to CABG (OR=0.02; *P*=0.015).

Conclusions: PCI was associated with a lower adverse clinical outcome than CABG in patients with multivessel CAD. ***(Iranian Heart Journal 2022; 23(1): 25-33)***

KEYWORDS: Coronary artery bypass grafting, Coronary artery disease, Iran, Outcome, Angioplasty

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Coronary artery disease (CAD) is well recognized as the leading cause of cardiovascular mortality and disability worldwide. [1] CAD is directly responsible for more than half of cardiovascular deaths [2] while 4% to 10% of patients with CAD are aged less than 45 years old. [3,4]

Coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI) are both treatment procedures for patients with multivessel CAD. In previous studies, the risks of major cardiovascular events and mortality were reported to be greater with CABG than with PCI. [5,6] On the other hand, some studies have reported that CABG is generally preferred over PCI for patients with multivessel CAD. [7] It is not clear whether CABG should be recommended over PCI for all patients with multivessel CAD.

Recent years have seen significant progress in nonsurgical therapies such as drug-eluting stents, newer anticoagulant-antiplatelet treatments, and aggressive lipid-lowering drugs, all of which have led to improvements in the outcomes of nonsurgical therapies. Furthermore, improvements in surgical therapies like nearly-universal arterial graft use and better postoperative care have made the majority of previously published data on surgical outcomes obsolete. [8-10] Given that PCI continues to evolve and surgical outcomes improve, it is difficult to answer this question: “What is the best revascularization method for patients with multivessel CAD?” Therefore, the aim of our study was to compare the one-year therapeutic outcomes of coronary artery bypass surgery and angioplasty in patients with Multivessel CAD.

METHODS

Study Population and Design

This retrospective cohort study was conducted in Imam Ali Cardiovascular Center, Kermanshah University of Medical Sciences (KUMS), Iran. Imam Ali Cardiovascular Center is the main cardiovascular center in western Iran and a mega general hospital with 280 active beds. This cardiovascular center provides care services and covers more than 2 million people, most of them Kurdish with Caucasian ethnicity.

With the aim of a 2-year evaluation of patients, we collected data from those admitted to the hospital with a diagnosis of acute coronary syndrome (ACS) between March 2017 and March 2019. Patients with multivessel CAD who were candidates for bypass surgery but refused CABG and were potentially amenable to PCI were included in the PCI group. Likewise, patients with multivessel CAD who were candidates for bypass surgery and were potentially amenable to CABG were included in the CABG group. The exclusion criteria consisted of having a history of CABG or PCI, suffering from chronic kidney disease, having an ejection fraction of 35% or less, not having resided in the city of Kermanshah for the past 6 months, and having a history of on-pump CABG. Finally, 150 patients comprised the study population. The eligible participants were divided into a CABG group and a PCI group based on their treatment. Out of these patients, 75 underwent CABG and 75 PCI.

Ethics

The Research Ethics Committee of the Research Deputyship of Kermanshah University of Medical Sciences (KUMS) approved the study protocol in March 2016 (Ethics registration code: KUMS.REC.1398.381). Further, the participants provided written informed consent. Individual personal information was kept confidential.

Instrument and Data Collection

With the aid of a checklist, data were collected by a nurse, who had been trained

specifically for this purpose. The checklist was developed and verified by experts, consisting of a cardiologist and a statistician. All the completed checklists were checked for errors by a quality control physician before the final analysis. The collected data were composed of demographic characteristics (eg, age), clinical histories (eg, previous myocardial infarction), biochemical findings (eg, the cholesterol level), echocardiographic findings (eg, ejection fraction), medications (eg, ASA), in-hospital complications of the treatment procedure (eg, bleeding), and follow-up (clinical follow-ups, including mortality). The standardized definitions of all the variables (eg, clinical diagnoses) were used.
The patients were assessed via follow-up visits at the end of the first year in Imam Ali Cardiovascular Center. Interviews were conducted with the patients to take their medical history, and echocardiography was performed for the entire study population at the end of the first year.

Statistical Analysis

Data analysis was performed using the Statistical Package for Social Sciences (SPSS) software, version 23.0, (IBM Corp, Chicago, US). Quantitative variables, including body mass index and age, were described as the mean (SD) and categorical variables as frequencies (percentages). Differences between the groups were assessed by using the independent *t* tests for continuous variables and those with normal distributions and the χ^2 test (or the Fisher exact test) for categorical variables. A multiple logistic regression model was used to determine factors associated with referral to CABG or PCI. The dependent variable was the type of revascularization, and PCI was considered the reference category. In the logistic regression analysis, variables with a *P*-value of less than 0.20 were entered in the bivariate analysis. A *P*-value of less than 0.05 was considered statistically significant.

RESULTS

The demographic and clinical characteristics of the study population (N=150) are reported in Table 1. The mean age was 63.48 (SD=9.73) years in the PCI group and 60.54 (SD=10.85) years in the CABG group (*P*=0.741). The CABG group was more likely than the PCI group to have left main disease (*P*=0.001).
The 2 study groups had similar treatment patterns. At discharge, prescription of nitrates (*P*=0.001) was significantly more frequent in the PCI group, whereas the CABG group was more likely to take rivaroxaban (*P*=0.042), warfarin (*P*=0.020), and angiotensin receptor blockers (*P*=0.002). At follow-up, the PCI group was more likely to take clopidogrel (*P*=0.001) (Table 2).
Table 3 summarizes the in-hospital events and complications after CABG or PCI. The patients treated with CABG were more likely to have bleeding than those treated with PCI (*P*=0.003). Additionally, the patients undergoing CABG had significantly higher rates of arrhythmia than those undergoing PCI (*P*=0.045).
At follow-up, the mean (SD) ejection fraction was 45.60% (SD=7.49) for the PCI group and 42.62% (SD=11.87) for the CABG group (*P*< 0.001). The CABG group had, on average, a higher creatinine level than the PCI group (2.02 [SD=0.30] vs 1.13 [SD=0.20]; *P*=0.048).
As is demonstrated by Table 4, the mortality rate was significantly different between the 2 treatment groups (9.3% of the CABG group vs 1.3% of the PCI group; *P*=0.029). The incidence of in-stent restenosis (ISR) was 4.0% in the PCI group (*P*=0.080). At the end of the first year, 4.0% of the CABG group had implantable cardioverter-defibrillators due to pleural effusion, but the

difference between the 2 groups was not statistically significant (*P*=0.080).
A binary logistic regression model was employed to identify predictors of revascularization procedures, and the results revealed that left main disease was associated with an increased odds of referral to CABG (OR=0.02; *P*=0.015) (Table 5).

Table 1. Demographic and clinical characteristics of the study population (N=150)

Variables	PCI (n=75) Mean (SD) or N(%)	CABG (n=75) Mean (SD) or N(%)	*P*-value
Age (y)¶	63.48(9.73)	60.54(10.85)	0.082*
BMI (kg/m^2)¶	26.66(4.09)	26.93(4.56)	0.756*
Female	26 (34.7)	25 (33.3)	0.863**
Education Level			0.569**
• Illiterate	31(41.9)	34(45.3)	
• primary/guidance school	29 (39.2)	22(29.3)	
• High school	11 (14.5)	13 (21.3)	
• College or university	3 (4.1)	3 (4.0)	
Socioeconomic Status			0.745**
• Very poor and poor	3 (4.1)	5 (4.3)	
• Moderate	40 (54.1)	36 (48.0)	
• Good and very good	31(41.9)	35(46.7)	
Current smoking	22 (29.3)	26 (34.7)	0.484**
Current addiction	13 (17.3)	22 (29.3)	0.082**
Diabetes mellitus	31 (41.3)	31 (41.3)	1**
Hypercholesterolemia	29 (38.7)	34 (45.3)	0.408**
Hypertension	46 (61.3)	40 (53.3)	0.322**
Prior CVA	2 (2.7)	0 (0)	0.157***
Prior MI	35 (46.7)	37 (49.3)	0.586**
Prior PVD	0 (0)	1 (1.3)	0.316**
Prior IHD	20 (26.7)	18 (24.0)	0.707**
Prior HF	8 (10.7)	13 (17.3)	0.239**
Double-vessel disease	18 (24.0)	17 (23.0)	0.882**
Triple-vessel disease	56 (75.7)	56 (75.7)	1**
Left main disease	0 (0)	17 (16.6)	<0.001***
LDL¶	89.86(30.61)	88.12(29.70)	0.341*
HDL¶	40.80(11.06)	41.16(10.21)	0.421*
TG¶	145.42(61.14)	154.10(86.75)	0.093*
Total cholesterol¶	172.76(41.16)	156.36(35.29)	0.177*
Cr¶	1.09(0.19)	1.11(0.20)	0.367*
EF¶	45.26(8.88)	43.46(10.71)	0.056*

PCI, Percutaneous coronary intervention; CABG, Coronary artery bypass grafting; BMI, Body mass index; CVA, Cerebrovascular accident; MI, Myocardial infarction; PVD, Peripheral vascular disease; IHD, Ischemic heart disease; HF, Heart failure; LDL, Low-density lipoprotein; HDL, High-density lipoprotein; TG, Triglycerides; Cr, Creatinine; EF, Ejection fraction

¶ Continuous variables are expressed as mean±SD, otherwise n (%).

* the *t* test; ** the χ^2 test; *** the Fisher exact test

Table 2. Discharge and follow-up medications

Variables	Discharge Therapy			Follow-up Therapy		
	PCI (n=75)	CABG (n=75)	*P*-value	PCI (n=74)	CABG (n=68)	*P*-value
Aspirin	72 (96.0)	72 (96.0)	1	63 (86.3)	60 (88.2)	0.490
Nitrates	34 (45.3)	6 (8.0)	0.001	10 (13.5)	7 (10.3)	0.495
Beta-blockers	67 (89.3)	70 (93.3)	0.497	46 (63.0)	44 (64.7)	0.834
ACE inhibitors	21 (27.0)	28 (36.0)	0.368	14 (19.2)	15 (20.1)	0.912
ARB	16 (21.3)	37 (49.3)	0.002	17 (23.6)	17 (25.0)	0.570
Rivaroxaban	0 (0)	4 (5.3)	0.042	0 (0)	2 (2.9)	0.140
Diuretics	6 (8.0)	1 (1.3)	0.053	3 (4.1)	1 (1.5)	0.346
Warfarin	4 (5.3)	13 (17.3)	0.020	1 (1.3)	3 (4.4)	0.265
Statins	67 (89.3)	66 (88.0)	0.968	53 (72.6)	57 (83.8)	0.212
Clopidogrel	67 (89.3)	65 (86.7)	0.614	52 (71.2)	(36.8) 25	0.001

PCI, Percutaneous coronary intervention; CABG, Coronary artery bypass grafting; ACE, Angiotensin-converting Enzyme; ARB, Angiotensin receptor blockers

Table 3. In-hospital adverse events in the patients undergoing PCI or CABG (N=150)

Variables	PCI (n=75)	CABG (n=75)	*P*-value
Tamponade	1 (1.3)	2 (2.7)	0.559
Bleeding	(0) 0	8 (10.7)	0.003
Stent thrombosis	1 (1.3)	(0) 0	0.315
Catheter or graft infection	0 (0)	2 (2.7)	0.154
Arrhythmia	0 (0)	5 (6.7)	0.045
MI	1 (1.3)	(0) 0	0.315
Blood clots after surgery	0 (0)	3 (4.0)	0.080
Pericarditis	0 (0)	2 (2.7)	0.154
CKD	1 (1.3)	3 (4.0)	0.304

PCI, Percutaneous coronary intervention; CABG, Coronary artery bypass grafting; MI, Myocardial infarction; CKD, Chronic kidney disease

Table 4. Clinical 12-month outcomes of the patients undergoing PCI or CABG (N=150)

Variable	PCI (n=75)	CABG (n=75)	*P*-value
EF	45.60±7.49	42.62±11.87	<0.001
Cr	2.02±0.30	1.13±0.20	0.048
DHF	3 (4.0)	2 (2.7)	0.649
Death	1 (1.3)	7 (9.3)	0.029
Chest tube insertion	0 (0)	1 (1.3)	0.316
ACS	4 (5.3)	2 (2.7)	0.405
ISR	3 (4.0)	(0) 0	0.080
Arrhythmia	0 (0)	1 (1.3)	0.316
Pleural effusion	0 (0)	3 (4.0)	0.080

PCI, Percutaneous coronary intervention; CABG, Coronary artery bypass grafting; DHF, Decompensated heart failure; ACS, Acute coronary syndrome; ISR, In-stent restenosis; ICD, Implantable cardioverter-defibrillator

Table 5. Predictors for the type of revascularization in the entire study population (N= 149)

	Logistic Regression	
Variables	**OR (95% CI)**	***P*-value**
Addiction	0.62 (0.23-1.68)	0.355
Current smoking	1.27 (0.53-3.12)	0.589
Left main disease	0.02 (0.01-0.50)	0.015
Hypercholesterolemia	0.64 (0.31-1.31)	0.229
Prior CVA	3.55 (0.16-77.84)	0.421
Hypertension	1.88 (0.90-3.89)	0.089
Prior HF	0.47 (0.17-1.30)	0.148

CVA, Cerebrovascular accident; HF, Heart failure

DISCUSSION

In this retrospective cohort study, we sought to evaluate the clinical characteristics and 1-year outcomes of CABG and PCI in patients with multivessel CAD in Imam Ali Cardiovascular Center at KUMS, Iran, between March 2016 and March 2019.

We found that our CABG group featured more patients with left main disease, indicating that the CABG group had more patients with complex coronary lesions, which could be responsible for a more adverse outcome. Our results concur with the findings of a study conducted by Marui et al, [11] who reported that their CABG patients were more likely to have left main disease. In agreement with our study, Ben-Gal et al [5] and Becher et al [12] showed that patients undergoing CABG compared with PCI were more likely to have left main disease.

We found that our CABG group had significantly higher rates of major bleeding and arrhythmia than our PCI group. This finding is similar to that in an investigation by Ben-Gal et al, [5] who reported higher rates of major bleeding in their CABG group than in their PCI group. Becher et al [12] reported patients undergoing CABG experienced significantly more periprocedural adverse events, including cardiac arrhythmia and/or cardiopulmonary resuscitation, and had a higher need for blood transfusion than those undergoing PCI. In contrast, Gunn et al [13] reported no difference in terms of bleeding between their CABG and PCI groups.

Mortality was significantly higher in our CABG group than in our PCI group, which is in line with the findings of previous studies. By way of example, Rodriguez et al [6] observed that patients undergoing CABG had a significantly higher rate of mortality than those undergoing PCI. In a study performed in Massachusetts, the United States of America, the mortality rate was higher in the CABG group than in the PCI group. [14] Likewise, Hallberg et al [15] compared clinical outcomes between CABG and PCI groups and showed that the mortality rate in patients with diabetes mellitus started to increase a few years post-CABG.

On the other hand, many other reports have found converse results. For instance, Abdallah et al [16] reported that CABG provided a better intermediate-term health situation and quality of life than PCI for patients with diabetes mellitus and multivessel CAD. In a meta-analysis done by Sipahi et al, [17] CABG decreased long-term mortality by 27% compared with PCI. Conversely, Hannan et al [18] reported that mortality was significantly elevated in their PCI group compared with their CABG group. Kapur et al [19] observed no difference concerning mortality between CABG and PCI groups at 5 years' follow-up. Notably, these studies may have compared CABG with PCI using bare-metal stents or older generations of PCI. [20, 21]

ISR is, however, common with the PCI treatment strategy. In our study, the rates of stent thrombosis and ISR were low in patients treated with PCI, which may have been in consequence of the use of new generations of drug-eluting stents. [22, 23]

In our study, similar treatments were recommended for both CABG and PCI groups; nonetheless, the patients treated with PCI were more likely to take antiplatelets (viz, clopidogrel) and nitrates, whereas the patients treated with CABG were more likely to take antihypertensives (angiotensin receptor blockers) and anticoagulants (viz, rivaroxaban and warfarin). Consistent with our results, Shiomi et al [24] reported that patients treated with PCI were more likely to take antiplatelets (viz, clopidogrel) and nitrates, and those treated with CABG were more likely to take an anticoagulant (viz, warfarin).

We observed that left main disease was associated with an increased probability of referral to CABG. In contrast, Fink et al [25] reported that the male sex, prior aspirin treatment, diabetes mellitus, triple-vessel CAD, and SYNTAX scores greater than 32 were associated with referral to CABG.

Limitations

The salient limitation of the current study is the poor documentation of the patients' past medical records. Therefore, we checked the data through both electronic medical records (the hospital information system) and paper records. Moreover, our data were derived from a single center; thus, our study participants may not be representative of the whole multivessel CAD population undergoing CABG or PCI. Other weaknesses of note are the nearly small study cohort, the retrospective design, and non-randomization. Be that as it may, despite our relatively small sample size, we believe that the size of our study population was sufficient to help us attain our primary aim of comparing the outcomes of CABG and PCI in patients with multivessel CAD.

CONCLUSIONS

The results of the current study suggest that, in clinical practice, PCI may be associated with a more desirable outcome than CABG in patients with multivessel CAD. Major bleeding events, arrhythmias, and mortality were significantly higher in our patients treated with CABG than in our patients undergoing PCI. In conclusion, PCI is safe and could represent a good alternative to CABG for patients with multivessel CAD.

REFERENCES

1. Shyu K-G, Wu C-J, Mar G-Y, Hou CJ-Y, Li A-H, Wen M-S, et al. Clinical characteristics, management and in-hospital outcomes of patients with acute coronary syndromed observations from the Taiwan ACS full spectrum registry. **Acta Cardiol Sin** 2011; 27: e44.

2. Feeman Jr W. Risk factors versus inflammation in atherothrombotic disease. **Circulation** 2002; 106: e31.

3. Shemirani H, Separham K. The relative impact of smoking or Hypertension on severity of premature coronary artery disease. 2007.

4. Doughty M, Mehta R, Bruckman D, Das S, Karavite D, Tsai T, et al. Acute myocardial infarction in the young—The University of Michigan experience. **American heart journal** 2002; 143: 56-62.

5. Ben-Gal Y, Moses JW, Mehran R, Lansky AJ, Weisz G, Nikolsky E, et al. Surgical versus percutaneous revascularization for multivessel disease in patients with acute coronary syndromes: analysis from the ACUITY (Acute Catheterization and Urgent Intervention Triage Strategy) trial. **JACC: Cardiovascular Interventions** 2010; 3: 1059-67.

6. Rodriguez A, Bernardi V, Navia J, Baldi J, Grinfeld L, Martinez J, et al. Argentine randomized study: coronary angioplasty with stenting versus coronary bypass surgery in patients with multiple-vessel disease (ERACI II): 30-day and one-year follow-up results. **Journal of the American College of Cardiology** 2001; 37: 51-8.

7. Frye RL, Alderman EL, Andrews K, Bost J, Bourassa M, Chaitman BR, et al. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease: the Bypass Angioplasty Revascularization Investigation (BARI) investigators. **New England Journal of Medicine** 1996; 335: 217-25.

8. Henderson RA, Pocock SJ, Sharp SJ, Nanchahal K, Sculpher MJ, Buxton MJ, et al. Long-term results of RITA-1 trial: clinical and cost comparisons of coronary angioplasty and coronary-artery bypass grafting. **The Lancet** 1998; 352: 1419-25.

9. Investigators BARI. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. **New England Journal of Medicine** 1996; 335: 217-25.

10. Participants CT. First-year results of CABRI (coronary angioplasty versus bypass revascularisation investigation). **The Lancet** 1995; 346: 1179-84.

11. Marui A, Kimura T, Nishiwaki N, Mitsudo K, Komiya T, Hanyu M, et al. Percutaneous coronary intervention versus coronary artery bypass grafting in patients with end-stage renal disease requiring dialysis (5-year outcomes of the CREDO-Kyoto PCI/CABG Registry Cohort-2). **The American journal of cardiology** 2014; 114: 555-61.

12. Becher T, Baumann S, Eder F, Perschka S, Loßnitzer D, Fastner C, et al. Comparison of peri and post-procedural complications in patients undergoing revascularisation of coronary artery multivessel disease by coronary artery bypass grafting or protected percutaneous coronary intervention with the Impella 2.5 device. **European Heart Journal: Acute Cardiovascular Care** 2019; 8: 360-8.

13. Gunn J, Kuttila K, Kiviniemi T, Ylitalo A, Biancari F, Juvonen T, et al. Outcome after coronary artery bypass surgery and percutaneous coronary intervention in patients with atrial fibrillation and oral anticoagulation. **Annals of medicine** 2014; 46: 330-4.

14. Rodriguez A, Boullon F, Perez-Baliño N, Paviotti C, Liprandi MIS, Palacios IF. Argentine randomized trial of percutaneous transluminal coronary angioplasty versus coronary artery bypass surgery in multivessel disease (ERACI): in-hospital results and 1-year follow-up. **Journal of the American College of Cardiology** 1993; 22: 1060-7.

15. Hällberg V, Palomäki A, Lahtela J, Voutilainen S, Tarkka M, Kataja M. Associations of metabolic syndrome and diabetes mellitus with 16-year survival after CABG. **Cardiovascular diabetology** 2014; 13: 25.

16. Abdallah MS, Wang K, Magnuson EA, Spertus JA, Farkouh ME, Fuster V, et al. Quality of life after PCI vs CABG among patients with diabetes and multivessel coronary artery disease: a randomized clinical trial. **Jama** 2013; 310: 1581-90.

17. Sipahi I, Akay MH, Dagdelen S, Blitz A, Alhan C. Coronary Artery Bypass Grafting vs Percutaneous Coronary Intervention and Long-term Mortality and Morbidity in Multivessel Disease: Meta-analysis of Randomized Clinical Trials of the Arterial Grafting and Stenting Era. **JAMA Internal Medicine** 2014; 174. doi: 10.1001/jamainternmed.2013.12844

18. Hannan EL, Racz MJ, McCallister BD, Ryan TJ, Arani DT, Isom OW, et al. A comparison of three-year survival after coronary artery bypass graft surgery and percutaneous transluminal coronary angioplasty. **Journal of the American College of Cardiology** 1999; 33: 63-72.

19. Kapur A, Bartolini D, Finlay MC, Qureshi AC, Flather M, Strange JW, et al. The Bypass Angioplasty Revascularization in Type 1 and Type 2 Diabetes Study: 5-year follow-up of revascularization with percutaneous coronary intervention versus

coronary artery bypass grafting in diabetic patients with multivessel disease. **Journal of Cardiovascular Medicine** 2010; 11: 26-33.

20. Kapur A, Hall RJ, Malik IS, Qureshi AC, Butts J, de Belder M, et al. Randomized comparison of percutaneous coronary intervention with coronary artery bypass grafting in diabetic patients: 1-year results of the CARDia (Coronary Artery Revascularization in Diabetes) trial. **Journal of the American College of Cardiology** 2010; 55: 432-40.

21. Mohr FW, Morice M-C, Kappetein AP, Feldman TE, Ståhle E, Colombo A, et al. Coronary artery bypass graft surgery versus percutaneous coronary intervention in patients with three-vessel disease and left main coronary disease: 5-year follow-up of the randomised, clinical SYNTAX trial. **The lancet** 2013; 381: 629-38.

22. Palmerini T, Benedetto U, Biondi-Zoccai G, Della Riva D, Bacchi-Reggiani L, Smits PC, et al. Long-term safety of drug-eluting and bare-metal stents: evidence from a comprehensive network meta-analysis. **Journal of the American College of Cardiology** 2015; 65: 2496-507.

23. Bangalore S, Guo Y, Samadashvili Z, Blecker S, Xu J, Hannan EL. Everolimus eluting stents versus coronary artery bypass graft surgery for patients with diabetes mellitus and multivessel disease. **Circulation: Cardiovascular Interventions** 2015; 8: e002626.

24. Shiomi H, Morimoto T, Hayano M, Furukawa Y, Nakagawa Y, Tazaki J, et al. Comparison of long-term outcome after percutaneous coronary intervention versus coronary artery bypass grafting in patients with unprotected left main coronary artery disease (from the CREDO-Kyoto PCI/CABG Registry Cohort-2). **The American journal of cardiology** 2012; 110: 924-32.

25. Fink N, Nikolsky E, Assali A, Shapira O, Kassif Y, Barac YD, et al. Revascularization strategies and survival in patients with multivessel coronary artery disease. **The Annals of thoracic surgery** 2019; 107: 106-11.