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SYSTEMATIC REVIEW

The outcome of percutaneous coronary intervention compared to coronary artery bypass grafting in left main coronary artery stenosis: a systematic review

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ABSTRACT

Background: Coronary artery bypass graft (CABG) surgery has been recommended as the standard treatment for patients with left main coronary artery (LMCA) disease. However, with advances in interventional cardiology, percutaneous coronary intervention (PCI) has been increasingly used for LMCA disease although long-term outcomes comparing PCI with CABG remain limited. **Objectives**: This systematic review was performed using PubMed/MEDLINE, ScienceDirect, and Google Scholar databases to analyze PCI and CABG's effects on patients with coronary artery disease. **Methods:** This systematic review used all studies on the differences in PCI and CABG intervention outcomes in left main coronary artery stenosis. This search yielded 1,427 studies, of which 18 studies were included for the final analysis. In the studies, 62,632 patients were treated with PCI and CABG. A total of 17 studies stated that CABG provides better outcomes than PCI. However, one study stated otherwise. **Conclusion:** Other factors that also affect PCI or CABG outcomes include patient risk factors before revascularization, SYNTAX score, and gender. Among LMCA stenosis patients, CABG is associated with lower incidence of mortality, repeat revascularization, myocardial infarction, and MACE than PCI. Meanwhile, PCI results in lower stroke incidence.

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Highlights

1. Coronary artery disease (CAD) has been the leading cause of death worldwide, with the two most well-established revascularization modalities being coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI).
2. CABG has better long-term outcome in mortality, repeat revascularization, myocardial infaction and MACCE. Meanwhile, PCI has a better long-term outcome in stroke.

BACKGROUND

Coronary artery disease (CAD) has been the leading cause of death worldwide and is predicted to remain the leading cause of death for the next 20 years. The most well-established revascularization modalities to treat CAD are coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI) (Papadopoulos et al., 2017). One of the types of CAD is left main coronary artery (LMCA) disease which affects 57% of patients that undergo coronary angiography. LMCA disease has a 50% mortality rate for patients who do not go under revascularization for three years. The standard treatment for LMCA disease patients was CABG surgery, which has been recommended as the standard treatment. However, the latest advanced method that has been used for LCMA is PCI, which has better outcomes (Zheng et al., 2016).

OBJECTIVE

This systematic review was conducted to investigate the clinical outcomes of PCI and CABG in patients with LMCA disease.

MATERIAL AND METHOD

Structure

This review was constructed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic review and meta-analysis. The data were obtained based on recent studies from the last ten years that were found during the literature search. These studies were all on percutaneous coronary intervention outcomes compared to coronary artery bypass grafting in left main coronary artery stenosis. Existing studies were identified by three independent reviewers (FM, CFA, and AT) through the PubMed, ScienceDirect, and Google Scholar databases using the search terms (PCI* OR "percutaneous coronary intervention*" OR "coronary revascularization*") AND (CABG* OR "coronary artery bypass grafting*" OR "coronary artery bypass surgery*" OR "aortocoronary bypass*") AND ("acute coronary syndrome*" OR "myocardial ischemia*") AND ("left main coronary artery*" OR "left main coronary artery disease*"). The data were also found through manual searches. The abstracts and full texts were reviewed by five researchers (FM, CFA, AT, AS, and ZE). For supplementary information considered incomplete, the reviewers contacted the studies' authors to confirm and resolve disagreements.

Inclusion and Exclusion Criteria

Studies were included if they met all the following criteria: (1) studies related to PCI or CABG outcomes; and (2) the study's subjects diagnosed with left main coronary artery stenosis. Abstracts without full text publications were excluded. Studies that met any of the following criteria were also excluded. The exclusion criteria included (1) studies that were not written in the English language; (2) were not related to the main subjects; (3) were not original research; (4) did not have inadequate or unavailable data; and (5) were repeated studies.

Data Extraction and Quality Assessment

First, the items for data collection and the methodology for event count extraction were standardized. The selected studies were extracted by two authors (CFA and AT) to prevent duplication studies using the standardized data extraction table. The following important headings were extracted from these studies: journal author, year, country, sample size, study design, syntax score/diagnosis, PCI/CABG,

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risk factor (smoking, hypertension, CKD, DM, HF), long-term mortality, long-term MACE, long-term re-vascularization, long-term myocardial infarction, and long-term stroke. Any disagreement was resolved upon consensus.

RESULT

Overview of Literature Search

The literature search identified 1,247 studies identified from the Pubmed, ScienceDirect and Google Scholar databases. The screening process results in 1,030 titles and abstracts after removing duplicates, leaving 27 studies to be selected and analyzed for qualitative synthesis as summarized in **Figure 1**.

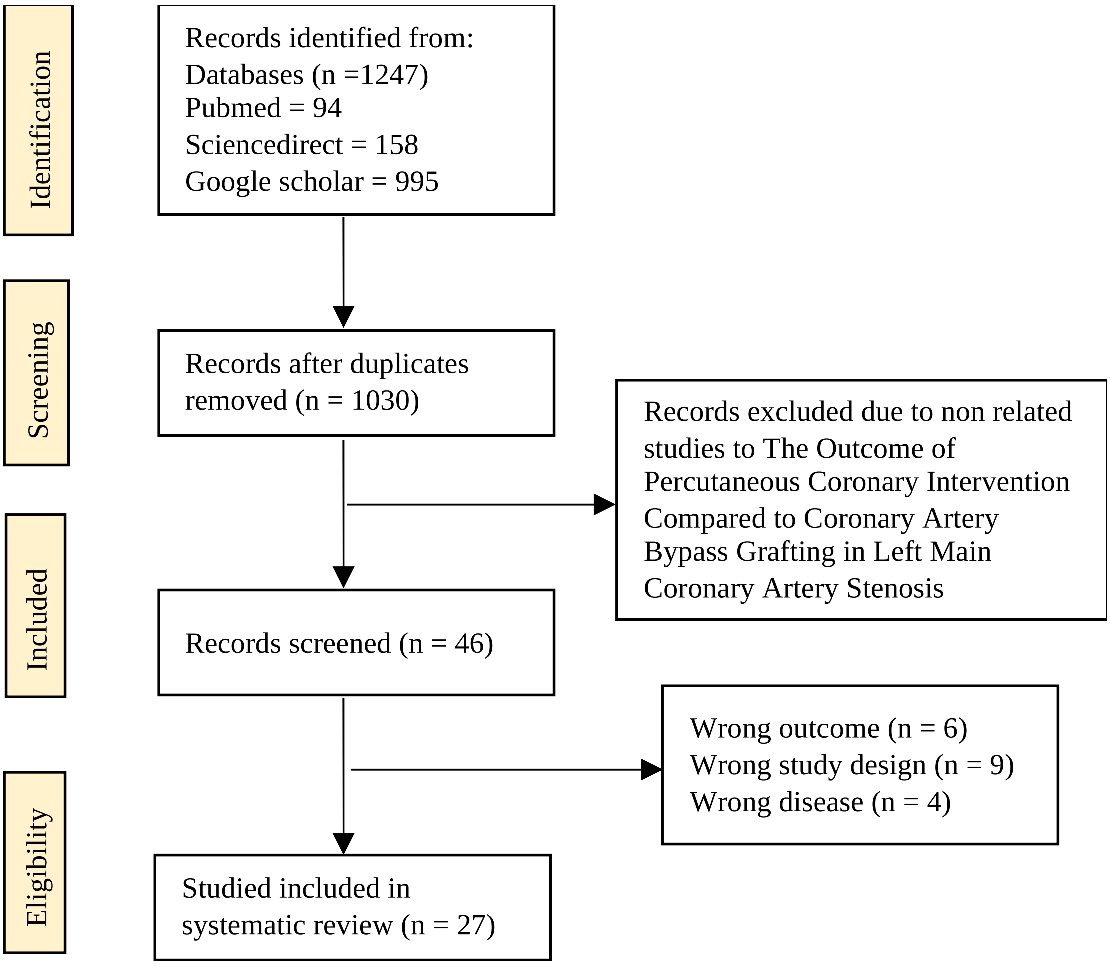

Figure 1. PRISMA flowchart of the literature selection

Study Characteristics

In this review, 27 studies were included. A total 55,995 participants were enrolled in the selected studies on differences PCI and CABG intervention outcomes in left main coronary artery stenosis patients, as summarized in **Table 1**.

Table 1. Main Characteristics of Reviewed Studies

No.	Journal Author, Year and Country	Sample Size and Study Design	Revascularization Method	Risk Factor	Patients Syndrome Induced	Long Term Mortality	Long Term Revascularization	Long Term Myocardial Infarction	Long Term Stroke	Late MACE
1	Naganuma et al, 2014 Italy	856 Prospective study-DELTA multinational registry	PCI and CABG	Hypertension, Dyslipidemia, Smoker, IDDM, NIDDM, CKD,	ULMCA	3 years : 46 patients (9.5%) : 26 cardiac death (5.4%) + 20 noncardiac death (4.1%). HR: 1.31, 95% CI: 0.74 to 2.32; p : 0.348	3 years : 45 patients (9.3%). HR: 1.94, 95% CI: 1.03 to 3.64; p : 0.039	3 years : 20 patients (3.9%). HR: 1.38, 95% CI: 0.82 to 2.31; p : 0.220	3 years : 8 patients (1.7%). HR: 1.25, 95% CI: 0.78 to 2.01; p : 0.350	3 years : 97 patients (20.1%). HR: 1.40, 95% CI: 0.93 to 2.10; p : 0.104
						3 years : 29 patients (7.7%) : 15 cardiac death (4.0%) + 14 noncardiac death (3.7%). HR: 1.31, 95% CI: 0.74 to 2.32; p : 0.348	3 years : 14 patients (3.7%). HR: 2.00, 95% CI: 0.90 to 4.45; p : 0.090	3 years : 18 patients (4.8%). HR: 1.38, 95% CI: 0.82 to 2.31; p : 0.220	3 years : 8 patients (2.1%). HR: 1.25, 95% CI: 0.78 to 2.01; p : 0.350	3 years : 58 patients (15.5%). HR: 1.40, 95% CI: 0.93 to 2.10; p : 0.104
2	Jeong et al, 2013 South Korea	899 Retrospective study-registry	PCI (DES) and OPCAB	Diabetes Mellitus, Hypertension, Smoking, Previous PCI, CKD, Dyslipidemia, Previous MI, Cerebrovascular Disease, PVD	ULMCA	0-8 years: HR 1.435, CI :0.62–3.31, p value: 0.396	0-8 years: incidence on PCI 10.1%, on OPCAB 1.3%, HR 5.508, CI :1.87–16.22, p value: 0.002	0-8 years: incidence on PCI 4.3%, on OPCAB 1.8%HR 4.730, CI :0.99–22.63, p value: 0.049	0-8 years: incidence on PCI 1.7%, on OPCAB 1.3%, HR 3.010, CI :0.33–27.44, p value: 0.329	0-8 years: incidence on PCI 24.1% (83 patients) OPCAB 13.1% (72 patients), HR 1.249, CI :2.165–8.121, p value: < 0.001

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3	Buszman et al, 2016 Poland	105 Prospective observational study-LE MANS Trial	PCI and CABG	Hypertension, Hypercholesterolemia, Previous MI, DM	ULMCA with/without multivessel CAD	10 years: 21.6%, p value:0.41	10 years: repeated revascularization 26.1% (p value: 0.39), re PCI 19.6% (p value: 0.81) (HR: 1.34; 95% CI: 0.61 to 2.95; p : 0.46)	10 years: 8.7% (HR: 1.14; 95% CI: 0.30 to 4.25; p 1⁄4 0.83)	10 years: stroke and TIA 4.3% (HR: 2.85; 95% CI: 0.40 to 20.4; p 1⁄4 0.29)	10 years: 52.2%, p value:0.42
						10 years: 30.2%, p value:0.41	10 years: repeated revascularization 31.3% (p value: 0.39), re PCI 27.1% (p value: 0.81) (HR: 1.34; 95% CI: 0.61 to 2.95; p : 0.46)	10 years: 10.4% (HR: 1.14; 95% CI: 0.30 to 4.25; p 1⁄4 0.83)	10 years: stroke and TIA 6.3% (HR: 2.85; 95% CI: 0.40 to 20.4; p 1⁄4 0.29)	10 years: 62.5%, p value:0.42
4	Papadopoulos et al, 2017 Cyprus	140 Prospective observational study	PCI (Second-generation DES) and CABG	Smoker, Hyperlipidemia, Hypertension, Diabetes Mellitus, Family History, Overweight, CAD, EF<30%, CKD	CAD (MVD and/or ULMCAD)	1 year: PCI 4 patients (5.7%), CABG 8 (11.4%), p value: 0.115	1 year: PCI 3 patients (4.3%), CABG 6 patients (8.6%), p value: 0.781	1 year: Angina : PCI 7 patients (10%), CABG 13 patients (18.6%), p value: 0.577. MI : PCI 0 patients (0%), CABG 3 patients (4.3%), p value: 0.997	NA	NA
5	Gallo et al, 2020 America	4595 Randomized Trial	PCI (DES) and CABG	Diabetes Mellitus	NA	30 days OR = 0.65 (95% CI 0.30, 1.39), p=0.27 ; 1 year OR = 0.80 (95% CI 0.57, 1.12), p=0.20 ; 5 years OR = 1.13 (95%	30 days OR = 0.56 (95% CI, 0.29, 1.08) p= 0.08 ; 1 year OR = 1.74 (95% CI, 1.35, 2.23) p<0.001 ; 5 years OR = 1.89 (95% CI, 1.58, 2.26) p<0.001	30 days OR = 0.75 (95% CI, 0.53, 1.06) p= 0.11 ; 1 year OR = 0.90 (95% CI, 0.68, 1.18) p= 0.45; 5 years OR = 1.43 (95% CI,	30 days OR = 0.39 (95% CI, 0.16, 0.98) p = 0.05, 1 year OR = 0.39 (95% CI, 0.21, 0.73), p = 0.003; 5 years OR = 0.88	30 days OR = 0.66 (95% CI, 0.49, 0.90) p = 0.009; 1 year 0.78 (95% CI, 0.63, 0.96) p = 0.02; 5 years OR = 1.22 (95% CI, 1.05,

						CI 0.93, 1.38), p=0.21		1.13, 1.79) p= 0.003	(95% CI, 0.61, 1.28), p = 0.51	1.42) p = 0.009
6	Anand et al, 2016 India	117 Retrospective observational study	PCI and CABG	Diabetes Mellitus, Hypertension, Dyslipidemia, Smoker, CHF	NA	30 days 1 (2.7%) vs 2 (2.5%) OR = 1.08 (0.09-12.30) p = 0.95 ; 12 months 2 (5.41%) vs 3 (3.75%) OR = 1.44 (0.23 - 8.99) p = 0.69 ; 30 months 3 (8.11%) vs 3 (3.75%) OR = 2.16 (0.42-11.22) p = 0.36	30 days 0vs 0 ; 12 months 2 (5.41%) vs 0 OR = 10.73 (95%CI 0.50-229.15) p = 0.13 ; 30 months 3 (8.11%) vs 0 OR = 15.03 (95%CI 0.76-298.4) p = 0.08	30 days 0 vs 0 ; 12 months 1 (2.70%) vs 0 OR = 6.44 (95%CI 0.26 - 161.83) p = 0.26 ; 30 months 1 (2.70%) vs 0 OR = 6.44 (95%CI 0.26 - 161.83) p = 0.26	30 days 0 vs 2 (2.5%) OR = 0.43 (0.02-9.17) P = 0.59 ; 12 months 0 vs 2 (2.5%) OR = 0.43 (0.02-9.17) P = 0.59 ; 30 months 0 vs 2 (2.5%) OR = 0.43 (0.02-9.17) P = 0.59	30 days 1 (2.7%) vs 4 (5%) OR = 0.54 (95%CI 0.06-5.01) p = 0.59 ; 12 months 3 (8.11%) vs 5 (6.25%) OR = 1.29 (95%CI 0.29-5.72) p = 0.73 ; 30 months 5 (13.51%) vs 5 (6.25%) OR = 2.16 (95%CI 0.59-7.93) p = 0.24
7	Hsin-Ru Li et al, 2017 Taiwan	99 Retrospective observational study	PCI (DES) and CABG	Hypertension, Smoking, Dyslipidemia	Diabetic nephrophaty	30 days 2 (4.3%) vs 4 (7.5%) P; 0.68 ; long term 21 (45.7%) vs 31 (58.5%) P : 0.20	15 (32.6%) VS 5 (9.4%) P < 0.01	7 (15.2%) VS 4 (7.5%) P : 0.23	1 (2.2%) VS 3 (5.7%) P : 0.62	30 days 2 (4.3%) vs 4 (7.5%) P : 0.68 ; long term 31 (67.4%) VS 34 (64.2%) P : 0.73
8	Sotomi et al, 2017 UK	3280 Randomized Trial	PCI (DES) and CABG	Hypertension, Diabetes Mellitus, Smoker, Dyslipidemia,	NA	1611 - 1837 days; HR 1.17 (0.82 - 1.67) p : 0.40	HR 2.03 (1.67 - 2.46) p <0.00001	HR 2.16 (1.54-3.02) p < 0.00001	hr 0.68 (0.43-1.07) p : 0.10	hr 1.45 (1.26-1.67) p <0.00001

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52				Copd, Peripheral Vascular Disease, Silent Myocardhial Ischemia, Angina						
9	Fei Gao et al, 2015 China	2082 Prospective observastional study	PCI and CABG	NA	NA	32 months: no significant difference was observed between the TRI and CABG groups in all-cause mortality (4.0% vs 5.2%; P : .375).	significantly increased target vessel revascularization rate (16.8% vs 6.3%; P < .0001) observed in the TRI group favored CABG.	TRI and the CABG groups (8.0% vs 11.5%; P : .061).	TRI and the CABG groups (8.0% vs 11.5%; P : .061).	NA
10	Fudong Hu et al, 2017 China	276 Prospective observational study	PCI and CABG	NA	NA	1-12 months: (7.7% vs. 17.6%, P = 0.019) were observed less frequently in the PCI group	NA	(7.7% vs. 17.6%, P = 0.019) were observed less frequently in the PCI group	(7.7% vs. 17.6%, P = 0.019) were observed less frequently in the PCI group	NA
11	Catalina et al, 2016 USA	1800 Prospective study	PCI and CABG	NA	NA	NA	5 years: repeat revascularization occurred more often after initial PCI than after initial CABG (25.9% vs 13.7%, respectively; p < 0.001),	NA	NA	NA
12	Moroni et al, 2022	6253	PCI (DES) and CABG	NA	NA	Median 29 months: the rates of all-cause death were 9.4% in the	NA	In hospital MI occurred in 4.4% of patients	NA	NA

	Multicenter	Prospective study				CABG group and 10.6% in the PCI group (AHR, 0.76; 95% CI, 0.59–0.97; P=0.028).		undergoing PCI and 24.2% of patients undergoing CABG (AOR, 5.00; 95% CI, 3.99–6.25; P<0.001).		
13	Kong Yong Cui et al, 2018 China	14130 Randomized Trial	PCI (DES) and CABG	Previous MI	NA	NA	≥5 years: PCI has higher repeat revascularization than PCI (HR = 3.09, 95% CI: 2.33-4.10)	DES was significantly associated with higher incidence of MI (HR = 1.56, 95% CI: 1.09-2.22)	no difference was found between the two strategies regard as the rate of death, cardiac death and stroke.	NA
14	Fernando et al, 2022 Italy	558 Prospective study	PCI and CABG	Diabetes, Acute Coronary Syndrome	NA	0-4 years: No significant difference was found in overall mortality in the two groups (11.1 ± 2.1% vs. 15.2 ± 2.5%; p : 0.443).	significantly more frequent in PCI than in CABG cohort (6% vs. 2%; p : 0.010).	rates of ST-elevation myocardial infarction (10% vs. 2%; p < 0.001, respectively, in PCI and CABG groups) and left ventricular dysfunction (28% vs. 14%; p < 0.001) were higher in the PCI group.	NA	NA

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15 54	Niels Holm et al, 2019 Nine northern European countries	1201 Randomized trial	PCI and CABG	NA	NA	Median 4.9 years: All-cause mortality was estimated in 9% after PCI versus 9% after CABG (HR 1·08 [95% CI 0·74–1·59]; p=0·68);	17% after PCI versus 10% after CABG (HR 1·73 [95% CI 1·25–2·40]; p=0·0009).	myocardial infarction was estimated in 8% after PCI versus 3% after CABG (HR 2·99 [95% CI 1·66–5·39]; p=0·0002);	NA	NA
16	Anthony Gershlick et al, 2018 USA	1905 Prospective study	PCI and CABG	NA	NA	NA	3 years: (13.0% vs. 7.2%, OR: 2.00, 95% CI: 1.41 to 2.85; p : 0.0001),	(15.6% vs. 14.9%, odds ratio [OR]: 1.08, 95% confidence interval [CI]: 0.81 to 1.42; p : 0.61)	(15.6% vs. 14.9%, odds ratio [OR]: 1.08, 95% confidence interval [CI]: 0.81 to 1.42; p : 0.61)	NA
17	Duk-Woo Park et al, 2020 Korea	600 Prospective study	PCI and CABG	NA	NA	10 years: (14.5% vs 13.8%; HR 1.13 [95% CI, 0.75–1.70])	(16.1% vs 8.0%; HR 1.98 [95% CI, 1.21–3.21).	(18.2% vs 17.5%; HR 1.00 [95% CI, 0.70–1.44])	(18.2% vs 17.5%; HR 1.00 [95% CI, 0.70–1.44])	NA
18	Hyun et al, 2020 Korea	2240 Retrospective study-MAIN COMPARE registry	PCI (DES and BMS) and CABG	Hypertension, Diabetes, Hyperlipidemia, Smoking, Cerebrovascular disease, Chronic Kidney Disease	Silent Ischemia, Stable Angina, Unstable Angina, NSTEMI	0-5 years: HR 1.19 (0.79–1.82) p value: 0.42 >5 years: HR 1.44 (1.06–1.96) p value: 0.02	0-5 years: HR 4.76 (2.86–7.69) p value: <0.001 >5 years: HR 2.33 (1.09–4.98) p value: 0.03	0-5 years: HR 1.11 (0.76–1.64) p value: 0.59 >5 years: 1.52 (1.13–2.05) p value: 0.006	0-5 years: HR 1.11 (0.76–1.64) p value: 0.59 >5 years: 1.52 (1.13–2.05) p value: 0.006	NA NA
19	Zheng et al, 2016 China	4046 Prospective study-registry	PCI (DES) and CABG	Hypertension, Hyperlipidemia, Diabetes Mellitus, Smoking, COPD, Family	Silent Ischemia, Stable Angina, Unstable Angina	3 years: HR 1.71 (1.32–2.21) p value: <0.001	3 years: HR 4.91 (3.91–6.16) p value: <0.001	3 years: HR 2.00 (1.61–2.50) p value: <0.001	3 years: HR 0.18 (0.13–0.26) p value: <0.001	3 years: HR 2.44 (1.75–3.42) p value: <0.001

				History of CAD, BMI, Creatine						
20	Yu et al, 2016 China	922 Prospective Observational Study	PCI (DES) and CABG	Diabetes Mellitus, Smoking, Hypertension, Family History, Dyslipidemia	NSTEMI, STEMI, Stable Angina, Unstable Angina, Silent Ischemia	Median 7.1 years: HR 0.647 (0.439–0.954) p value: 0.027	Median 7.1 years: HR 2.256 (1.633–3.115) p value: <0.001	Median 7.1 years: HR 1.407 (0.836–2.366) p value: 0.196	Median 7.1 years: HR 0.298 (0.153–0.581) p value: <0.001	Median 7.1 years: HR 1.204 (0.951–1.523) p value: 0.122
21	Ahn et al, 2015 China	600 Prospective Observational Study	PCI and CABG	NA	NA	5 years: HR 0.73 (0.39–1.37) p value: 0.32	5 years: HR 1.86 (1.09–3.17) p value: 0.020	5 years: HR 1.20 (0.37–3.93) p value: 0.76	5 years: HR 0.99 (0.14–7.02) p value: 0.99	5 years: HR 1.27 (0.84–1.90) p value: 0.26
22	Morrice et al, 2014 USA	1800 Prospective Observational Study	PCI and CABG	NA	NA	5 years: HR 0.88 [0.58, 1.32] p value: 0.53	5 years: HR 4.16 [1.71, 10.10] p value: <0.001	5 years: HR 1.67 [0.91, 3.10] p value: 0.10	5 years: HR 0.33 [0.12, 0.92] p value: 0.03	5 years: HR 1.23 [0.95, 1.59] p value: 0.12
23	Makikallio et al, 2016 Multicenter (Latvia, Estonia, Lithuania, Germany, Norway, Sweden, Finland, the UK, and Denmark)	1202 Prospective Observational Study-NOBLE trial	PCI and CABG	BMI, Diabetes Mellitus, Hypertension, Active Smoking,	Stable Angina Pectoris, Acute Coronary Syndrome	5 years: HR 1·08 (0·67–1·74) p value: 0·84	5 years: HR 1·50(1·04–2·17) p value: 0·0304	5 years: HR 2·87 (1·40–5·89) p value: 0·0040	5 years: HR 1·93 (0·17–21·26) p value: 0·59	5 years: HR 1·51 (1·13–2·00) p value: 0·0044
24	Stone et al, 2016 UK	1905 Prospective study	PCI (everolimus-eluting	Diabetes, Hypertension, Hyperlipidemia, Current Smoker,	STEMI, NSTEMI, Unstable Angina,	30 days: HR 0.90 (0.37–2.22) p value: 0.82	30 days: HR 0.54 (0.21–1.35) p value: 0.18	30 days: HR 0.63 (0.42–0.95) p value: 0.02	30 days: HR 0.50 (0.19–1.33) p value: 0.15	NA

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56			stents) and CABG	BMI, Thrombocytopenia, Anemia	Stable Angina, Silent Ischemia	3 years: HR 1.34 (0.94–1.91) p value: 0.11	3 years: HR 1.72 (1.27–2.33) p value: <0.001	3 years: HR 0.93 (0.67–1.28) p value: 0.64	3 years: HR 0.77 (0.43–1.37) p value: 0.37	NA
25	Ono et al, 2021 Netherlands	1800 Prospective study-SYNTAX Trials	PCI and CABG	>70 years, BMI, Diabetes Mellitus, Metabolic Syndrome, Hypertension, Dyslipidemia, Current Smoking, Previous MI, Cerebrovascular Disease,Peripheral Vascular Disease, COPD, CKD, CHF, Creatine Clearance, LVEF	Silent Ischemia, Stable Angina, Unstable Angina	5 years: elderly HR 1.08 (0.75–1.55) p value: 0.678; non elderly HR 1.46 (0.98–2.18) p value: 0.064	5 years: elderly HR 2.11 (1.35–3.31) p value: 0.001; non elderly HR 2.04 (1.57–2.67) p value: <0.001	5 years: elderly HR 2.08 (1.10–3.91) p value: 0.024; non elderly HR 2.76 (1.63–4.66) p value: <0.001	5 years: elderly HR 0.78 (0.35–1.73) p value: 0.534; non elderly HR 0.48 (0.22–1.08) p value: 0.075	5 years: elderly HR 1.18 (0.90–1.56) p value: 0.233; non elderly HR 1.69 (1.36–2.10) p value: <0.001
						10 years: elderly HR 1.08 (0.84–1.40) p value: 0.530; non elderly HR 1.30 (1.00–1.69) p value: 0.052	NA	NA	NA	NA
26	Park et al, 2020 Korea	3488 Prospective study-ongoing IRIS MAIN Registry	PCI and CABG	BMI, Hypertension, Diabetes Mellitus, Hyperlipidemia, Smoking, Previous MI, Chronic Lung Disease, Chronic Renal Failure, Dyalisis, CHF	Silent Ischemia, Stable Angina, Unstable Angina, NTEMI, STEMI	5 years Normal LV HR: 0.79 (0.591.07) p value: 0.12	5 years Normal LV HR: 3.38 (2.294.99) p value: <0.001	5 years Normal LV HR:1.26 (0.592.69) p value: 0.56	5 years Normal LV HR: 0.59 (0.331.07) p value: 0.08	NA
						5 years Mild LV HR: 1.00 (0.601.66) p value: 0.99	5 years Mild LV HR: 5.44 (1.8615.93) p value: 0.002	5 years Mild LV NA	5 years Mild LV HR: 0.36 (0.091.40) p value: 0.14	NA
						5 years Moderate LV HR: 1.35 (0.772.38) p value: 0.30	5 years Moderate LV HR: 4.84 (1.2818.32) p value: 0.02	5 years Moderate LV HR: 3.78	5 years Moderate LV HR: 1.02	NA

								(0.3442.1) p value: 0.28	(0.293.63) p value: 0.97	
						5 years Severe LV HR: 1.36 (0.822.27) p value: 0.23	5 years Severe LV HR: 1.86 (0.625.62) p value: 0.27	5 years Severe LV HR: 2.92 (0.4817.8) p value: 0.25	5 years Severe LV HR: 1.41 (0.395.12) p value: 0.60	NA
27	Park et al, 2021 Korea	5349 Prospective study-ongoing IRIS MAIN Registry	PCI and CABG	BMI, Hypertension, Diabetes Mellitus, Hyperlipidemia, Smoking, Previous Myocardial Infarction, Previous Percutaneous Coronary Intervention, Previous Cerebrovascular Accident, Peripheral Artery Disease, Chronic Lung Disease, Chronic Renal Failure, Dialysis, Congestive Heart Failure, Atrial Fibrillation, Acute Coronary Syndrome	Silent Ischemia, Stable Angina, Unstable Angina, NTEMI, STEMI	5 years Female HR: 1.12 (0.67−1.87) p value: 0.661	5 years Female HR: 5.75 (2.94−11.26) p value: <0.001	5 years Female Unadjusted HR: 1.56 (0.49−4.91) p value: 0.450	5 years Female Unadjusted HR: 0.59 (0.24−1.47) p value: 0.259	NA
						5 years Male HR: 0.89 (0.69−1.13) p value: 0.326	5 years Male HR: 4.90 (3.31−7.27) p value: <0.001	5 years Male Unadjusted HR: 1.52 (0.75−3.07) p value: 0.245	5 years Male Unadjusted HR: 0.58 (0.36−0.91) p value: 0.019	NA
						10 years Female HR: 1.21 (0.77−1.90) p value: 0.415	10 years Female HR: 6.30 (3.23−12.29) p value: <0.001	10 years Female Unadjusted HR: 1.31 (0.48−3.53) p. value: 0.599	10 years Female Unadjusted HR: 0.50 (0.23−1.12) p value: 0.094	NA
						10 years Male HR: 0.94 (0.75−1.16) p value: 0.542	10 years Male HR: 5.05 (3.48−7.32) p value: <0.001	10 years Male Unadjusted HR: 1.58 (0.82−3.06) p value: 0.171	10 years Male Unadjusted HR: 0.60 (0.39−0.94) p value: 0.025	NA

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DISCUSSION

PCI Compared to CABG

The findings show no significant difference between PCI and CABG on myocardial infarction (MI) at the earlier follow-up, but CABG had better outcomes due to the lower MI incidence. PCI had a higher MI incidence than CABG due to two reasons. First, there was no periprocedural MI. It was reported that CABG surgery had a high myocardial infarction incidence in LM patients due to periprocedural MI (Ellis et al., 1998). Second, PCI management involves LMCA bifurcation. PCI to LMCA bifurcation is technically demanding and has been associated with high adverse clinical event rates (Naganuma et al., 2013). Low repeat revascularization rates were discovered in long-term follow –ups for CABG. The high repeat revascularization rate could be secondary to first-generation DES use. In previous studies, second-generation DES implantation resulted in fewer major adverse cardiac events compared with first-generation DESs, primarily because of lower target lesion and vessel revascularization rates (H. S. Jeong et al., 2013). The other reason for low revascularization in CABG could be internal mammary artery (IMA) graft use in the majority of the cases. IMA graft usage during CABGs has been proven to reduce repeat revascularization incidence because of its resistance to atherosclerosis development (Otsuka et al., 2013). The patients that underwent PCI had significantly low risk of strokes at the one-month and one-year follow-ups. Meanwhile, in CABG procedures, high stroke incidence has been recorded during the 30 days of follow-up (Palmerini et al., 2012). This indicates that PCI has better outcomes in lowering stroke incidence compared to CABG. The stroke incidence in PCI was suggested to be due to discontinuation of dual antiplatelets after a year. Other PCI advantages could be seen in MACCE after at least three years and five-year post-operative observations. However, this advantage could not be seen within one year, due to high revascularization and MI rates in the PCI arm. PCI improved the mortality outcome, possibly due to newer stents and techniques: second generation drug-eluting stents (DES) (one study) and first generation (two study).

PCI with DES Compared to CABG

PCI and CABG are the main options to treat LMCA disease (Papadopoulos et al., 2017). Many studies have reported that CABG has a higher survival rate than PCI (Holm et al., 2020; Jeong et al., 2013; Yu et al., 2016). Jeong et al. (2013) reported higher incidences of MI, revascularization, and MACE in patients who received PCI with DES than in patients who underwent CABG. The study also reported that CABG was superior compared to PCI with DES in patients with unprotected LMCA disease in terms of early and late results (Jeong et al., 2013). However, few studies considered PCI noninferior to CABG (Stone et al., 2016; Wańha et al., 2022). In spite of that, the PCI application with drug-eluting stents (DES) for LMCA disease is increasing (Jeong et al., 2013). A prospective study held by Papadopoulos et al. (2017) at the Nicosia General Hospital reported higher incidences of mortality, MI, angina, and revascularization in the CABG group than in the PCI with second-generation DES group, although these results are not significant. The study had 140 patients as its sample with a one-year follow-up period. The higher incidences in the CABG group were probably due to the small sample size and the limited follow-up period; therefore, the results may not have been suitably powered for the measured outcome. Yet, Papadopoulos still recommended CABG as the preferred intervention to treat LMCA disease patients with SYNTAX scores from 23 to 32 or higher (Papadopoulos et al., 2017). Other studies also recommended CABG in patients with more extensive diseases, chronic total occlusion, and risk factors including diabetes mellitus (Jeong et al., 2013). Hu et al. reported no significant differences in outcomes between the PCI with DES group and CABG group in low to moderate SYNTAX score patients. As a result, their findings highlight that PCI with DES was an effective and safe treatment strategy with similar clinical outcomes to CABG (Hu et al., 2017). In addition, PCI with second-generation DES may be a reasonable alternative to CABG to treat patients with LMCA disease in the near future (Papadopoulos et al., 2017).

Risk Factors Associated with Post-PCI and CABG Outcomes

Things are considered when comparing PCI with CABG outcomes. In addition to the follow-up time, the patient's condition before the revascularization procedure is also important to note. Patients with more complex risk factors will have worse outcomes than patients with fewer risk factors. From the studies summarized, several risk factors that can affect results include age, diabetes mellitus, smoking, hypertension, family history, dyslipidemia, EF, creatine, and BMI. Yu et al. stated that EF, creatinine, and previous stroke were composite independent predictors for cardiac death, MI, and stroke end points in the DES group. Age and EF were said to be independent predictors in the CABG group (Yu et al., 2016). Zheng et al. also stated that PCI is a reasonable alternative treatment to CABG for patients with less complex diseases, whereas a greater survival rate was found in CABG patients with more complex diseases (Zheng et al., 2016).

SYNTAX Score Associated with Post-PCI and CABG Outcomes

The SYNTAX score is a grading tool using angiographic imaging to assess the anatomy of coronary artery disease (CAD) which was initially described in the SYNTAX trial. It is beneficial to determine the complexity of CAD (Li et al., 2017). Buszman et al. (2008) reported non-significant outcomes between PCI and CABG groups within 10-year follow-ups in LMCA disease patients with low and medium complexity of coexisting CAD determined by their SYNTAX score (Buszman et al., 2008). The CABG group showed higher risk of MACE, death, MI, stroke, and revascularization numerically, but this was statistically insignificant. However, this study was limited by its relatively small number of randomized patients (Buszman et al., 2008). In a study by Naganuma et al. (2014), the PCI group's syntax score was 26.1 ± 12.3 and the CABG group was 35.5 ± 13.1. They reported similar outcomes in hospital events, including all-cause death, TVR, cerebrovascular accidents, and MACCE. Although, the CABG group showed higher risk of MI. After a four-year follow-up, they reported higher risk of TVR, all-cause death, and MACCE in the PCI group. However, there were similar outcomes of cerebrovascular accidents and MI[10]; therefore, PCI constitutes as an alternative therapy for CABG in patients with low and medium SYNTAX scores, but not in patients with high SYNTAX scores (Naganuma et al., 2014). According to a prospective study conducted by Li et al. (2017), those with SYNTAX scores above 33 had better outcomes in the CABG group (Li et al., 2017).

Sex Differences Associated with Post-PCI and CABG Outcomes

A study by Moroni et al. (2022) compared sex differences in outcomes following percutaneous coronary intervention or coronary artery bypass graft for left main disease. The all-cause mortality rates were 9.4% in the CABG group and 10.6% in the PCI group. Death occurred in 5.6% of women who received CABG compared to 11.7% of women who underwent PCI. In the case of men, 11.6% of those who got CABG died compared to 10.2% of those who underwent PCI. There were no significant differences overall in outcomes between CABG and PCI at long-term follow-ups. Despite this, women with ULMCA lesions who underwent revascularization were likely to be older and have a higher frequency of comorbidities compared to males. In contrast to men, women who underwent CABG appeared to have much lower risks of mortality, MI, or CVA (Moroni et al., 2022).

According to Park et al. (2022) the all-cause death rates for females treated with CABG and PCI at five years and five to ten years were comparable (Park et al., 2022). Differing from the study mentioned above, the CABG and PCI's relative treatment effects on longer-term risks of the main composite outcomes (i.e., death, MI, or stroke) and all-causes mortality did not significantly interact with gender. In all cases, regardless of gender, PCI increased the risk of subsequent revascularization. Following LMCA revascularization with CABG or PCI, gender did not independently increase the risk of the primary outcomes or all-cause death (Moroni et al., 2022).

Strength and limitation

This current study requires more clinical consideration, such as patients' condition before revascularization

CONCLUSION

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Among patients with LMCA stenosis, CABG is associated with lower incidence of mortality, repeat revascularization, myocardial infarction, and MACE than PCI. On the other hand, PCI has a lower stroke incidence. However, based on this review, there are other important considerations which also affect the outcomes after PCI or CABG, such as patient risk factors before revascularization, SYNTAX score, and gender.

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Conflict of Interest

All authors have no conflict of interest.

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Author Contribution

All the authors have contributed to all process in this research, including preparation, data gathering and analysis, drafting and approval for publication of this manuscript.

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