DOI: 10.7860/JCDR/2022/51190.16279

Review Article

Surgery Section

Determinants of Percutaneous Coronary Intervention and Coronary Artery Bypass Grafting: A Systematic Review and Meta-analysis

PREMJITHLAL BHASKARAN[1], TS SANAL[2], INDIA PREMJITHLAL BHASKARAN[3], NIKOLAOS ANASTASIOU[4]

ABSTRACT

Introduction: Coronary Artery Bypass Graft (CABG) surgery has potential benefits for patients with Coronary Artery Disease (CAD). The consensus associated with Percutaneous Coronary Intervention (PCI) and CABG was in terms of clinical outcomes, type of vessel disease, repeat revascularisation, stroke, myocardial infarction, and heart failure. Hence, a comparison of PCI versus CABG is becoming important to identify patients who would benefit from PCI and CABG.

Aim: This review was conducted to identify the pathophysiological determinants of PCI and CABG.

Materials and Methods: In the present systematic review, Medline (PubMed), EMBASE, ProQuest, and the Cochrane database were searched, by using the key words "PCI" OR "percutaneous coronary intervention" AND "CABG" OR "coronary artery bypass grafting". The searches were restricted from January 2009 to June 2021, with studies published in the English language. Comparative studies of CABG versus PCI with stent placement were the inclusion criteria. For meta-analysis Mantel-Haenszel Odds Ratio (MHOR) with its 95% Confidence Interval (CI), Mean Difference (MD) with its 95% CI were computed.

Results: Overall, 408 titles or abstracts were identified from the initial search, of which full manuscripts of 93 studies were retrieved, in the first phase. Later, 71 studies were not retrieved. Of the remaining 22 studies, 19 were subjected to meta-analysis. This review contributes a sample size of 17,053. Mean age of the study population of PCI group was 66.15±10.71 years and in CABG group it was 66.16±9.43 years. PCI was performed among patients with higher ejection fraction (MD=2.13; 95% CI=1.75 to 2.52) or higher Synergy between percutaneous coronary intervention with Taxus and coronary artery bypass surgery (SYNTAX) score (MD=-3.43; 95% CI=-3.98 to -2.87). CABG was considered for the patients with a higher Euro score (MD=0.28; 95% CI=0.2 to 0.35).

Conclusion: The ejection fraction, SYNTAX score, euro score, type of vessel disease, chronic kidney disease, and diabetes are the determinants of PCI and CABG.

Keywords: Coronary artery disease, Ejection fraction, Euro score, Revascularisation

INTRODUCTION

Percutaneous coronary intervention is focused on treating flow disrupting lesions and it is constrained to new infarcts. The CABG supports the flow distal to the occluded vessel. The CABG was primarily done in patients with triple vessel disease and PCI was performed in single or double vessel diseased cases [1].

Even though PCI is routinely followed, the CABG is considered as gold standard for cardiac remodelling. The consensus associated with PCI and CABG was in terms of safety outcomes, especially an increase in repeat revascularisation in PCI and an increase in the incidents of strokes among CABG cases. However, CABG is the best revascularisation technique, conferring decreased mortality and risk of repeat revascularisation [2]. PCI is suggested to be an appropriate revascularisation procedure in patients with a lower SYNTAX score and CABG is preferred for the cases with a high euro score [3]. Non surgical patients present a challenge in the treatment and are recommended for the PCI with bare metal stents. Unfortunately, the mortality and revascularisation rates are inferior among PCI cases, when compare with CABG [4].

The CABG is not a cure for Coronary Heart Disease (CHD), as it does not stop disease progression and the grafts can calcify with restenosis. It also carries the risks of Myocardial Infarctions (MI), stroke, arrhythmias and death. PCI has advanced the survival of patients with CHD by reducing the need for CABG. Independent of stent type used, the PCI reports patient survival as well as the incidence of MI [2]. Despite the development in stent technology, pharmacotherapy or adjunctive imaging, which made the use of PCI a common treatment regimen, CABG continues to be the standard treatment for CAD. However, the optimal revascularisation procedure in CAD patient's remains controversial [5]. The emergence of drug eluting stents and advancement in technology has caused a pivotal role in cardiology [6]. Hence, identifications of patients who would benefit from PCI and CABG would be intriguing. This review aimed to identify the pathophysiological determinants of PCI and CABG.

MATERIALS AND METHODS

In the present systematic review, Medline (PubMed), EMBASE, ProQuest, and the Cochrane database were searched, by utilising a combination of the relevant Medical Subject Heading (MeSH) terms and the key words "PCI" OR "percutaneous coronary intervention" AND "CABG" OR "coronary artery bypass grafting". In the Cochrane database the search was limited by the term "clinical trial". The searches were restricted from January 2009 to June 2021 with studies published in the English language. Citations were screened at the title or abstract level and retrieved as a full report if they were clinical studies, compared PCI with CABG.The literature search and analysis was conducted from December 2020 to June 2021.

Inclusion criteria: Randomised Controlled Trials (RCTs), cohort and descriptive studies, which made an attempt to address the pathophysiological characteristics of revascularisation procedures, were included. The studies conducted on adult patients who underwent PCI or CABG irrespective of study setting and regions were also included.

Exclusion criteria: If the outcome measure (pathophysiological determinants) was not reported or was impossible to extract or calculate from the available results, then such studies were excluded.

Study Procedure

Search strategy: Screening criteria in preliminary search were the pathophysiological determinants associated with PCI and CABG. In the second phase full manuscripts of all the studies which qualified the screening criteria, were obtained. Selection criteria were applied to each of these studies and valid studies were subjected for final data extraction.

Methods used to collect the data: The keywords "PCI" OR "percutaneous coronary intervention" AND "CABG" OR "coronary artery bypass grafting" were entered into different database and year-wise search was conducted. Titles or abstracts were screened for the content and full manuscripts of the studies were obtained. All the downloaded articles were studied and subjected for eligibility criteria and a list of selected studies was obtained. They were further subjected for inclusion and relevant data were extracted.

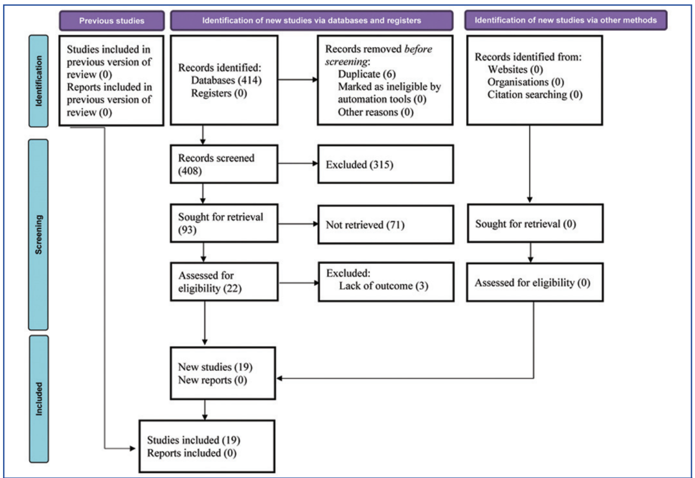
Quality assessment: All the included studies for meta-analysis were subjected to methodological quality appraisal using the Cochrane risk of bias assessment tool, and the Joanna Briggs Institute (JBI) checklist for descriptive and cohort studies [7, 8]. For each item the response was recorded as yes or no and a credit point of "one" was assigned for yes and "zero" for no. Total counts of all the points were obtained. Higher counts indicates well appraisal.

STATISTICAL ANALYSIS

For meta-analysis MHOR, MD, and 95% CI were computed by using the fixed effect model. The Chi- square and I^2 statistic were used to test heterogeneity [9].The Review Manager Software (Rev Man 5, Cochrane collaboration, Oxford, England) was used for data analytics [10].

RESULTS

Overall, 408 citations were identified from the initial search, of which 93 studies were retrieved. Later, 315 studies were excluded. Of the remaining 22 studies, 19 were subjected to meta-analysis in the second phase [Table/Fig-1]. The critical appraisal of the studies included in the present review has been shown in [Table/Fig-2] [11-32].



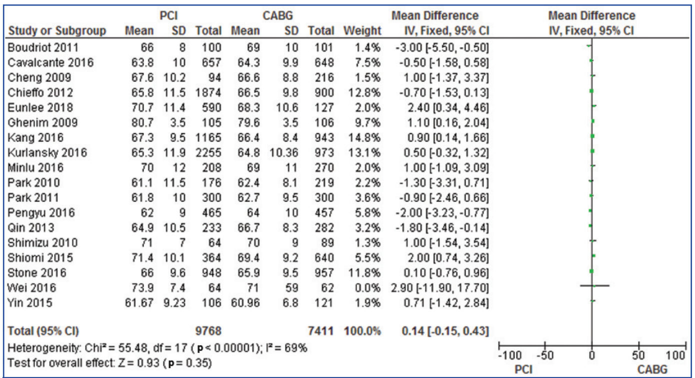
[Table/Fig-1]: PRISMA 2021 flow diagram.

The studies selected for meta-analysis (n=19) contributed a sample of size 17,053 [Table/Fig-1]. A total of 9,663 (57%) patients underwent PCI and 7,390 (43%) underwent CABG. Mean age of the study population in PCI group was 66.15±10.71 and in CABG group it was 66.16±9.43.Thus age was homogeneous (MD=0.14; 95% CI=-0.15 to 0.43) between PCI and CABG [Table/Fig-3].

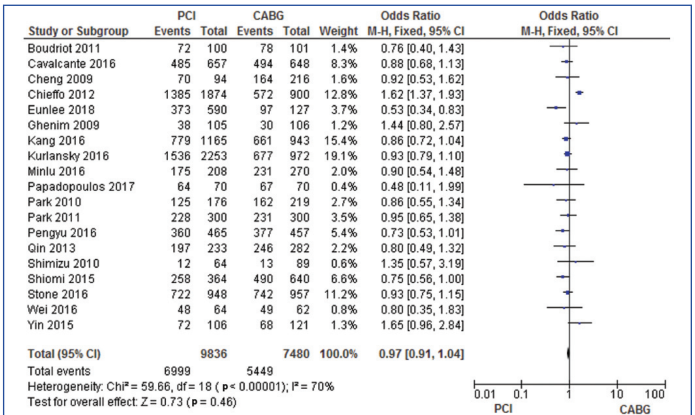
The majority of the study population was males (71% in the PCI group and 73% in CABG). Performance of PCI or CABG was not associated (MHOR=0.97; 95% CI=0.91 to 1.04) with gender [Table/Fig-4].

Study	Design	Sample size	Appraisal score
Boudriot E et al., [11]	RCT	201	5/7
Cavalcante R et al., [12]	RCT	1305	4/7
Cheng CI et al., [13]	Cohort	269	8/12
Chieffo A et al., [14]	Cohort	2774	8/12
Eeunlee S et al., [15]	Cohort	717	8/12
Ghenim R et al., [16]	Cohort	111	8/12
Kang SH et al., [17]	Cohort	2108	9/12
Kurlansky P et al., [18]	Cohort	3212	7/12
Minlu T et al., [19]	Cohort	478	7/12
Papadopoulos K et al., [20]	Cohort	140	8/12
Park DW et al., [21]	Cohort	395	9/12
Park SJ et al., [22]	RCT	600	5/7
Pengyu T et al., [23]	Cohort	922	7/12
Quin Q et al., [24]	Cohort	515	7/12
Shimizu T et al., [25]	Descriptive	153	8/10
Shiomi H et al., [26]	Cohort	1004	8/12
Stone GW et al., [27]	RCT	1896	2/7
Wei Z et al., [28]	Descriptive	126	6/10
Yin Y et al., [29]	Descriptive	127	9/10
Kawecki D et al., [30]#	RCT	145	2/7
Naganuma T et al., [31]#	RCT	829	2/7
Rathod KS et al., [32]#	RCT	1,23,780	4/7

[Table/Fig-2]: Critical appraisal of the studies [11-32].
#Excluded from meta-analysis (lack of outcomes)



[Table/Fig-3]: Age according to PCI and CABG.



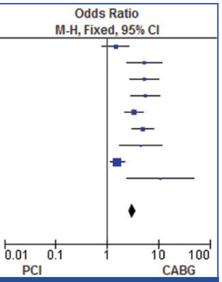
[Table/Fig-4]: Gender according to PCI and CABG.

The PCI was extensively performed in single vessel disease cases (MHOR=3.09; 95% CI=2.6 to 3.68) or double vessel disease cases (MHOR=2.52; 95% CI=2.25 to 2.81) [Table/Fig-5,6]. The patients with triple vessel disease underwent CABG (MHOR=0.24; 95% CI=0.21 to 0.26) [Table/Fig-7].

Choices for PCI and CABG was not associated with peripheral vascular diseases (MHOR=0.99; 95% CI=0.82 to 1.19), cardiovascular diseases (MHOR=0.92; 95% CI=0.56 to 1.52), previous MI (MHOR=1.1; 95% CI=1 to 1.21), previous heart failure

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	35	100	27	101	11.5%	1.48 [0.81, 2.70]
Eunlee 2018	141	590	7	127	5.8%	5.38 [2.45, 11.81]
Minlu 2016	44	208	13	270	5.9%	5.30 [2.77, 10.15]
Park 2010	46	176	13	219	5.6%	5.61 [2.92, 10.78]
Pengyu 2016	96	465	33	457	17.4%	3.34 [2.20, 5.08]
Qin 2013	84	233	29	282	11.1%	4.92 [3.08, 7.85]
Shimizu 2010	18	64	7	89	2.8%	4.58 [1.78, 11.79]
Shiomi 2015	89	364	108	640	39.0%	1.59 [1.16, 2.19]
Wei 2016	17	64	2	62	1.0%	10.85 [2.39, 49.32]
Total (95% CI)		2264		2247	100.0%	3.09 [2.60, 3.68]
Total events	570		239			

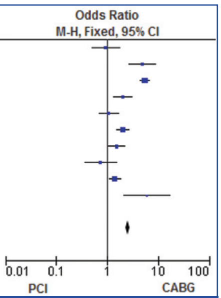
Heterogeneity: Chi² = 37.62, df = 8 (p < 0.00001); I² = 79%
Test for overall effect: Z = 12.68 (p < 0.00001)



[Table/Fig-5]: Single vessel diseases according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	26	100	28	101	5.1%	0.92 [0.49, 1.71]
Eunlee 2018	212	590	13	127	3.4%	4.92 [2.70, 8.94]
Kang 2016	660	1165	182	943	21.7%	5.46 [4.48, 6.67]
Minlu 2016	64	208	49	270	7.4%	2.00 [1.31, 3.07]
Park 2010	47	176	56	219	9.1%	1.06 [0.68, 1.67]
Pengyu 2016	174	465	105	457	16.5%	2.00 [1.50, 2.67]
Qin 2013	81	233	73	282	10.7%	1.53 [1.04, 2.23]
Shimizu 2010	15	64	26	89	4.1%	0.74 [0.35, 1.55]
Shiomi 2015	131	364	182	640	21.0%	1.41 [1.08, 1.86]
Wei 2016	22	64	5	62	0.8%	5.97 [2.09, 17.06]
Total (95% CI)		3429		3190	100.0%	2.52 [2.25, 2.81]
Total events	1432		719			

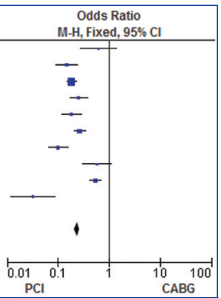
Heterogeneity: Chi² = 127.61, df = 9 (p < 0.00001); I² = 93%
Test for overall effect: Z = 16.37 (p < 0.00001)



[Table/Fig-6]: Double vessels diseases according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	11	100	17	101	1.1%	0.61 [0.27, 1.38]
Eunlee 2018	237	590	104	127	7.7%	0.15 [0.09, 0.24]
Kang 2016	505	1165	761	943	35.6%	0.18 [0.15, 0.22]
Minlu 2016	91	208	203	270	7.4%	0.26 [0.17, 0.38]
Park 2010	43	176	140	219	7.0%	0.18 [0.12, 0.28]
Pengyu 2016	164	465	307	457	15.0%	0.27 [0.20, 0.35]
Qin 2013	32	233	173	282	10.1%	0.10 [0.06, 0.16]
Shimizu 2010	31	64	55	89	1.8%	0.58 [0.30, 1.11]
Shiomi 2015	113	364	293	640	11.0%	0.53 [0.41, 0.70]
Wei 2016	13	64	55	62	3.3%	0.03 [0.01, 0.09]
Total (95% CI)		3429		3190	100.0%	0.24 [0.21, 0.26]
Total events	1240		2108			

Heterogeneity: Chi² = 89.02, df = 9 (p < 0.00001); I² = 90%
Test for overall effect: Z = 25.55 (p < 0.00001)

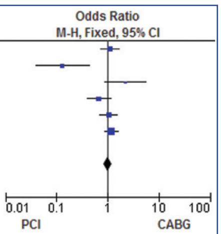


[Table/Fig-7]: Triple vessel diseases according to PCI and CABG.

(MHOR=0.91; 95% CI=0.78 to 1.05), Hyperlipidemia (MHOR=1; 95% CI=0.88 to 1.14) smoking habit (MHOR=0.89; 95% CI=0.83 to 0.95), hypertension (MHOR=0.93; 95% CI=0.87 to 1) and stroke (MHOR=1.04;95% CI=0.91 to 1.19) [Table/Fig-8-15].

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Cavalcante 2016	52	657	47	648	19.0%	1.10 [0.73, 1.66]
Park 2010	3	176	26	219	9.9%	0.13 [0.04, 0.43]
Park 2011	15	300	7	300	2.9%	2.20 [0.89, 5.48]
Pengyu 2016	24	465	34	452	14.3%	0.67 [0.39, 1.15]
Shiomi 2015	45	364	76	640	21.1%	1.05 [0.71, 1.55]
Stone 2016	97	945	84	951	32.8%	1.18 [0.87, 1.61]
Total (95% CI)		2907		3210	100.0%	0.99 [0.82, 1.19]
Total events	236		274			

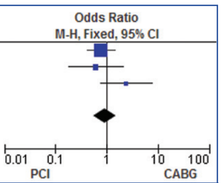
Heterogeneity: Chi² = 17.45, df = 5 (p = 0.004); I² = 71%
Test for overall effect: Z = 0.12 (p = 0.91)



[Table/Fig-8]: Peripheral vascular diseases according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Eunlee 2018	51	590	14	127	66.5%	0.76 [0.41, 1.43]
Park 2010	4	176	8	219	22.0%	0.61 [0.18, 2.07]
Shimizu 2010	8	64	5	89	11.6%	2.40 [0.75, 7.71]
Total (95% CI)		830		435	100.0%	0.92 [0.56, 1.52]
Total events	63		27			

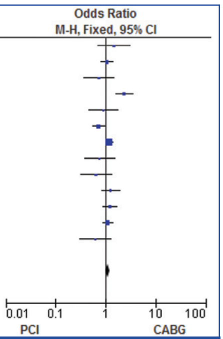
Heterogeneity: Chi² = 3.36, df = 2 (p = 0.19); I² = 40%
Test for overall effect: Z = 0.33 (p = 0.74)



[Table/Fig-9]: Cardiovascular diseases according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	19	100	14	101	1.4%	1.46 [0.69, 3.10]
Cavalcante 2016	114	655	107	642	10.9%	1.05 [0.79, 1.41]
Cheng 2009	12	53	62	216	2.3%	0.73 [0.36, 1.48]
Eunlee 2018	410	590	63	127	3.9%	2.31 [1.57, 3.42]
Ghenim 2009	19	105	21	106	2.1%	0.89 [0.45, 1.78]
Kang 2016	93	1165	101	943	12.6%	0.72 [0.54, 0.97]
Kurlansky 2016	298	958	621	2254	31.3%	1.19 [1.01, 1.40]
Park 2010	15	176	24	219	2.4%	0.76 [0.38, 1.49]
Park 2011	13	300	20	300	2.3%	0.63 [0.31, 1.30]
Qin 2013	56	233	57	282	4.8%	1.25 [0.82, 1.90]
Shiomi 2015	70	364	105	640	7.5%	1.21 [0.87, 1.69]
Stone 2016	169	935	161	953	16.0%	1.09 [0.86, 1.38]
Yin 2015	14	106	24	121	2.4%	0.62 [0.30, 1.26]
Total (95% CI)		5740		6904	100.0%	1.10 [1.00, 1.21]
Total events	1302		1380			

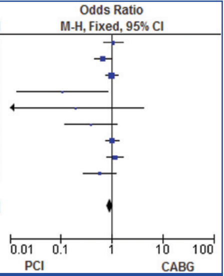
Heterogeneity: Chi² = 31.48, df = 12 (p = 0.002); I² = 62%
Test for overall effect: Z = 1.91 (p = 0.06)



[Table/Fig-10]: Previous MI according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Eunlee 2018	447	590	95	127	10.2%	1.05 [0.68, 1.64]
Kang 2016	50	1165	59	943	16.8%	0.67 [0.46, 0.99]
Kurlansky 2016	181	2247	79	969	27.2%	0.99 [0.75, 1.30]
Park 2010	1	176	11	219	2.6%	0.11 [0.01, 0.85]
Park 2011	0	300	2	300	0.7%	0.20 [0.01, 4.16]
Shimizu 2010	4	64	13	89	2.7%	0.39 [0.12, 1.26]
Shiomi 2015	76	364	131	640	20.2%	1.03 [0.75, 1.41]
Stone 2016	67	946	59	952	14.7%	1.15 [0.80, 1.66]
Wei 2016	19	64	26	62	5.0%	0.58 [0.28, 1.22]
Total (95% CI)		5916		4301	100.0%	0.91 [0.78, 1.05]
Total events	845		475			

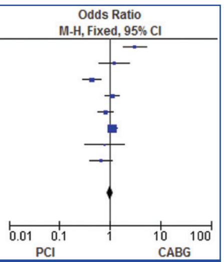
Heterogeneity: Chi² = 13.80, df = 8 (p = 0.09); I² = 42%
Test for overall effect: Z = 1.28 (p = 0.20)



[Table/Fig-11]: Previous heart failure according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Cheng 2009	68	94	99	216	3.6%	3.09 [1.83, 5.23]
Papadopoulos 2017	46	70	43	70	3.2%	1.20 [0.60, 2.40]
Park 2010	62	176	121	219	15.0%	0.44 [0.29, 0.66]
Park 2011	127	300	120	300	14.8%	1.10 [0.80, 1.52]
Qin 2013	82	233	113	282	14.2%	0.81 [0.57, 1.16]
Stone 2016	668	934	652	941	39.6%	1.11 [0.91, 1.36]
Wei 2016	11	64	13	62	2.3%	0.78 [0.32, 1.91]
Yin 2015	47	106	66	121	7.3%	0.66 [0.39, 1.12]
Total (95% CI)		1977		2211	100.0%	1.00 [0.88, 1.14]
Total events	1111		1227			

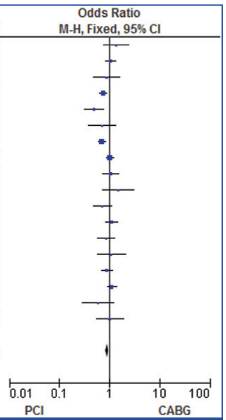
Heterogeneity: Chi² = 38.89, df = 7 (p < 0.00001); I² = 82%
Test for overall effect: Z = 0.01 (p = 0.99)



[Table/Fig-12]: Hyperlipidemia according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	40	100	33	101	1.1%	1.37 [0.77, 2.45]
Cavalcante 2016	187	657	179	648	7.2%	1.04 [0.82, 1.33]
Cheng 2009	25	53	109	216	1.3%	0.88 [0.48, 1.60]
Chieffo 2012	520	1874	306	900	16.6%	0.75 [0.63, 0.88]
Eunlee 2018	338	590	93	127	3.6%	0.49 [0.32, 0.75]
Ghenim 2009	25	106	32	105	1.4%	0.70 [0.38, 1.30]
Kang 2016	574	1165	547	943	17.1%	0.70 [0.59, 0.84]
Kurlansky 2016	335	973	763	2254	16.8%	1.03 [0.88, 1.20]
Minlu 2016	98	208	124	270	3.2%	1.05 [0.73, 1.51]
Papadopoulos 2017	26	70	20	70	0.7%	1.48 [0.73, 3.00]
Park 2010	52	176	81	219	2.8%	0.71 [0.47, 1.09]
Pengyu 2016	143	465	131	457	5.1%	1.11 [0.83, 1.47]
Qin 2013	57	233	77	282	2.9%	0.86 [0.58, 1.28]
Shimizu 2010	31	64	41	89	1.0%	1.10 [0.58, 2.09]
Shiomi 2015	154	364	291	640	6.8%	0.88 [0.68, 1.14]
Stone 2016	286	948	268	957	10.4%	1.11 [0.91, 1.35]
Wei 2016	21	64	28	62	1.1%	0.59 [0.29, 1.22]
Yin 2015	23	106	26	121	1.1%	1.01 [0.54, 1.91]
Total (95% CI)		8216		8461	100.0%	0.89 [0.83, 0.95]
Total events	2935		3149			

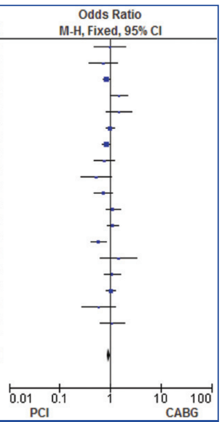
Heterogeneity: Chi² = 38.94, df = 17 (p = 0.002); I² = 56%
Test for overall effect: Z = 3.31 (p = 0.0009)



[Table/Fig-13]: Smoking habit according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	82	100	83	101	1.0%	0.99 [0.48, 2.03]
Cheng 2009	35	53	157	216	1.4%	0.73 [0.38, 1.39]
Chieffo 2012	1200	1874	609	900	19.8%	0.85 [0.72, 1.01]
Eunlee 2018	420	590	79	127	2.5%	1.50 [1.01, 2.24]
Ghenim 2009	77	105	69	106	1.2%	1.47 [0.82, 2.66]
Kang 2016	884	1165	716	943	12.8%	1.00 [0.82, 1.22]
Kurlansky 2016	1713	2254	771	973	17.3%	0.83 [0.69, 1.00]
Minlu 2016	163	208	223	270	2.8%	0.76 [0.48, 1.20]
Papadopoulos 2017	41	70	51	70	1.4%	0.53 [0.26, 1.07]
Park 2010	83	176	121	219	3.8%	0.72 [0.49, 1.08]
Park 2011	163	300	154	300	4.7%	1.13 [0.82, 1.55]
Pengyu 2016	286	465	269	457	7.0%	1.12 [0.86, 1.45]
Qin 2013	132	233	195	282	5.1%	0.58 [0.41, 0.84]
Shimizu 2010	54	64	70	89	0.6%	1.47 [0.63, 3.41]
Shiomi 2015	312	364	542	640	3.8%	1.08 [0.75, 1.56]
Stone 2016	703	943	701	949	11.9%	1.04 [0.84, 1.27]
Wei 2016	39	64	45	62	1.2%	0.59 [0.28, 1.25]
Yin 2015	71	106	79	121	1.6%	1.08 [0.62, 1.87]
Total (95% CI)		9134		6825	100.0%	0.93 [0.87, 1.00]
Total events	6458		4934			

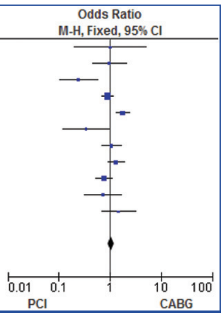
Heterogeneity: Chi² = 30.37, df = 17 (p = 0.02); I² = 44%
Test for overall effect: Z = 1.92 (p = 0.05)



[Table/Fig-14]: Hypertension according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	3	100	3	101	0.7%	1.01 [0.20, 5.13]
Cavalcante 2016	14	355	14	344	3.5%	0.97 [0.45, 2.06]
Cheng 2009	13	216	11	53	4.2%	0.24 [0.10, 0.58]
Kang 2016	137	1165	121	943	29.8%	0.91 [0.70, 1.18]
Kurlansky 2016	78	973	106	2250	14.9%	1.76 [1.30, 2.39]
Morice 2014	5	357	14	348	3.5%	0.34 [0.12, 0.95]
Pengyu 2016	45	465	42	457	9.7%	1.06 [0.68, 1.65]
Shiomi 2015	54	364	75	640	11.7%	1.31 [0.90, 1.91]
Stone 2016	52	947	67	956	15.9%	0.77 [0.53, 1.12]
Wei 2016	13	64	16	62	3.3%	0.73 [0.32, 1.69]
Yin 2015	17	106	14	121	2.8%	1.46 [0.68, 3.13]
Total (95% CI)		5112		6275	100.0%	1.04 [0.91, 1.19]
Total events	431		483			

Heterogeneity: Chi² = 33.37, df = 10 (p = 0.0002); I² = 70%
Test for overall effect: Z = 0.54 (p = 0.59)

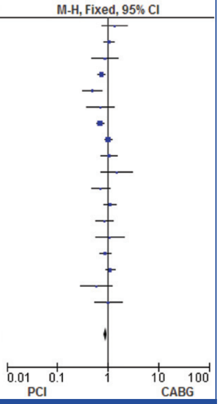


[Table/Fig-15]: Stroke according to PCI and CABG.

Diabetic patients underwent (MHOR=0.89; 95% CI=0.83 to 0.95) CABG and in the cases of chronic kidney diseases (MHOR=1.41; 95% CI=1.1 to 1.81) PCI was performed [Table/Fig-16,17].

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Boudriot 2011	40	100	33	101	1.1%	1.37 [0.77, 2.45]
Cavalcante 2016	187	657	179	648	7.2%	1.04 [0.82, 1.33]
Cheng 2009	25	53	109	216	1.3%	0.88 [0.48, 1.60]
Chieffo 2012	520	1874	306	900	16.6%	0.75 [0.63, 0.88]
Eunlee 2018	338	590	93	127	3.6%	0.49 [0.32, 0.75]
Ghenim 2009	25	106	32	105	1.4%	0.70 [0.38, 1.30]
Kang 2016	574	1165	547	943	17.1%	0.70 [0.59, 0.84]
Kurlansky 2016	335	973	763	2254	16.8%	1.03 [0.88, 1.20]
Minlu 2016	98	208	124	270	3.2%	1.05 [0.73, 1.51]
Papadopoulos 2017	26	70	20	70	0.7%	1.48 [0.73, 3.00]
Park 2010	52	176	81	219	2.8%	0.71 [0.47, 1.09]
Pengyu 2016	143	465	131	457	5.1%	1.11 [0.83, 1.47]
Qin 2013	57	233	77	282	2.9%	0.86 [0.58, 1.28]
Shimizu 2010	31	64	41	89	1.0%	1.10 [0.58, 2.09]
Shiomi 2015	154	364	291	640	6.8%	0.88 [0.68, 1.14]
Stone 2016	286	948	268	957	10.4%	1.11 [0.91, 1.35]
Wei 2016	21	64	28	62	1.1%	0.59 [0.29, 1.22]
Yin 2015	23	106	26	121	1.1%	1.01 [0.54, 1.91]
Total (95% CI)		**8216**		**8461**	**100.0%**	**0.89 [0.83, 0.95]**
Total events	2935		3149			

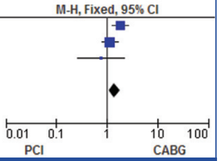
Heterogeneity: Chi² = 38.94, df = 17 (p = 0.002); I² = 56%
Test for overall effect: Z = 3.31 (p = 0.0009)



[Table/Fig-16]: Diabetes according to PCI and CABG.

Study or Subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Chieffo 2012	137	1874	37	900	43.4%	1.84 [1.27, 2.67]
Minlu 2016	84	208	101	270	49.0%	1.13 [0.78, 1.64]
Papadopoulos 2017	7	70	9	70	7.6%	0.75 [0.26, 2.15]
Total (95% CI)		**2152**		**1240**	**100.0%**	**1.41 [1.10, 1.81]**
Total events	228		147			

Heterogeneity: Chi² = 4.67, df = 2 (p = 0.10); I² = 57%
Test for overall effect: Z = 2.70 (p = 0.007)

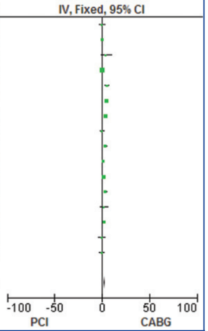


[Table/Fig-17]: Chronic kidney disease (CKD) according to PCI and CABG.

The PCI was performed among patients with higher ejection fraction (MD=2.13; 95% CI=1.75 to 2.52) or higher SYNTAX score (MD=-3.43; 95% CI=-3.98 to -2.87). CABG was performed among the patients with a higher euro score (MD=0.28; 95% CI=0.2 to 0.35) [Table/Fig-18-20].

Study or Subgroup	PCI Mean	PCI SD	PCI Total	CABG Mean	CABG SD	CABG Total	Weight	Mean Difference IV, Fixed, 95% CI
Boudriot 2011	65	10	100	65	9.5	101	2.0%	0.00 [-2.70, 2.70]
Cavalcante 2016	59.3	13.9	657	59.3	11.1	648	7.9%	0.00 [-1.36, 1.36]
Cheng 2009	60.5	17.8	53	56.4	19.5	216	0.5%	4.10 [-1.35, 9.55]
Chieffo 2012	53.8	12	1874	53.3	11.5	900	17.0%	0.50 [-0.43, 1.43]
Eunlee 2018	37.8	12.3	590	32.6	12	127	2.7%	5.20 [2.89, 7.51]
Kang 2016	55.9	11.4	1165	51.4	13.2	943	12.9%	4.50 [3.43, 5.57]
Kurlansky 2016	53.78	16.81	2255	50.08	11.9	973	14.1%	3.70 [2.68, 4.72]
Minlu 2016	49	12	208	49	12	270	3.1%	0.00 [-2.17, 2.17]
Park 2010	59.9	7.7	176	56.5	11.2	219	4.2%	3.40 [1.53, 5.27]
Park 2011	61.7	8.3	300	60.6	8.5	300	8.1%	1.10 [-0.24, 2.44]
Pengyu 2016	64	8	465	62	10	457	10.7%	2.00 [0.83, 3.17]
Qin 2013	65.1	9.1	233	61.6	10.5	282	5.1%	3.50 [1.81, 5.19]
Shimizu 2010	59	13	64	57	11.5	89	0.9%	2.00 [-1.98, 5.98]
Shiomi 2015	62	11	364	60	9.8	640	7.9%	2.00 [0.64, 3.36]
Stone 2016	57	9.6	55	57.3	9	46	1.1%	-0.30 [-3.93, 3.33]
Wei 2016	48.2	8.9	64	48.8	7.5	62	1.8%	-0.60 [-3.47, 2.27]
Total (95% CI)			**8623**			**6273**	**100.0%**	**2.13 [1.75, 2.52]**

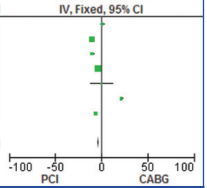
Heterogeneity: Chi² = 74.50, df = 15 (p < 0.00001); I² = 80%
Test for overall effect: Z = 10.93 (p < 0.00001)



[Table/Fig-18]: Ejection fraction according to PCI and CABG.

Study or Subgroup	PCI Mean	PCI SD	PCI Total	CABG Mean	CABG SD	CABG Total	Weight	Mean Difference IV, Fixed, 95% CI
Boudriot 2011	24	10	100	23	8	101	4.9%	1.00 [-1.51, 3.51]
Chieffo 2012	28.6	14.3	1874	38.9	13.2	900	26.4%	-10.30 [-11.38, -9.22]
Qin 2013	24.1	10.5	283	34.5	12	282	8.9%	-10.40 [-12.26, -8.54]
Shiomi 2015	26.5	7	364	30	8	640	34.0%	-3.50 [-4.45, -2.55]
Stone 2016	20.6	6.2	2	20.5	6.1	2	0.2%	0.10 [-11.95, 12.15]
Wei 2016	27.3	6.9	64	6	0.37	62	10.7%	21.30 [19.61, 22.99]
Yin 2015	26.25	4.97	106	32.45	6.06	121	14.9%	-6.20 [-7.64, -4.76]
Total (95% CI)			**2793**			**2108**	**100.0%**	**-3.43 [-3.98, -2.87]**

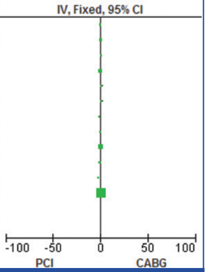
Heterogeneity: Chi² = 1056.22, df = 6 (p < 0.00001); I² = 99%
Test for overall effect: Z = 12.12 (p < 0.00001)



[Table/Fig-19]: SYNTAX score according to PCI and CABG.

Study or Subgroup	PCI Mean	PCI SD	PCI Total	CABG Mean	CABG SD	CABG Total	Weight	Mean Difference IV, Fixed, 95% CI
Boudriot 2011	2.4	1	100	2.6	1.3	101	5.3%	-0.20 [-0.52, 0.12]
Cavalcante 2016	3.3	2.5	657	3.4	2.5	648	7.4%	-0.10 [-0.37, 0.17]
Cheng 2009	6.9	3.5	94	6.4	3.3	216	0.8%	0.50 [-0.33, 1.33]
Chieffo 2012	4.9	3.6	1874	5.1	2.6	900	9.9%	-0.20 [-0.44, 0.04]
Ghenim 2009	8	2.7	105	7	2.2	106	1.2%	1.00 [0.34, 1.66]
Minlu 2016	7.1	5.1	208	6.4	4	270	0.8%	0.70 [-0.14, 1.54]
Park 2010	3.3	2.7	176	4.5	2.6	219	2.0%	-1.20 [-1.73, -0.67]
Park 2011	2.6	1.8	100	2.8	1.9	100	2.1%	-0.20 [-0.71, 0.31]
Pengyu 2016	5	1.5	465	5	1.2	457	17.8%	0.00 [-0.18, 0.18]
Qin 2013	3.7	2.3	233	4.5	2.6	282	3.0%	-0.80 [-1.22, -0.38]
Shimizu 2010	2.7	1.5	64	4.9	2	89	1.8%	-2.20 [-2.75, -1.65]
Wei 2016	6.8	0.22	64	6	0.37	62	48.0%	0.80 [0.69, 0.91]
Total (95% CI)			**4140**			**3450**	**100.0%**	**0.28 [0.20, 0.35]**

Heterogeneity: Chi² = 274.32, df = 11 (p < 0.00001); I² = 96%
Test for overall effect: Z = 7.33 (p < 0.00001)



[Table/Fig-20]: Euro score according to PCI and CABG.

DISCUSSION

The PCI and CABG improve prognosis in CAD patients by attenuating the ischaemic state and reversing the left ventricular remodelling [33]. Effectiveness of PCI and CABG is associated with revascularisation and clinical outcomes. Cases with an EF of 35% or less have reported better survival with CABG than PCI [34]. Those patients who undergo PCI multiple times before being referred for CABG were at higher risk for graft failure [33].

The CABG has been found to be superior to PCI in patients older than seventy years with respect to the incidence of adverse cardiac events. Among the patients younger than seventy years, there was no difference in the adverse cardiac events between PCI and CABG [35]. In this study, there was no difference in age between PCI and CABG groups. Also, the performance of PCI and CABG was not associated with gender. However, despite the similar prevalence of CAD between the genders, female cases were less likely to undergo revascularisation [36].

The PCI is associated with single or double vessel diseases and it is mainly driven by higher rates of myocardial infarction and revascularisation. CABG is associated with multi-vessel or unprotected left main coronary artery disease [15]. The lower rate of adverse cardiac or cerebrovascular events at one year among patients with triple vessel diseases or left main CAD (or both) induces CABG as standard care as compared with PCI [37]. CABG improves Left Ventricular (LV) function and it reverses adverse remodelling. This has resulted in improved survival rate and decreased the incidence of adverse cardiac events. However, CABG in patients without viable myocardium (hibernating/stunned myocardium) leads to an unfavourable structural alteration and the clinical benefits [38]. The magnitude of the recovered ventricular function was reported to be proportional to the amount of dysfunctional myocardium, greater than 25% LV (four from seventeen segment model) results in improvement in reverse remodelling [38]. The rate of peripheral vascular diseases, previous MI, heart failure, stroke, diabetes, hyperlipidemia, smoking habit and hypertension are consistently homogeneous between PCI and CABG.

Patients with previous CABG often develop progression of atherosclerotic diseases and hence they may require further revascularisation. Among such cases, PCI is associated with higher incidence of restenosis, procedural complications and chronic adverse cardiac events [32]. However, PCI with drug eluting stents for ostial or mid-shaft lesions in CAD demonstrated favourable clinical outcomes than PCI for distal bifurcation lesions [31]. The ability of drug eluting stents to reduce restenosis as compared to PCI with bare metal stents enhances their use in CAD. Thus, in left main stenosis has become an alternative to surgery and it favors for further revascularisation [30].

Patients with a high SYNTAX score undergo CABG and cases with a high euro score followed PCI. Performance of PCI is also associated with a higher ejection fraction [3]. PCI with stent implantation and CABG are associated with Q-wave MI, cerebrovascular accidents, angina, or stroke among CAD patients [12,15]. The Target Vessel Revascularisation (TVR) rates were reportedly higher among PCI group than CABG. This inferiority character of TVR was associated with repeat revascularisation, whereas the risk of MI was non inferior in PCI cases with lower perioperative morbidity [31]. In PCI group, the rate of long-term repeat revascularisation was higher than CABG. The decision towards PCI and CABG also determined by the anticipated periprocedural risk, graft occlusion and restenosis; based on the SYNTAX score, lesions observed in morphology, and underlying co-morbidities [23,27]

Limitation(s)

Stratification of patients into PCI and CABG was reported among the included studies have been followed by the eligibility criteria of this review. However, the PCI procedures can be altered with respect to number of stents implanted, repeated revascularisation, and types of techniques (culotte/V-stenting/protrusion/crush) used. These heterogeneities were the major limitations of this study.

CONCLUSION(S)

The PCI is thought to be limited mainly to single vessel disease whereas CABG provided better outcomes in complex multi vessel diseased cases. The ejection fraction, SYNTAX score, euro score, type of vessel disease, CKD, and presence of diabetes are the pathophysiological determinants for PCI and CABG.

REFERENCES

[1] Spadaccio C, Benedetto U. Coronary artery bypass grafting (CABG) vs. percutaneouscoronary intervention (PCI) in the treatment of multivesselcoronary disease: Quo vadis? A review of the evidences oncoronary artery disease. Ann Cardiothorac Surg. 2018;7(4):506-15.

[2] Doenst T, Haverich A, Serruys P, Bonow RO, Kappetein P, Falk V, et al. PCI and CABG for treating stable coronary artery disease: JACC review topic of the week. JACC. 2019;73(8):964-76.

[3] Bundhun PK, Yanamala CM, Huang F. Percutaneous coronary intervention, coronary artery bypass surgery and the SYNTAX score: A systematic review and meta-analysis. Sci Rep. 2017;7:43801-11.

[4] Rai P, Taylor R, Bittar MN. Long-term survival in patients who had CABG with or without prior coronary artery stenting. Open Heart. 2020;7:001160.

[5] Qiu M, Ding L, Zhan Z, Zhou H. Impact of time factor and patient characteristics on the efficacy of PCI vs CABG for left main coronary disease: A meta-analysis. Medicine (Baltimore). 2021;100(10):e25057.

[6] Qian C, Feng H, Cao J, Wei B, Wang Y. Meta-analysis of randomized control trials comparing drug-eluting stents versus coronary artery bypass grafting for significant left main coronary narrowing. Am J Cardiol. 2017;119:1338-43.

[7] Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. Cochrane handbook for systematic reviews of interventions version 6.1 (updated September 2020). Cochrane, 2020.

[8] Joanna Briggs Institute Critical appraisal tools for use JBI systematic reviewers. Joanna Briggs Institute. 2017. The University of Adelaide South Australia 5005. Accessed date: 8/2/2021.

[9] Julian PT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in Meta analysis. BMJ. 2003;327:557-60.

[10] RevMan 5 download RevMan web page. www.cc-ims.net/RevMan. Accessed date: 20/12/2020.

[11] Boudriot E, Thiele H, Walther T, Liebetrau C, Boeckstegers P, Pohl T, et al. Randomized comparison of percutaneous coronary intervention with sirolimus-eluting stents versus coronary artery bypass grafting in unprotected left main stem stenosis. J Am Coll Cardiol. 2011;57:538-45.

[12] Cavalcante R, Sotomi Y, Lee CW, Ahn JM, Farooq V, Tateishi H, et al. Outcomes after percutaneous coronary intervention or bypass surgery in patients with unprotected left main disease. J Am Coll Cardiol. 2016;68:999-1009.

[13] Cheng CI, Lee FY, Chang JP, Hsueh SK, Hsieh YK, Fang CY, et al. Long-term outcomes of intervention for unprotected left main coronary artery stenosis: Coronary stenting vs coronary artery bypass grafting. Circ J. 2009;73:705-12.

[14] Chieffo A, Meliga E, Latib A, Park SJ, Onuma Y, Capranzano P, et al. Drug-eluting stent for left main coronary artery disease. The DELTA registry: A multicenter registry evaluating percutaneous coronary intervention versus coronary artery bypass grafting for left main treatment. JACC Cardiovasc Interv. 2012;5:718-27.

[15] Eeunlee S, Young LH, Cho HJ, Seok CW, Kim H, Choi JO, et al. Coronary artery bypass graft versus percutaneous coronary intervention in acute heart failure. Heart. 2018;106:50-57.

[16] Ghenim R, Roncalli J, Tidjane AM, Bongard V, Ziani A, Boudou N, et al. One-year follow-up of nonrandomized comparison between coronary artery bypass grafting surgery and drug-eluting stent for the treatment of unprotected left main coronary artery disease in elderly patients (aged ≥75 years). J Interv Cardiol. 2009;22:520-26.

[17] Kang SH, Lee CW, Yun SC, Lee PH, Ahn JM, Park DW, et al. Coronary artery bypass grafting versus drug-eluting stent implantation for left main coronary artery disease (from a two-center registry). Am J Cardiol. 2010;105:343-51.

[18] Kurlansky P, Herbert M, Prince S, Mack M. Coronary artery bypass graft versus percutaneous coronary intervention meds matter: Impact of adherence to medical therapy on comparative outcomes. Circulation. 2016;134:1238-46.

[19] Lu TM, Lee WL, Hsu PF, Lin TC, Sung SH, Wang KL, et al. Long-term results of stenting versus coronary artery bypass surgery for left main coronary artery disease A single-center experience. J Chin Med Ass. 2016;79(7):356-62.

[20] Papadopoulos K, Lekakis I, Nicolaides E. Outcomes of coronary artery bypass graftingversus percutaneous coronary intervention with second-generation drug-elutingstents for patients with multi vessel andunprotected left main coronary arterydisease. SAGE Open Medicine. 2017;5:01-05.

[21] Park DW, Kim YH, Yun SC, Lee JY, Kim WJ, Kang SJ, et al. Long-term outcomes after stenting versus coronary artery bypass grafting for unprotected left main coronary artery disease: 10-year results of bare-metal stents and 5-year results of drug-eluting stents from the ASAN-MA IN (ASAN Medical Center-Left MAIN Revascularization) Registry. J Am Coll Cardiol. 2010;56:1366-75.

[22] Park SJ, Kim YH, Park DW, Yun SC, Ahn JM, Song HG, et al. Randomized trial of stents versus bypass surgery for left main coronary artery disease. N Engl J Med. 2011;364:1718-27.

[23] Yu XP, Wu CY, Ren XJ, Yuan F, Song XT, Luo YW, et al. Very long-term outcomes and predictors of percutaneous coronary intervention with drug-eluting stents versus coronary artery bypass grafting for patients with unprotected left main coronary artery disease. Chin Med J. 2016;129(7):763-70.

[24] Qin Q, Qian J, Wu X, Fan B, Ge L, Ge J, et al. A comparison between coronary artery bypass grafting surgery and percutaneous coronary intervention for the treatment of unprotected left main coronary artery disease. Clin Cardiol. 2013;36:54-60.

[25] Shimizu T, Ohno T, Ando J, Fujita H, Nagai R, Motomura N, et al. Mid-term results and costs of coronary artery bypass vs drug-eluting stents for unprotected left main coronary artery disease. Circ J. 2010;74:449-55.

[26] Shiomi H, Morimoto T, Furukawa Y, Nakagawa Y, Sakata R. Comparison of percutaneous coronary intervention with coronary artery bypass grafting in unprotected left main coronary artery disease 5-year outcome from CREDOK yoto PCI/CAB G Registry Cohort-2. Circ J. 2015;79:1282-89.

[27] Stone GW, Sabik JF, Serruys PW, Simonton CA, Généreux P, Puskas J, et al. Everolimus-eluting stents or bypass surgery for left main coronary artery disease. N Engl J Med. 2016;375:2223-35.

[28] Wei Z, Xie J, Wang K, Kang L, Dai Q, Bai J, et al. Comparison of percutaneous coronary intervention versus coronary artery bypass graft in aged patients with unprotected left main artery lesions. Int Heart J. 2016;57:682-88.

[29] Yin Y, Xin X, Geng T, Xu Z. Clinical comparison of percutaneous coronary intervention with domestic drug-eluting stents versus off pump coronary artery bypass grafting in unprotected left main coronary artery disease. Int J Clin Exp Med. 2015;8:14376-82.

[30] Kawecki D, Morawiec B, Fudal M, Milejski W, Jachec W, Nowalany-Kozielska E, et al. Comparison of coronary artery bypass grafting with percutaneous coronary intervention for unprotected left main coronary artery disease. Yonsei Med J. 2012;53(1):58-67.

[31] Naganuma T, Chieffo A, Meliga E, Capodanno D, Park SJ, Onuma Y, et al. Long-term clinical outcomes after percutaneous coronary intervention versus coronary artery bypass grafting for ostial/midshaft lesions in unprotected left main coronary artery from the DELTA registry: A multicenter registry evaluating percutaneous coronary intervention versus coronary artery bypass grafting for left main treatment. JACC Cardiovasc Interv. 2014;7:354-61.

[32] Rathod KS, Beirne AM, Bogle R, Firoozi S, Lim P, Hill J, et al. Prior coronary artery bypass graft surgery and outcome after percutaneous coronary intervention: An observational study from the pan-London percutaneous coronary intervention registry. J Am Heart Assoc. 2020;9:e014409.

[33] Nonaka M, Komiya T, Shimamoto T, Matsuo T. Multiple percutaneous coronary interventions may negatively impact cardiac remodeling after bypass surgery. Eur J Cardiothorac Surg. 2021;eza198.

[34] Wang S, Lyu Y, Cheng S, Liu J, Borah BJ. Clinical outcomes of patients with coronary artery diseases and moderate left ventricular dysfunction: Percutaneous coronary intervention versus coronary artery bypass graft surgery. Ther Clin Risk Manag. 2021;17:1103-11.

[35] Steigen T, Holm NR, Myrmel T, Endresen PC, Trovik T, Mäkikallio T, et al. Age-stratified outcome in treatment of left maincoronary artery stenosis: A NOBLE trial sub study. Cardiology. 2021;146:409-18.

[36] Guo L, Lv H, Zhong L, Wu J, Ding H, Xu J, et al. Gender differences in long-term outcomes of medical therapy and successful percutaneous coronary intervention for coronary chronic total occlusions. J Interv Cardiol. 2019;2019:2017958.

[37] Farag M, Gue YX, Brilakis ES, Egred M. Meta-analysis comparing outcomes of percutaneous coronary intervention of native artery versus bypass graft in patients with prior coronary artery bypass grafting. Am J Cardiol. 2021;140:47-54.

[38] Lakshman HVVSS, Rao DV. Revascularization in ischemic heart failure: A review. Indian J Clin Cardiol. 2020:1(1):31-36.

PARTICULARS OF CONTRIBUTORS:
1. Department of Cardiothoracic Surgery, Imperial College, London, United Kingdom.
2. Department of Biostatistics, Jothydev's Diabetes Hospital and Research Centre, Trivandrum, Kerala, India.
3. Department of Cardiovascular Surgery, Imperial College, London, United Kingdom.
4. Department of Thoracic Surgery, General Oncology Hospital, Agioi Anaragyroi, Athens, Greece.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Premjithlal Bhaskaran,
Department of Cardiothoracic Surgery, Imperial College, London, United Kingdom.
E-mail: lal@bhask.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 05, 2021
- Manual Googling: Nov 19, 2021
- iThenticate Software: Dec 08, 2021 (11%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? No
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 03, 2021**
Date of Peer Review: **Oct 05, 2021**
Date of Acceptance: **Dec 11, 2021**
Date of Publishing: **May 01, 2022**