

### **Review** Article

## Percutaneous Coronary Intervention versus Coronary Artery Bypass Grafting for Chronic Total Occlusion of Coronary Arteries: A Systematic Review and Meta-Analysis

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Introduction. Chronic total occlusion (CTO) of coronary arteries constitutes a substantial clinical challenge and has historically been managed through medical management and coronary artery bypass grafting (CABG). However, with the advancement in interventional technology, the success rate of percutaneous treatment has been significantly improved, and percutaneous coronary intervention (PCI) has emerged as a primary mode of treatment for CTOs, demonstrating remarkable clinical efficacy. The objective of this systematic review and meta-analysis is to evaluate and contrast the outcomes of PCI and CABG in patients with CTO. Methods and Results. A systematic search was conducted in the databases of PubMed, Embase, and Web of Science. The primary endpoints evaluated in this meta-analysis were the occurrence of major adverse cardiac events (MACE) and all-cause mortality. Secondary endpoints included myocardial infarction (MI), cardiac death, and the need for repeat revascularization. Nine studies, encompassing a total of 8,674 patients, were found to meet the criteria for inclusion and had a mean follow-up duration of 4.3 years. The results of the meta-analysis revealed that compared to CABG, PCI was associated with a lower incidence of all-cause mortality (RR: 0.78, 95% CI: 0.66–0.92; P = 0.003) and cardiac death (RR: 0.55; 95% CI: 0.31–0.96; P < 0.05), but an increased risk of myocardial infarction (MI) (RR: 1.96; 95%CI: 1.07-3.62; P < 0.05) and repeat revascularization (RR: 7.13; 95% CI: 5.69–8.94; P < 0.00001). There was no statistically significant difference in MACE (RR: 1.11; 95% CI: 0.69–1.81; P = 0.66) between the PCI and CABG groups. Conclusion. In the present meta-analysis comparing PCI and CABG in patients with chronic total occlusion of the coronary arteries, the results indicated that PCI was superior to CABG in reducing all-cause mortality and cardiac death but inferior in decreasing myocardial infarction and repeat revascularization. There was no statistically significant difference in MACE between the two groups.

#### 1. Introduction

Chronic total occlusion of the coronary artery refers to a pathological condition characterized by complete occlusion of the coronary artery, a TIMI blood flow grade of 0, and persistence for more than three months [1]. The prevalence of chronic total occlusion (CTO) is substantial, with a reported incidence of 15% to 20% of coronary heart disease patients undergoing coronary angiography examination in multiple large-scale, multicenter studies [2, 3]. A majority of these patients receive optimal guideline-directed medical therapy (GDMT), while others are treated through revascularization, and a minority undergo percutaneous coronary intervention (PCI) [4]. PCI for CTO lesions presents more challenges and complications than non-CTO lesions, with relatively lower success rates. Nevertheless, the success rate of CTO-PCI in experienced centers has improved significantly to 80% to 90% due to advancements in equipment, technology, and practitioner expertise [5, 6]. A multicenter, randomized controlled trial, involving a cohort of 396 patients, has demonstrated that CTO-PCI can relieve anginal symptoms and enhance quality of life when contrasted with the administration of optimal medical therapy (OMT) alone [7]. Compared to failed CTO-PCI, successful CTO-PCI is associated with the lower incidence rates of mortality, stroke, repeat revascularization, and recurrent angina [8]. In addition, a prospective study that included 1,777 patients demonstrated that CTO-PCI significantly improves survival and reduces the 1-year incidence of MACCE [3]. Presently, the principal benefit associated with CTO-PCI is regarded as the improvement of symptoms, while research data on whether it affects patients' long-term prognosis remains limited.

PCI and coronary artery bypass grafting (CABG) are two modalities for revascularization of patients with CTO. However, the impact of these two methods of revascularization on the prognosis of patients with CTO is still controversial. Hence, this meta-analysis aims to provide a more comprehensive understanding by comparing the PCI and CABG treatment strategies for CTO patients, incorporating all available cohort studies.

#### 2. Methods

2.1. Search Strategy. A systematic review was conducted by searching PubMed, Embase, and Web of Science databases for studies that compared PCI and CABG in patients with CTO. The search criteria utilized both MeSH terms and text words including "chronic total occlusion," "percutaneous coronary intervention," "coronary artery bypass grafting," and "revascularization." The search was performed from the year 2000 to March 2023, with no language restrictions, and included both fully published research and abstracts. This meta-analysis was registered with the International Prospective Register of Systematic Reviews (PROSPERO ID: CRD42022326498).

2.2. Inclusion and Exclusion Criteria. The studies included in this meta-analysis compared the outcomes between PCI and CABG in patients with CTO. The outcomes evaluated included all-cause mortality, MI, cardiac death, repeat revascularization, and the incidence of MACE.

The following studies were excluded from this metaanalysis: (1) studies comparing the outcomes between successful and unsuccessful PCI in patients with CTO; (2) studies comparing the outcomes between PCI and CABG in CTO patients who also had other illnesses; (3) studies that exclusively focused on one treatment strategy; and (4) studies conducted on animal subjects.

2.3. Study Selection. Our initial search generated 3,938 references (Figure 1). Of these, 3,922 (99.6%) were excluded from title and summary searches due to duplication, irrelevant content, animal subjects, unreported results of

interest, or other reasons. The remaining 16 studies were reviewed in full, and 7 were excluded because they did not report results of interest. Finally, nine studies [3, 9–16] met the inclusion criteria.

2.4. Data Extraction. The process of data extraction was performed by two researchers, W.C.Y. and L.S., using a standardized form. Any discrepancies were resolved through discussion between the researchers. The following information was collected: the author's name, year of publication, location of study participants, study design, age and gender of participants, and relevant results.

2.5. Outcomes. The primary focus of this meta-analysis was to assess the incidence of MACE and all-cause mortality. MACE was defined as a composite of cardiac death, cerebrovascular accident, MI, or repeat revascularization. The secondary outcomes were MI, cardiac death, and repeat revascularization.

2.6. Methodological Quality. The process of study selection, data collection and analysis, and reporting of results adhered to the guidelines set forth by the Epidemiological Observational Study (MOOSE) group [17]. We use the Newcastle-Ottawa Scale to appraise the quality of the studies (Table 1).

Weighted risk ratios (RRs) and 95% confidence intervals (CIs) were calculated for categorical variables. We used Cochrane Q-statistic and  $I^2$ -statistic to perform heterogeneity analysis [18]. We used a fixed-effects model to combine effect sizes when heterogeneity was insignificant ( $I^2 < 50\%$ ). When heterogeneity was significant ( $I^2 \ge 50\%$ ), we used a random-effects model. We conducted sensitivity analysis by eliminating each study in turn to assess the effect of each study on the pooling RRs. Funnel plots were performed to assess publication bias. We used RevMan 5.3 software (The Cochrane Collaboration, The Nordic Cochrane Centre, Copenhagen, Denmark) to perform our analyses.

#### 3. Results

3.1. Characteristics of Studies. As shown in Table 2, the base characteristics of the nine studies that we included were displayed. Of these, one is a randomized controlled trial (RCT), three are prospective cohort studies, and five are retrospective cohort studies. Our meta-analysis included 8674 patients, of whom 4466 underwent PCI and 4208 underwent CABG. The mean duration of follow-up was 4.3 years, and the internal validity of the eligible studies was evaluated as moderate, as depicted in Table 1.

*3.2.* All-Cause Mortality. The meta-analysis of 7723 patients revealed that 558 individuals, constituting 7.0% of the total sample, passed away during the follow-up period. The results indicated that PCI was correlated with a reduced incidence of all-cause mortality in comparison to CABG (RR: 0.78, 95% CI: 0.66–0.92; P = 0.003). (Figure 2(a)).

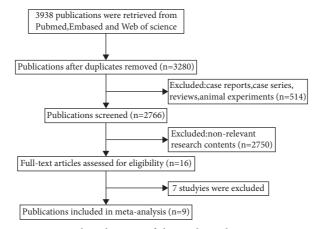


FIGURE 1: Flow diagram of the studies selection process.

TABLE 1: Quality of	f studies as per	• Newcastle	Ottawa scale.
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Serial numbers	Study	Study design	Selection	Comparability	Outcome
1	Gai et al.	Retrospective	***	*	***
2	Kawashima et al.	Randomized	***	*	***
3	Lin et al.	Prospective	****	*	***
4	Liu et al.	Prospective	***	*	***
5	Kim et al.	Retrospective	****	*	**
6	Woo et al.	Retrospective	***	*	***
7	Tomasello et al.	Prospective	***	*	**
8	Woo et al.	Retrospective	***	*	***
9	Luis et al.	Prospective	***	*	**

TABLE 2: Characteristics of studies.

First author	Publication year	ear Region $\begin{array}{c} \text{Sample size} \\ (n) \end{array}$ Age (mean $\pm$ SD)		Age (mean $\pm$ SD)	Male (%)	Follow-up
Gai et al.	2015	China	253	_		5 years
Kawashima et al.	2021	Netherlands	480	PCI: 64.7 ± 10.3 CABG: 64.5 ± 10.5	PCI: 79.3 CABG: 85.2	10 years
Lin et al.	2022	China	4324	PCI: 57.5 ± 10.6 CABG: 60.9 ± 9.1	PCI: 83.7 CABG: 83.0	5 years
Liu et al.	2011	China	6000	PCI: 60.16 ± 10.53 CABG: 61.47 ± 9.71	PCI: 74.5 CABG: 83.2	3 years
Kim et al.	2015	Republic of Korea	2024	CABG: 61.1 ± 9.6 PCI: 62.0 ± 11.1	CABG: 87.0 PCI: 86.9	46.5 months
Woo et al.	2019	Republic of Korea	2019	CABG: 62.9 ± 9.9 PCI: 63.1 ± 11.1	CABG: 83.8 PCI: 80.2	32 months
Tomasello et al.	2015	Italy	1777	CABG: 68.8 ± 8.9 PCI: 67.0 ± 10.6	CABG: 84 PCI: 84.8	12 months
Woo et al.	2015	Republic of Korea	738	_	_	3.5 years
Luis et al.	2021	Spain	1248	PCI: 62.8 ± 10.8 CABG: 65.3 ± 9.5	PCI: 85 CABG: 87	4.3 years

CABG = coronary artery bypass grafting; MACE = major adverse cardiac event; MI = myocardial infarction; PCI = percutaneous coronary intervention.

3.3. *MACE*. Of the nine studies examined, six reported a total of 368 MACE over the course of the follow-up period. The results indicated that PCI did not result in a lower incidence of MACE compared to CABG (RR: 1.11, 95% CI: 0.69–1.81; P = 0.66). (Figure 3(a)).

3.4. Myocardial Infarction. Of the nine studies analyzed, eight reported 232 instances of MI during the follow-up period. The results indicated that the incidence of MI was higher in the group undergoing PCI compared to the group receiving CABG, and the difference was found to be

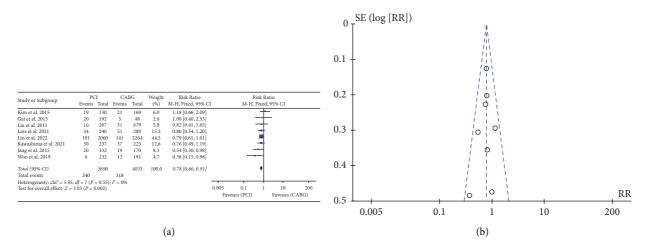


FIGURE 2: (a) Forrest plot for all-cause mortality. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; and CI = confidence interval. (b). Funnel plot for all-cause mortality.

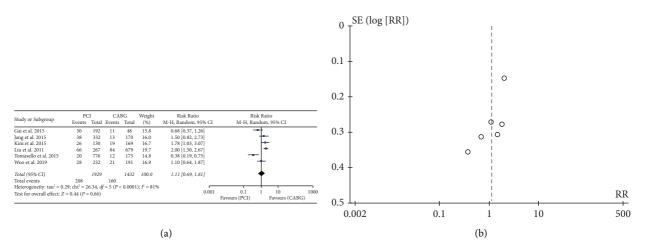


FIGURE 3: (a) Forrest plot for MACE. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; CI = confidence interval; MACE = major acute cardiovascular event. (b). Funnel plot for MACE. MACE = major acute cardiovascular event.

statistically significant (RR: 1.96, 95% CI: 1.07–3.62; P < 0.03). (Figure 4(a)).

3.5. Cardiac Death. Of the nine studies evaluated, six reported 231 cases of cardiac deaths during the follow-up period. The results indicated that the incidence of cardiac death was lower among individuals receiving PCI compared to those who underwent CABG (RR: 0.55; 95% CI: 0.31–0.96; P = 0.03). (Figure 5(a)).

3.6. Repeat Revascularization. Four of the nine studies in question revealed that there were 540 cases of repeat revascularization documented during the follow-up period. The result revealed that the incidence of repeat revascularization was higher among individuals who underwent PCI as compared to those who received CABG (RR: 7.42, 95% CI: 5.78–9.53; P < 0.00001). (Figure 6(a)).

3.7. Publication Bias Analysis. In our meta-analytic study, we utilized funnel plots to examine the presence of publication bias among all the studies that were included (Figures 2(b)-6(b)).

3.8. Sensitivity Analysis. We performed a leave-one-out meta-analysis to assess the influence of each individual study on the combined Relative Risks (RRs). The results of these sensitivity analyses showed that there was no noticeable alteration in the combined RRs, suggesting that the results are robust and stable (Figures 7–9).

#### 4. Discussion

To date, our study constitutes the first meta-analytic examination that focuses on comparing the clinical outcomes of PCI and CABG in the context of CTO patients. Our findings indicate that, compared to CABG, PCI has lower

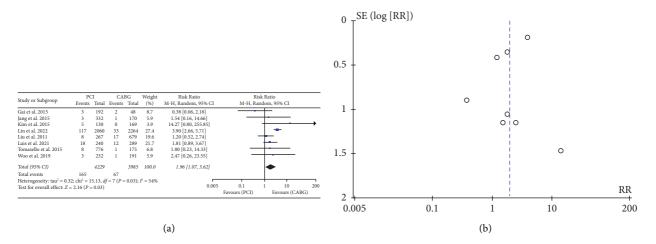


FIGURE 4: (a) Forrest plot for MI. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; CI = confidence interval; MI = myocardial infarction. (b). Funnel plot for MI. MI = myocardial infarction.

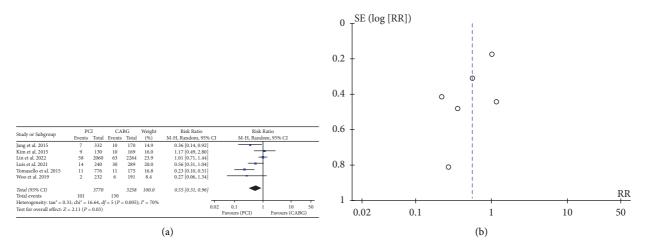


FIGURE 5: (a) Forrest plot for cardiac death. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; CI = confidence interval. (b). Funnel plot for cardiac death.

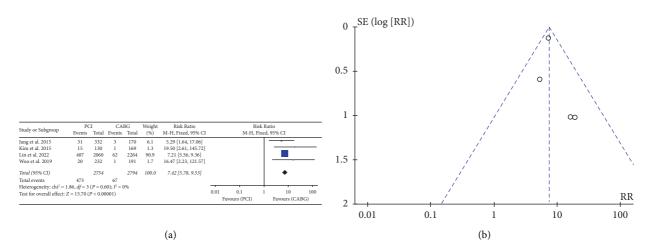


FIGURE 6: (a) Forrest plot for repeat revascularization. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; CI = confidence interval. (b). Funnel plot for repeat revascularization.

Study or Subgroup	PCI Events		CA Events		Weight (%)	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H. Random, 95% CI	Study or Subgroup	Perents		CA Events		Weight (%)	Risk Ratio M-H. Random, 95% CI	Risk Rat M-H. Random	
lang et al. 2015	7	332	10	170	0.0	0.36 [0.14, 0.92]		Jang et al. 2015	7	332	10	170	19.3	0.36 [0.14, 0.92]		
Kim et al. 2015	9	130	10	169	18.9	1.17 [0.49, 2.80]		Kim et al. 2015	9	130	10	169	20.4	1.17 [0.49, 2.80]		
in et al. 2022	58	2060	63	2264	27.8	1.01 [0.71, 1.44]	+	Lin et al. 2022	58	2060	63	2264	27.2	1.01 [0.71, 1.44]		
uis et al. 2021	14	240	30	289	23.5	0.56 [0.31, 1.04]		Luis et al. 2021	14	240	30	289	0.0	0.56 [0.31, 1.04]		
Fomasello et al. 2015	11	776	11	175	19.8	0.23 [0.10, 0.51]	(	Tomasello et al. 2015	11	776	11	175	21.1	0.23 [0.10, 0.51]		
Woo et al. 2019	2	232	6	191	10.0	0.27 [0.06, 1.34]		Woo et al. 2019	2	232	6	191	12.0	0.27 [0.06, 1.34]	+	
Total (95% CI)		3438		3088	100.0	0.59 [0.32, 1.09]	-	Total (95% CI)		3530		2969	100.0	0.53 [0.26, 1.09]	-	
Fotal events	94		120					Total events	87		100				-	
Heterogeneity: tau <sup>2</sup> = 0.3	32; chi <sup>2</sup> = 14	1.46, df	= 4 (P =	0.006);	$I^2 = 72\%$			Heterogeneity: tau <sup>2</sup> = 0	.46; chi2	= 15.94	df = 4 (I	P = 0.003	); I <sup>2</sup> = 759	6 <b>–</b>		
Test for overall effect: Z	= 1.68 (P =	0.09)				0.02 F	0.1 1 10 50 avours (PCI) Favours (CABG)	Test for overall effect: 2	2 = 1.72 (	P = 0.0	3)			0.	02 0.1 1 Favours (PCI)	10 50 Favours (CABG)
Study or Subgroup	PCI		CA		Weight	Risk Ratio	Risk Ratio	Study or Subgroup	P		CA		Weight	Risk Ratio	Risk Rat	
study of Subgroup	Events	Total	Events	Total	(%)	M-H, Random, 95% CI	M-H, Random, 95% CI	study or subgroup	Events	Total	Events	Total	(%)	M-H, Random, 95% CI	M-H, Random	1, 95% CI
ang et al. 2015	7	332	10	170	18.1	0.36 [0.14, 0.92]		Jang et al. 2015	7	332	10	170	15.7	0.36 [0.14, 0.92]		
im et al. 2015	9	130	10	169	0.0	1.17 [0.49, 2.80]		Kim et al. 2015	9	130	10	169	17.5	1.17 [0.49, 2.80]		_
in et al. 2022	58	2060	63	2264	27.5	1.01 [0.71, 1.44]	+	Lin et al. 2022	58	2060	63	2264	34.5	1.01 [0.71, 1.44]	+	
uis et al. 2021	14	240	30	289	23.6	0.56 [0.31, 1.04]		Luis et al. 2021	14	240	30	289	24.9	0.56 [0.31, 1.04]		
ïomasello et al. 2015	11	776	11	175	20.2	0.23 [0.10, 0.51]		Tomasello et al. 2015	11	776	11	175	0.0	0.23 [0.10, 0.51]		
Woo et al. 2019	2	232	6	191	10.6	0.27 [0.06, 1.34]		Woo et al. 2019	2	232	6	191	7.4	0.27 [0.06, 1.34]		
Total (95% CI)		3640		3089	100.0	0.47 [0.25, 0.89]	•	Total (95% CI)		2994		3083	100.0	0.69 [0.43, 1.11]	•	
Total events	92		120					Total events	90		119					
Heterogeneity: tau <sup>2</sup> = 0.3			= 4 (P =	0.004);	$I^2 = 74\%$	0.02	0.1 1 10 50	Heterogeneity: tau <sup>2</sup> = 0				= 0.08);	P = 51%	-	02 01	10 50
Fest for overall effect: Z	= 2.31 (P =	0.02)					avours (PCI) Favours (CABG)	Test for overall effect: 2	Z = 1.53 (	P = 0.13	3)			0.		Favours (CABG)
study or Subgroup	PCI Events		CA		Weight (%)	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H. Random, 95% CI	Study or Subgroup	P		CA Events		Weight (%)	Risk Ratio M-H. Random, 95% CI	Risk Rat M-H. Random	
ang et al. 2015		332	10	170	19.3	0.36 [0.14, 0.92]	M-11, Kandolii, 95% Ci	Jang et al. 2015	7	332	10	170	16.3	0.36 [0.14, 0.92]	M-11, Kalidolii	1, 93/0 CA
ing et al. 2015 Tim et al. 2015		130	10	169	21.0	1.17 [0.49, 2.80]		Kim et al. 2015	9	130	10	169	16.5	1.17 [0.49, 2.80]		_
in et al. 2015		2060	63	2264	0.0	1.01 [0.71, 1.44]	1	Lin et al. 2015	58	2060	63	2264	26.0	1.01 [0.71, 1.44]		
uis et al. 2022		2080	30	2204	27.6	0.56 [0.31, 1.04]		Luis et al. 2022	14	2000	30	2204	20.0	0.56 [0.31, 1.04]		
omasello et al. 2015		240	11	175	22.2	0.23 [0.10, 0.51]	I	Tomasello et al. 2015	14	776	11	175	18.3	0.23 [0.10, 0.51]		
Voo et al. 2019		232	6	191	10.0	0.27 [0.06, 1.34]		Woo et al. 2019	2	232	6	191	0.0	0.27 [0.06, 1.34]		
otal (95% CI)		1710		994	100.0	0.46 [0.26, 0.82]	•	Total (95% CI)		3538		3067	100.0	0.58 [0.33, 1.05]	•	
otal events	43		67					Total events	99		124				-	
leterogeneity: tau <sup>2</sup> = 0.2		40. df -		0.08): 12	= 52%			Heterogeneity: tau <sup>2</sup> = 0		= 15 23		P = 0.04	$I^2 = 74\%$	-		
fest for overall effect: Z			. (1 =		- 5270	0.02 F	0.1 1 10 50 avours (PCI) Favours (CABG)	Test for overall effect: 2			· ·	- 5.04)	. = 7470	0.	02 0.1 1 Favours (PCI)	10 50 Favours (CABG)

FIGURE 7: Results of sensitivity analysis for cardiac death. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; CI = confidence interval.

	PCI		CAE	C.	Weight	Risk Ratio	Risk Ratio		PC	71	CABG	Weight	Risk Ratio	Risk I	1 - +	
Study or Subgroup	Events 7			Total	(%)	M-H. Random, 95% CI	M-H. Random, 95% CI	Study or Subgroup			Events Tota		M-H. Random, 95% CI	M-H, Rando		
Gai et al. 2015	3	192	2	48	0.0	0.38 [0.06, 2.18]		Gai et al. 2015	3	192	2 48	10.3	0.38 [0.06, 2.18]		_	
Jang et al. 2015		332	1	170	5.0	1.54 [0.16, 14.66]		Jang et al. 2015	3	332	1 170		1.54 [0.16, 14.66]		•	
Kim et al. 2015		130	0	169	3.2	14.27 [0.80, 255.85]	· · · · · · · · · · · · · · · · · · ·	Kim et al. 2015	5	130	0 165		14.27 [0.80, 255.85]	1		
Lin et al. 2022		2060	33	2264	35.3	3.90 [2.66, 5.71]		Lin et al. 2022	117	2060	33 226		3.90 [2.66, 5.71]			
Liu et al. 2011		267	17	679	21.2	1.20 [0.52, 2.74]		Liu et al. 2011	8	267 240	17 679		1.20 [0.52, 2.74]			
Luis et al. 2021		240 776	12	289 175	24.5 5.8	1.81 [0.89, 3.67]		Luis et al. 2021	18 8	240 776	12 289		1.81 [0.89, 3.67]			
Tomasello et al. 2015 Woo et al. 2019		232	1	1/5	5.8	1.80 [0.23, 14.33] 2.47 [0.26, 23.55]		Tomasello et al. 2015 Woo et al. 2019	8	232	1 1/2		1.80 [0.23, 14.33] 2.47 [0.26, 23.55]			
woo et al. 2019	5	232	1	191	5.0	2.47 [0.20, 25.55]		W00 et al. 2019	5	232	1 191	0.9	2.47 [0.20, 25.55]			
Total (95% CI)		4037		3937	100.0	2.34 [1.37, 4.00]	•	Total (95% CI)		3962	330	5 100.0	2.25 [1.17, 4.31]		<b>•</b>	
Total events	162		65					Total events	157		50					
Heterogeneity: tau <sup>2</sup> = 0.			= 6 (P =	0.12); I	$^{2} = 41\%$	0.005	0.1 1 10 20	Heterogeneity: tau <sup>2</sup> =				$.09$ ; $I^2 = 45$	%			
Test for overall effect: Z	= 3.10 (P = 0	0.002)					0.1 1 10 20 avours (PCI) Favours (CABG)	<sup>0</sup> Test for overall effect:	Z = 2.44	(P = 0.)	01)		0.005		10	200
						1	avours (PCI) Favours (CABG)							Favours (PCI)	Favours (CA	LBG)
Study or Subgroup	PCI		CAE		Weight	Risk Ratio	Risk Ratio	Study or Subgroup	PC		CABG	Weight	Risk Ratio	Risk I		
, , ,	Events 7				(%)	M-H, Random, 95% CI	M-H, Random, 95% CI	, 01			Events Tota		M-H, Random, 95% CI	M-H, Rando	om, 95% CI	
Gai et al. 2015		192	2	48	9.6	0.38 [0.06, 2.18]		Gai et al. 2015	3	192	2 48	12.3	0.38 [0.06, 2.18]		_	
Jang et al. 2015		332	1	170	0.0	1.54 [0.16, 14.66]		Jang et al. 2015	3	332	1 170		1.54 [0.16, 14.66]			
Kim et al. 2015		130	0	169	4.4	14.27 [0.80, 255.85]	· · · · · · · · · · · · · · · · · · ·	Kim et al. 2015	5	130	0 169		14.27 [0.80, 255.85]	1	-	
Lin et al. 2022		2060	33	2264	28.1	3.90 [2.66, 5.71]		Lin et al. 2022	117	2060 267	33 226 17 679		3.90 [2.66, 5.71]			
Liu et al. 2011 Luis et al. 2021		267 240	17 12	679 289	20.8 22.8	1.20 [0.52, 2.74]		Liu et al. 2011 Luis et al. 2021	8	267	1/ 6/5		1.20 [0.52, 2.74] 1.81 [0.89, 3.67]			
Tomasello et al. 2015		240 776	12	289	7.6	1.81 [0.89, 3.67] 1.80 [0.23, 14.33]		Tomasello et al. 2021	18 8	240 776	12 285		1.80 [0.23, 14.33]			
Woo et al. 2019		232	1	1/5	6.7	2.47 [0.26, 23.55]		Woo et al. 2019	3	232	1 1/2		2.47 [0.26, 23.55]			
woo et al. 2019	5	232	1	191	0.7	2.47 [0.20, 25.55]		1100 et al. 2013	5	232	1 191	0.0	2.47 [0.20, 25.55]			
Total (95% CI)	2	3897		3815	100.0	1.98 [1.03, 3.82]	•	Total (95% CI)		3989	369	5 100.0	1.95 [0.90, 4.27]	-	•	
Total events	162		66					Total events	147		55					
Heterogeneity: tau <sup>2</sup> = 0.2			= 6 (P =	0.02); I	<sup>2</sup> = 60%	0.005	0.1 1 10 20	Heterogeneity: tau <sup>2</sup> =				.03); I <sup>2</sup> = 56	% 0.005		10	200
Test for overall effect: Z	= 2.04 (P = 0	0.04)					0.1 1 10 20 avours (PCI) Favours (CABG)	<sup>D</sup> Test for overall effect:	Z = 1.68	(P = 0.)	09)		0.005	0.1 1 Favours (PCI)	10 Favours (CA	
																100)
Study or Subgroup	PCI		CAE		Weight	Risk Ratio	Risk Ratio	Study or Subgroup	PC		CABG	Weight	Risk Ratio	Risk I		
7 0 1	Events 7			Total	(%)	M-H, Random, 95% CI	M-H, Random, 95% CI	, , ,			Events Tota		M-H, Random, 95% CI	M-H, Rando	om, 95% CI	
Gai et al. 2015		192 332	2	48 170	8.9 6.1	0.38 [0.06, 2.18]		Gai et al. 2015	3	192 332	2 48 1 170	9.7 6.7	0.38 [0.06, 2.18]			
Jang et al. 2015 Kim et al. 2015		332 130	1	169	0.0	1.54 [0.16, 14.66] 14.27 [0.80, 255.85]		Jang et al. 2015 Kim et al. 2015	5	332 130	0 169		1.54 [0.16, 14.66] 14.27 [0.80, 255.85]			
Lin et al. 2022		2060	33	2264	28.7	3.90 [2.66, 5.71]		Lin et al. 2013	117	2060	33 226		3.90 [2.66, 5.71]			
Liu et al. 2011		267	17	679	20.5	1.20 [0.52, 2.74]		Liu et al. 2011	8	267	17 679		1.20 [0.52, 2.74]	_	-	
Luis et al. 2021		240	12	289	22.6	1.81 [0.89, 3.67]	+	Luis et al. 2021	18	240	12 289		1.81 [0.89, 3.67]	+	-	
Tomasello et al. 2015	8	776	1	175	7.0	1.80 [0.23, 14.33]		Tomasello et al. 2015	8	776	1 175	7.7	1.80 [0.23, 14.33]			
Woo et al. 2019	3	232	1	191	6.1	2.47 [0.26, 23.55]		Woo et al. 2019	3	232	1 191	0.0	2.47 [0.26, 23.55]			
															•	
Total (95% CI)		4099		3816	100.0	1.82 [0.98, 3.37]	-	Total (95% CI)		3997	379	100.0	1.92 [0.99, 3.71]	i	-	
Total events Heterogeneity: tau <sup>2</sup> = 0.2	160	76 36	67	0.02) 5	5.00	_		Total events Heterogeneity: tau <sup>2</sup> =	162 0.27. shi2	15.1	66 2 46 c (D (	02) 5 (0	~			
			= 6 (P =	0.05); 1	= 30%	0.005	0.1 1 10 20	Preterogeneity: tau = 0 Test for overall effect:				(02); I = 00	70 0.005	0.1 1	10	200
							avours (PCI) Favours (CABG)	rescior overall effect.	2 - 192 (	r = 0.0	(5)			Favours (PCI)	Favours (CA	BG)
Test for overall effect: Z	= 1.89 (P = 0	0.06)				ł	avours (PCI) Favours (CABG)									
Test for overall effect: Z		0.06)			117 - 1 -				D.C		CURC	147.1.1.	ni li ni vi	n: 1 r		
Test for overall effect: Z Study or Subgroup	PCI		CAE		Weight	Risk Ratio	Risk Ratio	Study or Subgroup	PC		CABG	Weight	Risk Ratio	Risk H M H Rande		
Study or Subgroup	PCI Events	Total	Events	Total	(%)	Risk Ratio M-H, Random, 95% CI		, , ,	Events	Total	Events Tota	1 (%)	M-H, Random, 95% CI	Risk I M-H, Rando		
Study or Subgroup Gai et al. 2015	PCI Events 7 3	Total 192	Events 2	Total 48	(%) 7.2	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18]	Risk Ratio	Gai et al. 2015	Events 3	Total 192	Events Tota 2 48	1 (%) 9.8	M-H, Random, 95% CI 0.38 [0.06, 2.18]			
Study or Subgroup Gai et al. 2015 Jang et al. 2015	PCI Events 7 3 3	Total 192 332	Events 2 1	Total 48 170	(%) 7.2 4.4	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66]	Risk Ratio	Gai et al. 2015 Jang et al. 2015	Events	Total 192 332	Events Tota 2 48 1 170	1 (%) 9.8 6.8	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66]			
Study or Subgroup Gai et al. 2015	PCI Events 7 3 3 5	Total 192	Events 2	Total 48	(%) 7.2	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18]	Risk Ratio	Gai et al. 2015	Events 3 3	Total 192	Events Tota 2 48	1 (%) 9.8 6.8 4.5	M-H, Random, 95% CI 0.38 [0.06, 2.18]			<b>&gt;</b>
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011	PCI Events 7 3 3 5 117 2 8	Total 192 332 130 2060 267	2 1 0 33 17	Total 48 170 169 2264 679	(%) 7.2 4.4 2.7 0.0 32.3	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011	Events 3 5 117 8	Total 192 332 130 2060 267	Events     Tota       2     48       1     170       0     165       33     226       17     675	1 (%) 9.8 6.8 4.5 4 28.2 21.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74]			<b>&gt;</b>
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011 Luis et al. 2021	PCI Events 7 3 3 5 117 2 8 18	Total 192 332 130 2060 267 240	Events 2 1 0 33 17 12	Total 48 170 169 2264 679 289	(%) 7.2 4.4 2.7 0.0 32.3 44.0	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011 Luis et al. 2021	Events 3 5 117 8 18	Total 192 332 130 2060 267 240	Events     Tota       2     48       1     170       0     169       33     226       17     679       12     289	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67]			
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2021 Tomasello et al. 2021	PCI Events 7 3 3 5 117 2 8 18 8	Total 192 332 130 2060 267 240 776	Events 2 1 0 33 17 12 1	Total 48 170 169 2264 679 289 175	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 1.427 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2015 Liu et al. 2022 Liu et al. 2021 Tomasello et al. 2015	Events 3 5 117 8 18 8	Total 192 332 130 2060 267 240 776	Events     Tota       2     48       1     170       0     169       33     226       17     679       12     289       1     175	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33]			
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2021 Tomasello et al. 2021	PCI Events 7 3 3 5 117 2 8 18 8	Total 192 332 130 2060 267 240	Events 2 1 0 33 17 12	Total 48 170 169 2264 679 289	(%) 7.2 4.4 2.7 0.0 32.3 44.0	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011 Luis et al. 2021	Events 3 5 117 8 18	Total 192 332 130 2060 267 240	Events     Tota       2     48       1     170       0     169       33     226       17     679       12     289	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67]			
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2021 Luis et al. 2021 Tomasello et al. 2015 Woo et al. 2019	PCI Events 7 3 3 5 117 2 8 18 8 3	Total 192 332 130 2060 267 240 776 232	Events 2 1 0 33 17 12 1	Total 48 170 169 2264 679 289 175 191	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2 4.4	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.09 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.28, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2012 Liu et al. 2011 Luis et al. 2021 Tomasello et al. 2015 Woo et al. 2019	Events 3 5 117 8 18 8	Total 192 332 130 2060 267 240 776 232	Events     Tota       2     48       1     170       0     169       33     226       17     679       12     289       1     175       1     191	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0 6.8	M-H, Random, 95% Cl 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 1.427 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55]			
Study or Subgroup Gai et al. 2015 Jang et al. 2015 Lin et al. 2015 Lin et al. 2022 Lin et al. 2021 Tomasello et al. 2021 Tomasello et al. 2019 Tobtal (95% CI)	PCI Events 7 3 5 117 2 8 18 8 3	Total 192 332 130 2060 267 240 776	Events 2 1 0 33 17 12 1 1 1	Total 48 170 169 2264 679 289 175	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 1.427 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2021 Tomasello et al. 2021 Tomasello et al. 2015 Woo et al. 2019 Total (95% CI)	Events 3 5 117 8 18 8 3	Total 192 332 130 2060 267 240 776	Events     Tota       2     48       1     170       0     169       33     226       17     679       12     289       1     179       1     191       381     381	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0 6.8	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33]			
Study or Subgroup       Gai et al. 2015       Jang et al. 2015       Kim et al. 2015       Lin et al. 2022       Liu et al. 2021       Tomasello et al. 2011       Tomasello et al. 2019       Total (95% CI)       Total events	PCI Events 7 3 3 5 117 2 8 18 8 3 3	Total 192 332 130 2060 267 240 776 232 2169	Events 2 1 0 33 17 12 1 1 34	Total 48 170 169 2264 679 289 175 191 <i>1721</i>	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2 4.4 100.0	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.09 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.28, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2011 Luis et al. 2021 Tomasello et al. 2017 Woo et al. 2019 Total (95% CI) Total events	Events 3 5 117 8 18 8 3 157	Total 192 332 130 2060 267 240 776 232 3453	Events     Tota       2     48       1     170       0     166       33     226       17     675       12     286       1     175       1     191       381     66	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0 6.8 0 100.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55] 1.96 [1.01, 3.80]			
Study or Subgroup       Gai et al. 2015       Jang et al. 2015       Lin et al. 2012       Lin et al. 2021       Tomssello et al. 2011       Luis et al. 2021       Tomssello et al. 2019       Total (95% CI)       Total events       Heterogeneity: tau <sup>2</sup> = 0.1	PCI Events 7 3 3 5 5 117 2 8 18 8 3 3 48 00; chi <sup>2</sup> = 5.6	Total 192 332 130 2060 267 240 776 232 2169 52, df =	Events 2 1 0 33 17 12 1 1 34	Total 48 170 169 2264 679 289 175 191 <i>1721</i>	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2 4.4 100.0	Risk Ratio M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.09 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.28, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55]	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2015 Lin et al. 2022 Liu et al. 2021 Tomasello et al. 2017 Tomasello et al. 2019 Total (95% CI) Total events Heterogeneity: tau <sup>2</sup> =	Events 3 5 117 8 18 8 3 157 0.37; chi <sup>2</sup>	Total 192 332 130 2060 267 240 776 232 3453 = 14.9	Events     Tota       2     48       1     170       0     166       33     226       17     675       1     191       381     66       9, $df = 6$ ( $P = 0$	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0 6.8 0 100.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55] 1.96 [1.01, 3.80]	M-H, Rando		200
udy or Subgroup ai et al. 2015 ing et al. 2015 in et al. 2015 in et al. 2022 iu et al. 2021 ui et al. 2021 omasello et al. 2015 Voo et al. 2019 obtal (95% CI) otal events	PCI Events 7 3 3 5 5 117 2 8 18 8 3 3 48 00; chi <sup>2</sup> = 5.6	Total 192 332 130 2060 267 240 776 232 2169 52, df =	Events 2 1 0 33 17 12 1 1 34	Total 48 170 169 2264 679 289 175 191 <i>1721</i>	(%) 7.2 4.4 2.7 0.0 32.3 44.0 5.2 4.4 100.0	Risk Ratio M-H, Random, 95% C1 0.38 (006, 218) 1.54 (0.16, 14.66) 1.427 (0.80, 255.85] 3.90 (2.66, 5.71) 1.20 (0.52, 2.74] 1.80 (0.23, 1.43.3) 2.47 (0.26, 23.55) 1.50 (0.94, 2.41] 0.005	Risk Ratio	Gai et al. 2015 Jang et al. 2015 Kim et al. 2015 Lin et al. 2022 Liu et al. 2022 Tomasello et al. 2021 Tomasello et al. 2019 Total (95% CI) Total events Heteroseneity: tau <sup>2</sup> =	Events 3 5 117 8 18 8 3 157 0.37; chi <sup>2</sup>	Total 192 332 130 2060 267 240 776 232 3453 = 14.9	Events     Tota       2     48       1     170       0     166       33     226       17     675       1     191       381     66       9, $df = 6$ ( $P = 0$	1 (%) 9.8 6.8 4.5 4 28.2 21.0 23.0 0.0 6.8 0 100.0	M-H, Random, 95% CI 0.38 [0.06, 2.18] 1.54 [0.16, 14.66] 14.27 [0.80, 255.85] 3.90 [2.66, 5.71] 1.20 [0.52, 2.74] 1.81 [0.89, 3.67] 1.80 [0.23, 14.33] 2.47 [0.26, 23.55] 1.96 [1.01, 3.80] %	M-H, Rando	• • • • • • • • • • • • • • • • • • •	

FIGURE 8: Results of sensitivity analysis for MI. MI = myocardial infarction.

	D	CI	CI	ABG	147 1 1 4	Risk Ratio	Risk Ratio		PC	71	CAI	20	Weight	Risk Ratio	Dial	k Ratio	
Study or Subgroup	Events				Weight (%)	M-H. Fixed, 95% C		Study or Subgroup	Events		Events		(%)	M-H. Fixed, 95% C		k Ratio xed. 95% CI	
Kim et al. 2015	19	130	21	169	0.0	1.18 [0.66, 2.09]		Kim et al. 2015	19	130	21	169	6.2	1.18 [0.66, 2.09]		+-	
Gai et al. 2015	20	192	5	48	2.8	1.00 [0.40, 2.53]		Gai et al. 2015	20	192	5	48	0.0	1.00 [0.40, 2.53]			
Liu et al. 2011	10	267	31	679	6.2	0.82 [0.41, 1.65]		Liu et al. 2011	10	267	31	679	6.0	0.82 [0.41, 1.65]	-	+	
Luis et al. 2021	34	240	51	289	16.3	0.80[0.54, 1.20]		Luis et al. 2021	34	240	51	289	15.7	0.80[0.54, 1.20]		•	
Lin et al. 2022	101	2060	141	2264	47.4	0.79 [0.61, 1.01]	-	Lin et al. 2022	101	2060	141	2264	45.7	0.79 [0.61, 1.01]		4	
Kawashima et al. 2021	30	237	37	223	13.4	0.76 [0.49, 1.19]		Kawashima et al. 2021	30	237	37	223	13.0	0.76 [0.49, 1.19]	-	*	
Jang et al. 2015	20	332	19	170	8.9	0.54 [0.30, 0.98]		Jang et al. 2015	20	332	19	170	8.6	0.54 [0.30, 0.98]	-	-	
Woo et al. 2019	6	232	13	191	5.0	0.38 [0.15, 0.98]		Woo et al. 2019	6	232	13	191	4.9	0.38 [0.15, 0.98]		1	
Total (95% CI)		3560		3864	100.0	0.75 [0.63, 0.89]	*	Total (95% CI)		3498		3985	100.0	0.77 [0.65, 0.91]		•	
Total events	221		297					Total events	220		313						
Heterogeneity: chi2 = 3.83			$I^2 = 0\%$	5			0.005 0.1 1 10 200	Heterogeneity: chi2 = 5.6			); $I^2 = 0\%$	6			0.005 0.1	1 10	200
Test for overall effect: Z =	3.29 (P =	0.0010)					Favours (PCI) Favours (CABG)	Test for overall effect: Z =	= 3.08 (P =	0.002)					Favours (PCI)	Favours (CA	
Study or Subgroup		CI		ABG	Weight	Risk Ratio	Risk Ratio	Study or Subgroup	PO		CAI		Weight	Risk Ratio		k Ratio	
, , ,	Events				(%)	M-H, Fixed, 95% C	I M-H, Fixed, 95% CI	, , ,	Events		Events	Total	(%)	M-H, Fixed, 95% C	I M-H, Fiz	xed, 95% CI	
Kim et al. 2015	19	130	21	169	6.4	1.18 [0.66, 2.09]		Kim et al. 2015	19	130	21	169	7.1	1.18 [0.66, 2.09]		+-	
Gai et al. 2015	20	192	5	48	2.8	1.00 [0.40, 2.53]		Gai et al. 2015	20	192	5	48	3.1	1.00 [0.40, 2.53]	_		
Liu et al. 2011	10	267	31	679	0.0	0.82 [0.41, 1.65]	_	Liu et al. 2011	10	267	31	679	6.8	0.82 [0.41, 1.65]	_	Т	
Luis et al. 2021 Lin et al. 2022	34	240	51 141	289 2264	16.3 47.2	0.80[0.54, 1.20]		Luis et al. 2021 Lin et al. 2022	34	240 2060	51 141	289 2264	0.0	0.80[0.54, 1.20] 0.79 [0.61, 1.01]		<b>_</b>	
Lin et al. 2022 Kawashima et al. 2021	101 30	2060 237	141 37	2264	47.2	0.79 [0.61, 1.01] 0.76 [0.49, 1.19]		Lin et al. 2022 Kawashima et al. 2021	101 30	2060 237	141 37	2264	52.6 14.9	0.79 [0.61, 1.01] 0.76 [0.49, 1.19]	-	7	
Jang et al. 2015	30 20	332	37 19	170	13.4 8.8	0.54 [0.30, 0.98]		Jang et al. 2015	20	332	19	170	9.8	0.54 [0.30, 0.98]		-	
Woo et al. 2019	6	232	13	191	5.0	0.38 [0.15, 0.98]		Woo et al. 2019	6	232	13	191	5.6	0.38 [0.15, 0.98]		-	
	0		15			0.56 [0.15, 0.96]			0	232	15	191	5.0	0.58 [0.15, 0.98]			
Total (95% CI)		3423		3354	100.0	0.75 [0.66, 0.92]	*	Total (95% CI)		3450		3744	100.0	0.77 [0.65, 0.92]		•	
Total events	230		287					Total events	206		267						
Heterogeneity: chi <sup>2</sup> = 5.93			$I^{2} = 0\%$	5			0.005 0.1 1 10 200	Heterogeneity: chi <sup>2</sup> = 5.9			); $I^2 = 0.9$	6			0.005 0.1	1 10	200
Test for overall effect: Z =	2.99 (P =	: 0.003)					Favours (PCI) Favours (CABG)	Test for overall effect: Z =	= 2.84 (P =	0.005)					Favours (PCI)	Favours (CA)	BG)
	n	CI	C	ABG	Weight	Risk Ratio	Risk Ratio	Study or Subgroup	PO	I	CAI		Weight	Risk Ratio	Ris	k Ratio	
Study or Subgroup	P																
Study or Subgroup	Events	Total 1	Events	Total	(%)	M-H, Fixed, 95% C	M-H, Fixed, 95% CI	, , ,	Events		Events	Total	(%)	M-H, Fixed, 95% C	M-H, Fiz	xed, 95% CI	
Kim et al. 2015	Events 19	Total 1 130	Events 21	Total 169	(%) 10.9	1.18 [0.66, 2.09]	I M-H, Fixed, 95% CI	Kim et al. 2015	19	130	21	169	6.9	1.18 [0.66, 2.09]	I M-H, Fiz		
Kim et al. 2015 Gai et al. 2015	Events 19 20	Total 1 130 192	Events 21 5	Total 169 48	(%) 10.9 4.8	1.18 [0.66, 2.09] 1.00 [0.40, 2.53]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015	19 20	130 192	21 5	169 48	6.9 3.0	1.18 [0.66, 2.09] 1.00 [0.40, 2.53]	I M-H, Fiz		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011	Events 19 20 10	Total 1 130 192 267	21 5 31	Total 169 48 679	(%) 10.9 4.8 10.4	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011	19 20 10	130 192 267	21 5 31	169 48 679	6.9 3.0 6.6	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65]	I M-H, Fiz		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021	Events 19 20 10 34	Total 1 130 192 267 240	21 5 31 51	Total 169 48 679 289	(%) 10.9 4.8 10.4 27.6	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021	19 20 10 34	130 192 267 240	21 5 31 51	169 48 679 289	6.9 3.0 6.6 17.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20]	I M-H, Fiz 		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2022	Events 19 20 10 34 101	Total 1 130 192 267 240 2060	21 5 31 51 141	Total 169 48 679 289 2264	(%) 10.9 4.8 10.4 27.6 0.0	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2022	19 20 10 34 101	130 192 267 240 2060	21 5 31 51 141	169 48 679 289 2264	6.9 3.0 6.6 17.5 50.9	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01]	I M-H, Fiz		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2022 Kawashima et al. 2021	Events 19 20 10 34 101 30	Total 1 130 192 267 240 2060 237	21 5 31 51 141 37	Total 169 48 679 289 2264 223	(%) 10.9 4.8 10.4 27.6 0.0 22.8	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19]	M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2022 Kawashima et al. 2021	19 20 10 34 101 30	130 192 267 240 2060 237	21 5 31 51 141 37	169 48 679 289 2264 223	6.9 3.0 6.6 17.5 50.9 0.0	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19]	I M-H, Fiz		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Kawashima et al. 2021 Jang et al. 2015	Events 19 20 10 34 101 30 20	Total 1 130 192 267 240 2060 237 332	Events 21 5 31 51 141 37 19	Total 169 48 679 289 2264 223 170	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98]	M-H, Fixed, 95% Cl	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Kawashima et al. 2021 Jang et al. 2015	19 20 10 34 101 30 20	130 192 267 240 2060 237 332	21 5 31 51 141 37 19	169 48 679 289 2264 223 170	6.9 3.0 6.6 17.5 50.9 0.0 9.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98]	I M-H, Fi 		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2021 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019	Events 19 20 10 34 101 30	Total     1       130     192       267     240       2060     237       332     232	21 5 31 51 141 37	Total 169 48 679 289 2264 223 170 191	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Lin et al. 2021 Lin et al. 2022 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019	19 20 10 34 101 30	130 192 267 240 2060 237 332 232	21 5 31 51 141 37	169 48 679 289 2264 223 170 191	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	I M-H, Fi 		
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2021 Jang et al. 2022 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019 Total (95% CI)	Events 19 20 10 34 101 30 20 6	Total 1 130 192 267 240 2060 237 332	Events 21 5 31 51 141 37 19 13	Total 169 48 679 289 2264 223 170	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2021 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019 Total (95% CI)	19 20 10 34 101 30 20 6	130 192 267 240 2060 237 332	21 5 31 51 141 37 19 13	169 48 679 289 2264 223 170	6.9 3.0 6.6 17.5 50.9 0.0 9.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98]	I M-H, Fi - - -		
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Luis et al. 2021       Lin et al. 2022       Kawashima et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events	Events 19 20 10 34 101 30 20 6 139	Total 1 130 192 267 240 2060 237 332 232 1630	Events 21 5 31 51 141 37 19 13 177	Total 169 48 679 289 2264 223 170 191 1769	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	I M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Lin et al. 2021 Lin et al. 2021 Lin et al. 2022 Kawashima et al. 2021 Jang et al. 2019 Woo et al. 2019 Total (95% CI) Total events	19 20 10 34 101 30 20 6 210	130 192 267 240 2060 237 332 232 3453	21 5 31 51 141 37 19 13 281	169 48 679 289 2264 223 170 191 3810	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	I M-H, Fi - - - -		
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Luis et al. 2021       Lin et al. 2022       Kawashima et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events       Heterogeneity: chi² = 5.94	Events 19 20 10 34 101 30 20 6 139 i; df = 6 (4)	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43);	Events 21 5 31 51 141 37 19 13 177	Total 169 48 679 289 2264 223 170 191 1769	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	M-H, Fixed, 95% CI	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2021 Jang et al. 2022 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019 <i>Total</i> (95% CI) Total events Heterogeneity: chi <sup>2</sup> = 5.9	19 20 10 34 101 30 20 6 210 4; df = 6 (2)	130 192 267 240 2060 237 332 232 3453 ?= 0.43	21 5 31 51 141 37 19 13 281	169 48 679 289 2264 223 170 191 3810	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	I M-H, Fb		200
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Luis et al. 2021       Lin et al. 2022       Kawashima et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events	Events 19 20 10 34 101 30 20 6 139 i; df = 6 (4)	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43);	Events 21 5 31 51 141 37 19 13 177	Total 169 48 679 289 2264 223 170 191 1769	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]	+++++++++++++++++++++++++++++++++++++++	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Lin et al. 2021 Lin et al. 2021 Lin et al. 2022 Kawashima et al. 2021 Jang et al. 2019 Woo et al. 2019 Total (95% CI) Total events	19 20 10 34 101 30 20 6 210 4; df = 6 (2)	130 192 267 240 2060 237 332 232 3453 ?= 0.43	21 5 31 51 141 37 19 13 281	169 48 679 289 2264 223 170 191 3810	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98]		xed, 95% CI	
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Lius et al. 2021 Lin et al. 2021 Kavashima et al. 2021 Kavashima et al. 2021 More et al. 2019 Total (95% CJ) Total events Heterogeneity chi <sup>2</sup> = 5.9 Test for overall effect: Z =	Events 19 20 10 34 101 30 20 6 139 k; df = 6 (4 2.39 (P = P)	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); c 0.02) CI	Events 21 5 31 51 141 37 19 13 177 I <sup>2</sup> = 0% C.4	Total 169 48 679 289 2264 223 170 191 1769 5 ABG	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80[0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98] 0.77 [0.62, 0.95] Risk Ratio	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2015 Liu et al. 2011 Luis et al. 2021 Liu et al. 2021 Kavashima et al. 2021 Kavashima et al. 2021 Jang et al. 2015 Woo et al. 2019 Total eyents Heterogeneity: chi" = 5.9 Test for overall effect: Z =	$ \begin{array}{r}   19 \\   20 \\   10 \\   34 \\   101 \\   30 \\   20 \\   6 \\   210 \\   4; df = 6 (l \\   = 2.79 (P = l \\   Pc \\$	130 192 267 240 2060 237 332 232 3453 °= 0.43 0.005)	21 5 31 51 141 37 19 13 281 ); $F = 09$ CAI	169 48 679 289 2264 223 170 191 3810 5	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.38 [0.15, 0.98] 0.78 [0.66, 0.93] Risk Ratio	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Luis et al. 2021       Lin et al. 2022       Kawashima et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events       Heterogeneity: chi² = 5.94	Events 19 20 10 34 101 30 20 6 139 139 139 (P =	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); c 0.02) CI	Events 21 5 31 51 141 37 19 13 177 I <sup>2</sup> = 0% C.4	Total 169 48 679 289 2264 223 170 191 1769 5 ABG	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0	$\begin{array}{c} 1.18 \left[ 0.66, 2.09 \right] \\ 1.00 \left[ 0.40, 2.53 \right] \\ 0.82 \left[ 0.41 \right] , 1.65 \\ 0.80 \left[ 0.54, 1.20 \right] \\ 0.79 \left[ 0.64, 1.10 \right] \\ 0.76 \left[ 0.49, 1.19 \right] \\ 0.54 \left[ 0.30, 0.98 \right] \\ 0.38 \left[ 0.15, 0.98 \right] \\ 0.77 \left[ 0.62, 0.95 \right] \end{array}$	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Luis et al. 2021 Lin et al. 2021 Jang et al. 2022 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019 <i>Total</i> (95% CI) Total events Heterogeneity: chi <sup>2</sup> = 5.9	19 20 10 34 101 30 20 6 210 4; df = 6 (l = 2.79 (P =	130 192 267 240 2060 237 332 232 3453 °= 0.43 0.005)	21 5 31 51 141 37 19 13 281 pressure = 09	169 48 679 289 2264 223 170 191 3810 5	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0	$\begin{array}{c} 1.18 \left[ 0.66, 2.09 \right] \\ 1.00 \left[ 0.40, 2.53 \right] \\ 0.82 \left[ 0.41, 1.65 \right] \\ 0.80 \left[ 0.54, 1.20 \right] \\ 0.79 \left[ 0.61, 1.01 \right] \\ 0.76 \left[ 0.49, 1.19 \right] \\ 0.54 \left[ 0.30, 0.98 \right] \\ 0.38 \left[ 0.15, 0.98 \right] \\ 0.78 \left[ 0.66, 0.93 \right] \end{array}$	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Lui et al. 2011       Lui et al. 2021       Jang et al. 2012       Jang et al. 2015       Woo et al. 2019       Total (95% CT)       Total events       Heterogeneity: chi² = 5.9       Test for overall effect: Z =       Study or Subgroup       Kim et al. 2015	Events 19 20 10 34 101 30 20 6 139 139 139 139 Feet (12) 2.39 (P = 1) P Events 19	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); : 0.02) CI Total 1 130	Events 21 5 31 51 141 37 19 13 177 F = 0% Events 21	Total 169 48 679 289 2264 223 170 191 <i>1769</i> 5 WBG Total 169	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.00] 0.79 [0.61, 0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98] 0.77 [0.62, 0.95] Risk Ratio M-H, Fixed, 95% C 1.18 [0.66, 2.09]	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2015 Liu et al. 2011 Luis et al. 2021 Kawashima et al. 2021 Kawashima et al. 2021 Jang et al. 2015 Woo et al. 2019 <i>Total</i> (95% CJ) Total events Heterogeneity: chi <sup>2</sup> = 5.9 Test for overall effect: Z Study or Subgroup Kim et al. 2015	19 20 10 34 101 30 20 6 210 4; df = 6 (l = 2.79 (P = P(C Events 19	130 192 267 240 2060 237 332 232 3453 ° = 0.43 0.005) CI Total 130	21 5 31 51 141 37 19 13 281 Events 21	169 48 679 289 2264 223 170 191 3810 5 3G Total 169	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight (%) 6.3	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.89 [0.41, 1.65] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98] 0.78 [0.66, 0.93] Risk Ratio M-H, Fixed, 95% CC 1.18 [0.66, 2.09]	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Lius et al. 2011 Lins et al. 2021 Lins et al. 2021 Jang et al. 2015 Woo et al. 2015 Woo et al. 2015 Total (95% CI) Total (95% CI) Total (95% CI) Total events Heterogeneity-chi <sup>2</sup> = 5.9; Test for overall effect: Z = Study or Subgroup Kim et al. 2015	Events 19 20 10 34 101 30 20 6 139 34 (2) 6 139 (2) 4 5 6 139 139 139 139 14 5 6 12 19 20 10 10 10 10 10 10 10 10 10 1	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); : 0.02) CI Total 1 130 192	Events 21 5 31 51 141 37 19 13 177 $I^2 = 0\%$ Events 21 5	Total 169 48 679 289 2264 223 170 191 1769 5 ABG Total 169 48	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6 2.9	1.18 [0.66, 2.03] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.38 [0.15, 0.98] 0.77 [0.62, 0.95] Risk Ratio M-H, Fixed, 95% C 1.18 [0.66, 2.09]	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Liu et al. 2011 Liu et al. 2011 Liu et al. 2021 Lin et al. 2021 Jang et al. 2021 Jang et al. 2013 Woo et al. 2019 Total (95% CI) Total events Heterogeneity: chi <sup>2</sup> = 5.9 Test for overall effect: Z = Study or Subgroup Kim et al. 2015	19 20 10 34 101 30 20 6 210 4; df = 6 (l = 2.79 (P = P( <u>Events</u> 19 20	130 192 267 240 2060 237 332 232 3453 P = 0.43 0.005) CI Total 130 192	21 5 31 51 141 37 19 13 281 b); F = 0% CAI Events 21 5	169 48 679 289 2264 223 170 191 3810 5 3G Total 169 48	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight (%) 6.3 2.8	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80 [0.44, 2.53] 0.79 [0.61, 1.01] 0.76 [0.64, 0.19] 0.78 [0.66, 0.93] Risk Ratio M-H, Fized, 95% C 1.18 [0.66, 2.09]	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Lui et al. 2021       Lin et al. 2021       Jang et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events       Test for overall effect: Z =       Study or Subgroup       Kim et al. 2015       Gai et al. 2015       Liu et al. 2011	Events 19 20 10 34 101 30 20 6 139 i; df = 6 (I 2.39 (P = P Events 19 20 10 139 139 139 139 139 139 10 10 10 10 10 10 10 10 10 10	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); : 0.02) CI Total 1 130 192 267	Events 21 5 31 51 141 37 19 13 177 $I^2 = 0\%$ Events 21 5 31	Total 169 48 679 289 2264 223 170 191 1769 3 ABG Total 169 48 679 48 679	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6 2.9 6.3	1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.979 (0.61, 1.01) 0.76 (0.49, 1.19) 0.54 (0.30, 0.98) 0.54 (0.30, 0.98) 0.77 (0.62, 0.95) Risk Ratio M-H, Fixed, 95% CC 1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65)	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2015 Liu et al. 2011 Luis et al. 2021 Kawashima et al. 2021 Jang et al. 2021 Woo et al. 2019 <i>Total</i> (95% CJ) Total events Heterogeneity: ch <sup>2</sup> = 5.9 Test for overall effect: 2 Study or Subgroup Kim et al. 2015 Gai et al. 2015 Liu et al. 2011	19 20 10 34 101 30 20 6 210 4; df = 6 (l = 2.79 (P = P( Events) 19 20 0 10	130 192 267 240 2060 237 332 232 3453 P = 0.43 0.005) CI Total 130 192 267	21 5 31 51 141 37 19 13 281 281 Events 21 5 31	169 48 679 289 2264 223 170 191 3810 5 3G Total 169 48 679	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight (%) 6.3 2.8 6.1	1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.80 [0.54, 1.20] 0.79 [0.61, 1.01] 0.76 [0.49, 1.19] 0.54 [0.30, 0.98] 0.78 [0.66, 0.93] 0.78 [0.66, 0.93] Risk Ratio M-H, Fixed, 95% C 1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.82 [0.41, 1.65]	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
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Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Lui et al. 2021       Lui et al. 2021       Jang et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events       Test for overall effect: Z =       Study or Subgroup       Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Lui et al. 2021       Lui et al. 2021	Events 19 20 10 34 101 30 20 6 139 4 4f = 6 (I 2.39 (P = P Events 19 20 10 34 101 30 20 101 30 20 101 30 20 101 34 101 30 20 101 30 20 101 30 20 101 30 20 101 30 20 101 30 20 101 30 20 101 30 20 101 30 20 101 20 10 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 101 20 20 101 20 10 101 101	Total 1 130 192 267 240 2060 237 332 232 1630 P = 0.43); 0.02) CI Total 1 130 192 267 240 2060 240 207 240 2060 237 240 2060 237 240 2060 237 240 2060 237 232 232 232 232 232 232 232	Events 21 5 31 141 37 19 13 177 F = 0% CA Events 21 5 31 51 141 13 13 177 13 13 141 13 141 13 13 141 141	Total 169 48 679 289 2264 223 170 191 1769 48 679 48 679 289 2264	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6 2.9 6.3 16.7 48.5	1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.79 (0.61, 1.01) 0.76 (0.61, 1.01) 0.76 (0.61, 0.01) 0.54 (0.30, 0.038) 0.38 (0.15, 0.58) 0.77 (0.62, 0.95) M-H, Fixed, 95% CC 1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65)	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2015 Liu et al. 2011 Liu et al. 2021 Kawashima et al. 2021 Jang et al. 2021 Woo et al. 2019 <i>Total</i> (95% CJ) Total events Heterogeneity: che <sup>2</sup> = 5.9 Test for overall effect: Z : Study or Subgroup Kim et al. 2015 Gai et al. 2015 Gai et al. 2011 Liu et al. 2021	$\begin{array}{c} 19\\ 20\\ 10\\ 34\\ 101\\ 30\\ 20\\ 6\\ 210\\ 4; df = 6 \ (l = 2.79 \ (P = 0.000) \ (P =$	130 192 267 240 2060 237 332 232 3453 ° = 0.43 0.005) Cl Total 130 192 267 240 2060	21 5 31 141 37 19 13 281 281 Events 21 5 31 51 141 41 41 41 37 19 13 281 Events 21 51 141 141 281 281 21 21 21 21 21 21 21 21 21 2	169 48 679 289 2264 223 170 191 3810 6 3G Total 169 48 679 289 2264	6.9 3.0 6.6 17.5 50.9 9.5 5.4 100.0 Weight (%) 6.3 2.8 6.1 16.1 46.7	1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.80 (0.54, 1.26) 0.79 (0.61, 1.01) 0.76 (0.45, 1.19) 0.78 (0.64, 0.19) 0.54 (0.20, 0.28) 0.78 (0.66, 0.93) Risk Ratio M-H, Fixed, 95% G 1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65)	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Liu et al. 2011       Lin et al. 2021       Jang et al. 2021       Jang et al. 2013       Woo et al. 2019       Total (95% CI)       Total (95% CI)       Total (95% CI)       Total (95% CI)       Total oversits       Heterogeneity: chi² = 5.9.       Study or Subgroup       Kim et al. 2015       Liu et al. 2015       Liu et al. 2015       Liu et al. 2021       Lin et al. 2021	Events 19 20 10 34 101 30 20 6 139 (); df = 6 (i 2.39 (P = P Events 19 20 10 34 101 30 139 139 19 20 101 34 101 30 139 139 139 139 139 139 139 139	Total     1       130     192       267     240       2060     237       332     232       1630     P       P     0.43);       color     Total       192     267       240     2060       237     232	Events 21 5 31 51 141 37 19 13 177 <i>P</i> = 0% C/A Events 21 5 31 51 141 37 15 13 13 141 37 15 141 37 15 141 137 13 141 137 13 13 141 137 13 13 141 137 13 141 137 13 141 137 13 13 141 137 13 13 141 137 13 13 141 137 13 13 141 137 13 141 137 13 13 141 137 13 141 137 13 141 137 13 141 137 13 141 137 13 137 137 141 137 151 141 137 137 141 137 137 137 141 137 141 137 137 141 137 137 141 137 137 141 137 137 137 137 137 137 137 13	Total 169 48 679 2289 2264 223 170 191 1769 5 ABG Total 169 48 679 289 2264 223 2264 223	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6 2.9 6.3 16.7 48.5 13.8	1.18 (66, 2.09) 1.00 [0.40, 2.53] 0.82 [0.41, 1.65] 0.89(0.54, 1.20] 0.76 [0.49, 1.19] 0.76 [0.49, 1.19] 0.76 [0.49, 1.19] 0.76 [0.49, 1.19] 0.77 [0.62, 0.95] Risk Ratio M-H, Fixed, 95% C 1.18 [0.66, 2.09] 1.00 [0.40, 2.53] 0.89(0.54, 1.20] 0.76 [0.49, 1.19]	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2011 Liu et al. 2011 Liu et al. 2021 Kawashima et al. 2021 Jang et al. 2021 Woo et al. 2019 Woo et al. 2019 Total (95% CI) Total events Heterogeneity: ch' = 5.9 Test for overall effect: Z = Study or Subgroup Kim et al. 2015 Liu et al. 2015 Liu et al. 2021 Lin et al. 2021 Lin et al. 2021 Lin et al. 2021	19 20 10 34 101 30 20 6 210 4; df = 6 (l = 2.79 (P = Events 19 20 10 34 101 30	130 192 267 240 2060 237 332 232 3453 2= 0.43 0.005) 240 192 267 240 2060 237	21 5 31 141 37 19 13 281 281 (); F = 0% CAI Events 21 5 31 141 37 19 13 281 141 37 19 13 281 281 21 141 37 19 13 281 281 21 21 241 281 21 241 25 241 25 241 25 25 25 25 25 25 25 25 25 25	169 48 679 289 223 170 191 3810 3G Total 169 48 679 289 2264 223	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight (%) 6.3 2.8 6.1 16.1 46.7 13.3	1.18 (6.6, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.89 (0.54, 1.20) 0.76 (0.49, 1.19) 0.76 (0.49, 1.19) 0.76 (0.49, 1.19) 0.78 (0.66, 0.93) 0.78 [0.66, 0.93] 0.78 [0.66, 0.93] 0.78 [0.66, 0.93] 0.10 (0.40, 2.53) 0.80 (0.54, 1.20) 0.76 (0.49, 1.19)	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Lui et al. 2011       Lui et al. 2021       Jang et al. 2021       Jang et al. 2015       Woo et al. 2019       Total (95% CI)       Total events       Test for overall effect: Z =       Study or Subgroup       Kim et al. 2015       Gai et al. 2015       Liu et al. 2011       Luis et al. 2021       Kavashima et al. 2021       Jang et al. 2015	Events 19 20 10 34 101 30 20 6 139 (F = 19 20 10 34 101 30 2.39 (F = P Events 19 20 10 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 30 2.0 101 101 30 2.0 101 101 30 2.0 101 101 2.39 (F = 101 101 2.39 (F = 101 101 2.39 (F = 101 101 2.39 (F = 101 101 2.39 (F = 101 101 2.0 101 101 2.0 101 101 2.0 101 101 2.0 101 101 2.0 101 101 2.0 101 101 2.0 101 101 101 2.0 101 101 101 101 101 101 101 1	Total     1       130     192       167     240       2060     237       232     232       1630     232       CI     Total       130     192       267     240       2060     237       310     192       267     240       2060     237       332     232	Events 21 5 31 141 37 19 13 177 <i>P</i> = 0% C/ Events 21 5 31 141 37 19 13 177 <i>P</i> = 0% 21 5 31 141 37 19 13 10 13 10 13 10 13 10 13 10 10 13 10 13 10 10 10 10 10 10 10 10 10 10	Total 169 48 679 2289 2224 223 170 191 1769 5 WBG Total 169 48 679 289 2264 223 170 191 1769 289 2264 223 169 226 227 207 207 207 207 207 207 207	(%) 10.9 4.8 10.4 27.6 0.0 22.8 15.0 8.5 100.0 Weight (%) 6.6 2.9 6.3 16.7 48.5 13.8 0.0	1.18 (6.6, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.80 (0.54, 1.20) 0.76 (0.49, 1.19) 0.76 (0.49, 1.19) 0.76 (0.49, 1.19) 0.76 (0.49, 1.19) 0.58 (0.15, 0.98) 0.38 (0.15, 0.98) 0.77 (0.62, 0.95) Risk Ratio M-H, Fixed, 95% C 1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.79 (0.61, 1.01) 0.76 (0.49, 1.19) 0.54 (0.30, 0.98)	0.005 0.1 10 200 Favours (CABG) Risk Ratio	Kim et al. 2015 Gai et al. 2015 Liu et al. 2015 Liu et al. 2011 Luis et al. 2021 Kawashima et al. 2021 Jang et al. 2021 Woo et al. 2019 <i>Total</i> (95% CJ) Total events Heterogeneity: chi <sup>2</sup> = 5.9 Test for overall effect: Z Study or Subgroup Kim et al. 2015 Gai et al. 2015 Luis et al. 2021 Kawashima et al. 2021 Kawashima et al. 2021	$\begin{array}{c} 19\\ 20\\ 10\\ 34\\ 101\\ 30\\ 20\\ 6\\ 210\\ 4; df = 6 \ (l = 2.79 \ (P = 10^{-1})) \\ Ference \\ 19\\ 20\\ 10\\ 34\\ 101\\ 30\\ 20\\ \end{array}$	130 192 267 240 2060 237 332 232 3453 	21 5 31 141 37 19 13 281 b; $F = 0$ % CAI Events 21 5 31 51 141 37 19 13 281 13 281 14 21 5 31 14 13 281 14 13 281 14 21 21 21 21 21 21 21 21 21 21	169 48 679 289 2264 223 170 191 3810 5 3G Total 6 3G Total 6 48 679 289 2264 223 170	6.9 3.0 6.6 17.5 50.9 0.0 9.5 5.4 100.0 Weight (%) 6.3 2.8 6.1 16.1 46.7 13.3 8.7	1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.83 (0.41, 1.65) 0.83 (0.41, 1.65) 0.79 (0.61, 1.01) 0.76 (0.45, 1.120) 0.78 (0.64, 1.19) 0.54 (0.23, 0.28) 0.78 (0.66, 0.93) 78 (0.66, 0.93) 78 (0.66, 0.93) 1.18 (0.66, 2.09) 1.00 (0.40, 2.53) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.82 (0.41, 1.65) 0.79 (0.61, 1.01) 0.76 (0.49, 1.19) 0.54 (0.30, 0.98)	0.005 0.1 Favours (PCI) Risi	xed, 95% CI	
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FIGURE 9: Results of sensitivity analysis for all-cause mortality.

all-cause mortality and the occurrence of cardiac death, but a higher incidence of myocardial infarction and repeat revascularization. However, there were no statistically significant differences observed between the PCI and CABG groups in terms of the incidence of MACE.

CTO affects a range of 15-20% of patients with CAD [19]. Nonetheless, only a small proportion of CTO patients, ranging from 5 to 14%, undergo PCI [2, 20]. The management of patients with CTO is impacted by various factors, including the number of obstructed vessels, prior myocardial infarction status, and the presence of angina pectoris [21]. The advancement in technology and equipment has expanded the indications for CTO-PCI and improved its outcomes [22]. Several studies advocate revascularization as the optimal treatment strategy for CTO patients [9, 11, 15]. Despite ongoing debates regarding the optimal revascularization strategy, our meta-analysis has provided evidence that PCI is superior to CABG in terms of reducing all-cause mortality and the occurrence of cardiac death. This outcome could potentially be attributed to the advancements in interventional techniques in recent years.

Advancements in coronary guidewire design, operating techniques, and the utilization of the J-CTO score can aid in optimizing the choice of revascularization strategies to maximize benefits [23–25]. In particular, the use of vascular imaging techniques such as intravascular ultrasound (IVUS) in PCI has substantially enhanced clinical outcomes. In a comprehensive meta-analysis conducted by Jang et al. that

encompassing a cohort of 24,849 patients, IVUS-guided PCI significantly reduced the incidence of MACE events, allcause mortality, MI, target vessel revascularization, and stent thrombosis in patients compared with angiography-guided PCI [26]. For CTO-PCI, the influence of IVUS on procedural outcomes remains controversial. The results of a randomized controlled trial led by Kim et al. demonstrated that IVUS-guided CTO-PCI significantly reduced the 12month incidence of MACE in patients compared with the angiography group (hazard ratio: 0.35, 95% CI: 0.13-0.97) [27]. Another randomized controlled trial showed that there was no significant difference in the 2-year rates of MACE between the IVUS-guided and angiography-guided groups. Nevertheless, it is worth noting that within the IVUS-guided group, there were marked reductions in the rates of late instent lumen loss and stent restenosis [28]. The meta-analysis by Panuccio et al. included 2 randomized controlled trials and 3 observational studies encompassing 2,320 patients, which demonstrated that the IVUS-guided group significantly reduced the incidence of in-stent thrombosis compared with the angiography-guided group [29]. The application of IVUS in CTO-PCI specifically pertains to the optimization of stent-related parameters during CTO interventions, such as stent length and diameter and the assessment of the proximal cap and calcifications [30].

It is noteworthy that CTO-PCI is typically performed on low-risk patients with single-vessel disease, while high-risk patients with multi-vessel coronary disease, left main involvement, and a decreased left ventricular ejection a fraction are more likely to undergo CABG [3, 9, 14]. This could also contribute to the lower all-cause mortality and occurrence of cardiac death observed in the PCI group. The widespread use of second-generation drug-eluting stents is also thought to contribute to the improved outcomes of

PCI [16]. However, our meta-analysis indicates that PCI is inferior in reducing myocardial infarction compared to CABG, and no significant difference in MACE was observed between the two revascularization methods. This finding is aligned with the results of the BEST and SYNTAX trials [31, 32], which showed that although the rate of myocardial infarction was higher in the PCI group than in the CABG group, it did not result in increased mortality. In addition, our meta-analysis also confirms the previously reported higher incidence of repeat revascularization in the PCI group compared to the CABG group. This may be due to the use of the internal mammary artery (IMA) grafts in the CABG group, which has been associated with improved long-term patency rates [33].

In medical practice, the selection of a revascularization strategy typically involves consideration of several factors such as the extent of coronary artery disease, the physical state of the patient, and the patient's preferences. Our study's findings indicate that CABG does not possess a clear superiority in treating CTO. Conversely, our results demonstrate that PCI is more effective than CABG in reducing the all-cause mortality and the incidence of cardiac death, which could assist physicians in making more informed revascularization decisions for CTO patients. To our knowledge, our study is the first meta-analysis focusing on the effect of PCI and CABG on the prognosis of patients with CTO. Although there is a meta-analysis examining the effects of three treatment methods (OMT, PCI, and CABG) on CTO patients [34], it mainly focuses on revascularization and OMT, which is quite different from our study. Moreover, we included more studies, which changed the impact of these two types of revascularization on the prognosis of patients with CTO. In addition, the end points of our study were more comprehensive.

#### 5. Study Limitations

The choice of revascularization strategy for CTO patients by physicians may be influenced by various factors, including ACEF (age, creatinine, and ejection fraction), SYNTAX I, and SYNTAX II scores. However, our meta-analysis did not consider these factors as subgroups in the choice of management strategy, as the necessary data was not available in the original literature. In addition, the nine studies included in our meta-analysis had varying follow-up times, clinical outcomes, and criteria for enrollment, contributing to increased heterogeneity and affecting the generalizability of the results. The limited number of randomized controlled trials in our meta-analysis, as well as non-random factors such as patient characteristics and patient and physician preferences, may also impact the results. The number of CTO vessels may also affect clinical outcomes, but our metaanalysis did not address this aspect as relevant data was lacking.

#### 6. Conclusion

In the present meta-analysis comparing PCI and CABG in patients with chronic total occlusion of the coronary arteries, the results indicated that PCI was superior to CABG in reducing all-cause mortality and cardiac death, but inferior in decreasing myocardial infarction and repeat revascularization. The meta-analysis did not reveal a significant difference in MACE between the two groups. Further investigation is necessary to establish the most effective approach for revascularization in cases of CTO.

#### **Conflicts of Interest**

The authors declare that they no conflicts of interest.

#### **Authors' Contributions**

CW, SL, SN, and MZ conceived and designed the study. CW and SL performed the literature search. CW extracted and then SL, SN, YC, RK, and HY independently checked the data. CW, MZ, SL, RK, and SN performed the statistical analysis. CW wrote the first draft. MZ, CW, SL, and SN made substantial contributions to study conception and design, interpretation of results and revising the manuscript critically for intellectual content. All authors read and approved the final manuscript.

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