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Comparative analysis of factors associated with the choice of percutaneous and surgical intervention in the treatment of coronary artery disease: An integrative review

Análise comparativa entre os fatores associados à escolha da intervenção percutânea e cirúrgica no tratamento da doença arterial coronariana: Revisão integrativa

Análisis comparativo de los factores asociados a la elección de la intervención percutánea y quirúrgica en el tratamiento de la enfermedad arterial coronaria: Revisión integrativa

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Abstract
Coronary Artery Disease (CAD) is among the pathologies responsible for high mortality rates in Brazil, associated with a significant increase in cardiovascular risk factors. In this context, the purpose of this integrative literature review is to analyze and compare the factors influencing the appropriate choice between percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) in managing this cardiac condition, considering clinical and anatomical variables and the SYNTAX score. CAD presents a broad spectrum of clinical manifestations, and the therapeutic decision depends on individual patient characteristics, including lesion complexity, age, associated comorbidities, and ventricular function. CABG is the preferred clinical alternative for patients with diffuse disease and complex coronary anatomy, while PCI demonstrates better results in less severe lesions with faster recovery. Given the above, this research adopts an integrative literature review approach, seeking to consolidate evidence from the last five years to understand the criteria used in clinical practice and their implications for health outcomes. This comparative analysis aims to promote a more personalized management of CAD, assisting evidence-based therapeutic choices that optimize results for different patient profiles.
Keywords: Percutaneous Coronary Intervention; Coronary Artery Bypass Grafting; Coronary Artery Disease.

Resumo
A Doença Arterial Coronariana (DAC) está entre as patologias que mais acarretam uma alta taxa de mortalidade no Brasil, em associação a um aumento expressivo de fatores de risco cardiovascular. Nesse contexto, o presente projeto de revisão de literatura integrativa tem por objetivo analisar comparativamente os fatores que influenciam a escolha adequada entre a intervenção coronária percutânea (ICP) e a cirurgia de revascularização miocárdica (CRM) no manejo dessa condição, considerando variáveis clínicas, anatômicas e o escore SYNTAX. A DAC apresenta um espectro amplo de manifestações clínicas, e a decisão terapêutica depende de características individuais dos pacientes, incluindo a complexidade das lesões, idade, comorbidades associadas e função ventricular. A CRM é a alternativa clínica preferencialmente utilizada em pacientes com doença difusa e anatomia coronariana complexa, enquanto a ICP demonstra melhores resultados em lesões menos graves, com recuperação mais rápida. Em vista do exposto anteriormente, a pesquisa adotará uma abordagem integrativa de revisão da literatura, buscando consolidar evidências dos últimos cinco anos com a finalidade de compreender os critérios utilizados na prática clínica e suas implicações

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nos desfechos em saúde. A análise comparativa pretende fomentar um manejo mais personalizado da DAC, promovendo escolhas terapêuticas baseadas em evidências que otimizem os resultados para diferentes perfis de pacientes.
Palavras-chave: Intervenção Coronariana Percutânea; Cirurgia de Revascularização; Doença Arterial Coronariana.

Resumen
La Enfermedad Arterial Coronaria (EAC) se encuentra entre las patologías que más causan una alta tasa de mortalidad en Brasil, asociada a un aumento expresivo de factores de riesgo cardiovascular. En este contexto, el presente proyecto de revisión integradora de la literatura tiene como objetivo analizar comparativamente los factores que influyen en la elección adecuada entre la intervención coronaria percutánea (ICP) y la cirugía de revascularización miocárdica (CRM) en el manejo de esta condición, considerando variables clínicas, anatómicas y la puntuación SYNTAX. La EAC presenta un amplio espectro de manifestaciones clínicas y la decisión terapéutica depende de características individuales de los pacientes, incluyendo la complejidad de las lesiones, edad, comorbilidades asociadas y función ventricular. La CRM es la alternativa clínica preferentemente utilizada en pacientes con enfermedad difusa y anatomía coronaria compleja, mientras que la ICP demuestra mejores resultados en lesiones menos graves, con una recuperación más rápida. Ante lo expuesto, la investigación adoptará un enfoque integrador de revisión de la literatura, buscando consolidar evidencias de los últimos cinco años con la finalidad de comprender los criterios utilizados en la práctica clínica y sus implicaciones en los desenlaces de salud. El análisis comparativo pretende fomentar un manejo más personalizado de la EAC, promoviendo elecciones terapéuticas basadas en evidencias que optimicen los resultados para diferentes perfiles de pacientes.
Palabras clave: Intervención Coronaria Percutánea; Cirugía de Revascularización; Enfermedad Arterial Coronaria.

1. Introduction

Coronary Artery Disease (CAD) represents one of the main health problems in Brazil, being responsible for reduced quality of life and high mortality. Data from the Global Burden of Disease (GBD) show an increase in the number of individuals with CAD from 1.48 million in 1990 to more than 4 million in 2016, with an increase in gross prevalence from 0.99% to 1.85% (Oliveira et al., 2022). In the 2021 year, the standardized mortality rate was 67.1/100,000 inhabitants (De Oliveira et al., 2024). The increase in morbidity and mortality is related to the growth of classic risk factor such as hypertension, dyslipidemia, obesity, sedentary lifestyle, smoking, diabetes, and family history (factors that can mediate prevention) (Précoma et al., 2019).

The therapeutic choice between percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), or clinical treatment must consider individual risk, SYNTAX score II, and evidence-based clinical judgment (Marinho et al., 2018). The SYNTAX score is a valuable tool, especially in cardiac anatomical variations, assessing the number of affected arteries and lesion complexity (Okrainec et al., 2004; Serruys et al., 2009a; De Souza et al., 2018). Patients with reduced ejection fraction present higher risk, with CABG being preferred for enabling more complete revascularization (Bassan et al., 2025).

In this sense, comorbidities such as diabetes and chronic kidney disease (CKD) are determinants for the choice: diabetes is associated with diffuse CAD and worse outcomes after PCI, being a variable incorporated into SYNTAX II (Lawton et al., 2022). Furthermore, the glomerular filtration rate in CKD is an essential criterion for therapeutic decision-making (Neumann et al., 2019). For example, studies as SYNTAX and FAME II confirmed that in lesions of moderate to high complexity, CABG is associated with lower long-term mortality, although PCI reduces ischemic events compared to clinical treatment (Lawton et al., 2022). Therefore, this study aimed to comparatively analyze the factors that influence the appropriate choice between percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) in the management of this condition, considering clinical and anatomical variables and the SYNTAX score.

2. Methodology

This integrative systematic review (Snyder, 2019; Crossetti, 2012) is quantitative in nature in relation to the number of

13 (thirteen) articles selected to compose the "corpus of the research" and qualitative in nature in relation to the discussion performed on the three selected articles (Pereira et al., 2018; Risemberg et al., 2026).

Population and sample

The search was conducted in the PubMed database, using combinations of health descriptors (DeCS/MeSH): "Coronary Artery Disease", "Percutaneous Coronary Intervention", "Coronary Artery Bypass Grafting", and "SYNTAX Score". The population evaluated in these studies consisted of adult patients diagnosed with CAD of moderate to high anatomical complexity (including those with Left Main CAD and multivessel disease (three-vessel disease)). Besides that, the sample encompassed high-risk clinical subgroups, such as patients with Type 2 *Diabetes mellitus* and ventricular dysfunction, which underwent comparative revascularization procedures via PCI or CABG. The final sample consisted of 13 selected studies, published between 2020 and 2025, available in full text in English and Portuguese.

Inclusion criteria

Studies were included whether they met the following criteria: (1) involved patients diagnosed with CAD; (2) compared PCI and CABG treatments; (3) encompassed clinical outcomes such as mortality, adverse events, and the need for reintervention; (4) were randomized clinical trials, observational studies, systematic reviews, or relevant guidelines. Theses, dissertations, book chapters, and consensus statements that fell outside the scope of direct comparative analysis between interventions were excluded.

Data analysis

The selection process occurred in two stages: exploratory reading of titles and abstracts by two independent reviewers, followed of full analytical reading to verify eligibility. The methodological quality of the studies was guided by the PRISMA checklist. Data extracted (patient characteristics, selection criteria, and outcomes) were organized into tables for qualitative and descriptive analysis, seeking to identify patterns and divergences between therapeutic strategies.

Ethical Aspects

As this is an integrative review using secondary data from the public domain, the paper was exempt from research ethics committee approval, since the selected publications had already undergone prior committee approval. Copyrights and the integrity of original information were respected, ensuring proper citation of sources and the absence of conflicts of interest and external funding.

Study Design

This study was conducted according to the methodological framework of an Integrative Literature Review, structured in six distinct stages: (1) identification of the theme and formulation of the guiding question ("Which clinical and anatomical factors influence the decision between Percutaneous Coronary Intervention and Coronary Artery Bypass Grafting, and how do they impact the prognosis of patients with Coronary Artery Disease?"); (2) establishment of inclusion and exclusion criteria; (3) definition of information to be extracted from selected studies; (4) evaluation of the included studies; (5) interpretation of results; (6) presentation of the review/knowledge synthesis. Still, this review was reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement guidelines.

3. Results and Discussion

The present integrative review analyzed contemporary scientific evidence comparing PCI and CABG, reinforcing that the therapeutic decision for complex CAD is multifactorial and cannot be based solely on angiographic findings. The results showed that, while CABG remains the standard of care for high anatomical complexity and diabetes, "state-of-the-art" PCI has narrowed the gap in selected outcomes.

Overview of selected studies

The scientific literature search resulted in the inclusion of 13 studies published between 2020 and 2025 that met the eligibility criteria. The final sample comprises randomized clinical trials (RCTs), observational cohorts with long-term follow-up (up to 10 years), and systematic reviews with meta-analyses. The studies compared PCI and CABG in patients with complex coronary anatomy, including Left Main CAD and multivessel disease. Table 1 summarizes the characteristics and main findings of studies utilized in current review.

Table 1 - Summary of studies comparing PCI and CABG (2020–2025).

Title	Authors	Type of study	Number of participants	Year (Country)	Results
Ten-Year Outcomes After Percutaneous Coronary Intervention Versus Coronary Artery Bypass Grafting for Left Main Coronary Disease: Extended Follow-Up of the MAIN-COMPARE Study	Yoon et al.	Observational registry (10-year follow-up)	1.580	2020 (South Korea)	Among 1,580 patients, according to the distribution of the SYNTAX Score (SS), 34.6% were low, 22.2% intermediate, and 43.2% high. For high SS, the risk of PCI and CABG diverged significantly over 10 years. High SS and PCI showed a higher risk of death and a tendency toward worse outcomes. SS presented significant prognostic impact only in the PCI group, and not in the CABG group.
Outcomes of Left Main Revascularization after Percutaneous Intervention or Bypass Surgery	Scudiero et al.	Prospective registry	558	2022 (Italy)	In patients with ULMCAD, half with SYNTAX Score > 32, PCI and CABG presented similar composite outcomes at 4 years, but revascularization guided by ischemia was more frequent after PCI. Diabetes and EuroSCORE were the main predictors of outcomes.
Follow-Up and Outcome after Coronary Bypass Surgery Preceded by Coronary Stent Implantation	Hamiko et al.	Retrospective study	997	2023 (Germany)	Among 997 patients submitted to CABG, those with prior PCI (PCF) had more reinfarction, reangiography, and PCI than patients without prior PCI (no PCF). In the PCF group, those who did not follow the guidelines (GNC) had worse health, a higher SYNTAX score, and more left main stenosis than those who did follow them (GCO).
External Validation of the SYNTAX Score II 2020	Yamaji et al.	External validation of score	7.362	2020 (Japan)(CREDO-Kyoto)	The SSII-2020 predicted mortality at 5 years after PCI and CABG. For patients with absolute risk difference (ARD) predicted < 4.5%, mortality was similar for PCI and CABG. For ARD ≥ 4.5%, CABG showed superior survival rates. For MACCE, SSII-2020 didn't clearly guide the better treatment.
Percutaneous coronary intervention in unprotected left main coronary artery stenosis: Mid-term outcomes of a single-center observational study	Kumar et al.	Retrospective, single-center registry	661	2022 (India)	In 661 patients with ULMCA submitted to PCI (mean age 63,5 years, mean SYNTAX 27,9, FEVE 58%), 54% had 3 vesses diseases and 70,6% distal injuries. he in-hospital MACCE rate was 8.8%, and during follow-up it was 11.5% (8.4% cardiac deaths). Survival at 1, 3, and 5 years was 94%, 88%, and 84%, respectively. Age > 65 years and SYNTAX Score were independent predictors of mid- and long-term mortality.

Physiology-guided PCI versus CABG for left main coronary artery disease: insights from the DEFINE-LM registry	Warisawa et al.	Multicenter international registry	151	2023 (International, Europe, USA, Japan)	After 2.8 years, MACE in 8.3% in the PCI group and 8.8% in the CABG group (p = 0.043). FFR-guided PCI showed a lower rate of events in patients with intermediate complexity.
Multidisciplinary Heart Team Approach for Complex Coronary Artery Disease: Single Center Clinical Presentation	Young et al.	Prospective single-center study	166	2020 (USA)	In 166 high-risk patients (mean age 70 years, STS-PROM 3.6%, SYNTAX score 26), PCI was performed in 47.6% and CABG in 29.5%. A higher STS-PROM reduced the indication for CABG and increased medical therapy, and the SYNTAX score did not influence the choice. In-hospital mortality was 3.9% and at 30 days was 4.8%.
Percutaneous coronary intervention versus coronary artery bypass grafting in patients with coronary heart disease and type 2 *Diabetes mellitus*: Cumulative meta-analysis.	Xie et al.	Cumulative meta-analysis of randomized clinical trials	4.566	2021 (China)	CABG showed lower all-cause mortality, lower cardiac mortality, and lower need for repeat revascularization, while there was no difference in heart attack rate. PCI showed a smaller stroke rate. Differences in mortality emerged mainly after 3–5 years of follow-up.
Ten-year outcomes after percutaneous coronary intervention versus coronary artery bypass grafting for multivessel or left main coronary artery disease: a systematic review and meta-analysis	Feng et al.	Systematic review and meta-analysis (10-year follow-up)	Aggregated from clinical studies (8,621 patients: 3,013 participants from 5 randomized clinical trials and 5,608 participants from 4 observational studies)	2024 (Internacional)	No significant difference in mortality (OR = 1.03; 95% CI: 0.89–1.19), but PCI with a higher need for repeat revascularization (OR = 1.77; 95% CI: 1.08–2.89).
Five-year outcomes after state-of-the-art percutaneous coronary revascularization in patients with de novo three-vessel disease: final results of the SYNTAX II study	Banning et al.	Prospective study (5-year follow-up)	454	2022 (Europe)	The SYNTAX II strategy reduced mortality by 43% compared with SYNTAX I (HR = 0.57; 95% CI: 0.37–0.90).
Percutaneous Coronary Intervention Versus Coronary Artery Bypass Grafting in Patients With Left Main Disease With or Without Diabetes	Gaba et al.	Combined analysis of 4 randomized clinical trials	4.393	2024 (Multicenter, international)	Five-year mortality was similar between PCI and CABG (15.3% vs 14.1% in diabetics; 9.7% vs 8.9% in non-diabetics), but PCI showed a higher risk of spontaneous infarction (HR 2.01) and repeat revascularization (HR 2.12), especially in patients with diabetes, who had the highest excess of absolute risk over follow-up.
Comparative Efficacy of Percutaneous Coronary Intervention Versus Coronary Artery Bypass Grafting in the Treatment of Ischemic Heart Disease: A Systematic Review and Meta-Analysis of Recent Randomized Controlled Trials	LlerenaVelastegui et al.	Systematic review and meta-analysis	Aggregated from clinical studies (11,464 patients participating in 11 randomized clinical trials)	2024 (Internacional)	CABG reduced reinfarction and reintervencions; PCI showed a lower risk of stroke.
Percutaneous Coronary Intervention Versus Coronary Artery Bypass Grafting for Revascularization of Left Main Coronary Artery Disease	Park et al.	Narrative review	Aggregated from clinical studies (EXCEL: 1905 patients; NOBLE: 1,201 patients; SYNTAX: 705 patients; PRECOMBAT: 600 patients)	2023 (South Korea)	CABG had fewer late myocardial infarctions and less repeat revascularization. PCI had worse results in NOBLE, but similar to CABG in EXCEL. The result depends on anatomical complexity.

Source: Research data (2026).

Mortality and Long-Term Survival

The analysis of long-term data (up to 10 years) indicates that survival benefits are often time-dependent and anatomy-specific. In study of Yoon et al. (2020) was demonstrated that for patients with high anatomical complexity (SYNTAX score ≥33), CABG provided a significant survival advantage, whereas no difference was observed for low-to-intermediate scores. These findings corroborate with the meta-analysis conducted by Feng et al. (2024), which found no significant difference in overall mortality between the two strategies across the general cohort, although CABG showed better durability.

Revascularization and Complications

A consistent finding across the selected studies is the "trade-off" between repeat revascularization and stroke. Multiple studies, including the meta-analyses of Feng et al. (2024) and Llerena-Velastegui et al. (2024), confirmed that PCI is associated with a significantly higher rate of repeat revascularization and spontaneous myocardial infarction. Conversely, CABG is associated with a higher risk of cerebrovascular events (stroke) in the perioperative period.

Impact of Diabetes Mellitus

Diabetes Mellitus emerged as a critical modifier of treatment efficacy. In the studies of Xie et al. (2021) and Gaba et al. (2024) were provided robust evidence that in diabetic patients, particularly those with Left Main disease, CABG is associated with lower long-term mortality and fewer major adverse cardiac events compared to PCI. Although, Gaba et al. emphasized that the absolute risk difference for adverse events is more pronounced in diabetic patients, favoring surgical revascularization.

Role of SYNTAX Score and New Technologies

While the SYNTAX score remains a powerful prognostic tool for mortality in PCI patients, recent evidence suggested that technological advances may mitigate some risks of PCI. In this context, Banning et al. (2022) showed that "state-of-the-art" PCI utilizing drug-eluting stents, intravascular imaging, and physiological guidance (iFR/FFR, can achieve 5-year outcomes comparable to CABG in patients with three-vessel disease, challenging historical paradigms for selected patients.

Anatomical Complexity and the SYNTAX Score

Our main findings of this current report are in accordance with historical data from the SYNTAX trial, confirming that anatomical complexity is a major determinant of survival. In study of Yoon et al. (2020) was demonstrated that in patients with a SYNTAX score ≥33, CABG offers a clear survival benefit over 10 years. However, for low-to-intermediate scores, the mortality gap disappears. Interestingly, Young et al. (2020) observed that in real-world "Heart Team" meetings, the decision is often driven more by surgical risk (STS score) and patient frailty than by the SYNTAX score alone, suggesting an change for a more holistic patient assessment rather than a purely anatomy-based one.

The Diabetic Patient: A Critical Subgroup

It's known that *Diabetes mellitus* remains a decisive factor favoring surgery. The meta-analysis performed by Xie et al. (2021) and the pooled analysis conducted by Gaba et al. (2024) provided robust evidence that diabetic patients with multivessel or Left Main disease have significantly better survival and fewer major adverse cardiovascular events (MACE) with CABG. This finding is corroborated by the diffuse nature of atherosclerosis in diabetic patients, in this case the surgical grafting bypasses the entire diseased segment, whereas stents treat only localized lesions.

Procedural Outcomes: The Trade-off

The choice between PCI and CABG involves a trade-off between invasiveness and durability. Both Feng et al. (2024) and Llerena-Velastegui (2024) highlighted that while PCI offers a faster recovery and lower risk of periprocedural stroke, it carries a significantly higher burden of repeat revascularization. In the other hand, CABG provided a more durable solution but at the cost of higher initial morbidity and stroke risk. This "trade-off" must be discussed transparently with the patient during the informed consent process.

Technological Evolution

A novel finding demonstrated in this review is the impact of physiological guidance (FFR/iFR) and intravascular imaging (IVUS/OCT). Studies conducted by Banning et al. (2022) and Warisawa et al. (2023) suggested that when PCI is guided by these modern tools, outcomes in 3-vessel disease can be comparable to CABG at 5 years. This challenges the dogma that all multivessel diseases require surgery, opening a window for PCI in complex cases, provided that optimal technique is used.

Limitations

This present review of scientific literature has some limitations related to the methodology. The inclusion of observational studies introduced selection bias, due the patients eligible for both procedures (clinical equipoise) differ from those referred exclusively for one method. Furthermore, the definition of "complex CAD" varied slightly across the studies.

4. Conclusion

This integrative review consolidated current evidence regarding the therapeutic choice for complex CAD, demonstrating that the decision between PCI and CABG is no longer a binary dispute, but a spectrum of individualized indications. The analysis confirms that CABG remains the gold standard for patients with high anatomical complexity (high SYNTAX score) and being crucially, for those with *Diabetes mellitus*. In these subgroups, surgery offers superior long-term survival and durability, minimizing the need for repeat revascularization. However, PCI has established itself as a non-inferior and attractive strategy for patients with low-to-intermediate complexity. A major finding of this review is that the implementation of "state-of-the-art" PCI guided by intravascular imaging and physiology (FFR/iFR), has the potential to equalize outcomes in selected multivessel disease cases, challenging historical limitations. Therefore, we concluded that clinical practice must shift from a purely angiographic focus to an Integrated Heart Team approach. The decision-making process should integrate the SYNTAX score with clinical variables (frailty, comorbidities) and patient preferences regarding the trade-off between the invasiveness of surgery and the reintervention risk of stenting. Future research should focus on the long-term durability of physiology-guided PCI to determine if the surgical advantage persists in the era of precision medicine.

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