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LONG-TERM OUTCOMES OF DRUG-ELUTING STENTS VS. CONVENTIONAL ANGIOPLASTY: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: Cardiovascular diseases are the main cause of global morbidity and mortality, with coronary artery disease (CAD) being one of the main clinical manifestations. Percutaneous coronary intervention (PCI) has evolved considerably with the development of drug-eluting stents (DES), which deliver antiproliferative drugs to reduce restenosis, and alternatives such as drug-eluting balloons and resorbable scaffolds. This systematic review aims to compare the long-term clinical outcomes between DES and conventional angioplasty (CA), considering cardiovascular mortality, restenosis, and myocardial infarction. Methods: A systematic review was conducted according to the PRISMA guidelines, with searches in the PubMed database using MeSH descriptors and Boolean operators. Randomized studies published in the last five years comparing DES with CA were included. Case reports, editorials, and studies without a direct comparative group were excluded. The outcomes analyzed were cardiovascular mortality, restenosis rate, and incidence of myocardial infarction. Results: Four studies were included, totaling 774 patients. No studies reported cardiovascular mortality as the primary outcome. The restenosis rate was significantly lower with DES (26% vs. 56%, $p<0.05$). The incidence of infarction was lower in the DES group in one study (4.7% vs. 1.9%), while another showed identical incidence between DES and CA (33 events in each group). Conclusion: Drug-eluting stents demonstrate superiority in reducing restenosis and a trend towards a lower incidence of infarction, consolidating themselves as the preferred strategy for PCI. Future studies are needed to evaluate impacts on cardiovascular mortality and optimization of new therapeutic approaches.

Keywords: Drug-eluting stents. Conventional angioplasty. Self-expanding metal stents.

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INTRODUCTION

Cardiovascular diseases are the leading cause of morbidity and mortality worldwide, representing a major challenge for public and private health systems (WHO, 2021). Coronary artery disease (CAD) is one of the main manifestations of these diseases and can lead to serious complications, such as acute myocardial infarction and heart failure (Santos *et al.,* 2020). For the treatment of CAD, coronary revascularization through percutaneous coronary intervention (PCI) has been widely used, with significant advances in recent decades.

Initially, PCI was performed exclusively with balloon angioplasty, which, although effective in opening obstructed arteries, had high rates of restenosis due to adverse vascular remodeling and intimal hyperplasia (Smith *et al.,* 2019). The introduction of uncoated metal stents partially reduced this problem, providing better vessel support and decreasing restenosis rates compared to conventional angioplasty (Brown *et al.,* 2018). However, intimal hyperplasia remained a significant challenge, driving the development of drug-eluting stents, which release antiproliferative agents to reduce the inflammatory response and subsequent restenosis.

Currently, drug-eluting stents are widely used in clinical practice and have superiority over conventional metal stents (Garcia *et al.,* 2021). However, other strategies have been explored to optimize clinical outcomes and reduce long-term complications. Among these approaches are the use of drug-eluting balloons, which enable the release of antiproliferative drugs without the need for permanent implantation, and resorbable scaffolds, which provide temporary support to the vessel and disappear over time, minimizing the risks associated with permanent devices.

Recent studies also highlight the importance of lesion preparation strategies prior to stent placement, such as rotational atherectomy and balloon cutting, which aim to optimize stent expansion and improve angiographic outcomes (Lee *et al.,* 2022). Evidence suggests that the combination of these techniques can increase acute luminal gain and reduce the need for further revascularization.

Despite technological advances, some questions persist, especially regarding the incidence of major adverse cardiovascular events and the effectiveness of new strategies in comparison with traditional methods. The rates of restenosis, myocardial infarction, and target vessel failure continue to be determinant criteria for evaluating the efficacy of the devices and techniques used in coronary revascularization.

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In this context, this systematic review aims to analyze and compare the long-term clinical outcomes between the use of drug-eluting stents and other therapeutic approaches for the treatment of coronary artery disease, considering aspects such as restenosis rate, incidence of myocardial infarction, acute luminal gain, minimal stent area, stent expansion, and target vessel failure (Rodriguez *et al.,* 2023). Thus, it seeks to contribute to the identification of the best therapeutic strategies in percutaneous coronary intervention, providing subsidies for evidence-based clinical practice.

METHODS

This is a systematic review of the literature, conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), with the objective of comparing long-term clinical outcomes between drug-eluting stents (DE) and conventional angioplasty (CA).

The search was performed in the PubMED database, using the health sciences descriptors in the English version (MeSH), these descriptors were integrated with the Boolean operators "OR" and "AND", the search strategy was summarized in Table 1. Only randomized controlled trials, published in the last 5 years, that used human patients were included. The target population of this study included patients who underwent coronary angioplasty, were treated with drug-eluting stents, or conventional angioplasty. The outcomes used to measure the results of the study were: cardiovascular mortality, restenosis rate, and myocardial infarction (MI).

Table 1. Synthesis of the PubMED search strategy

INTERVENTION	("Coronary Angioplasty"[MeSH] OR "Percutaneous Coronary Intervention"[MeSH] OR "Balloon Angioplasty" OR "PCI" OR "Angioplasty, Balloon, Coronary")
CONTROL	("Drug-Eluting Stents"[MeSH] OR "DES" OR "Stents, Drug-Eluting" OR "Pharmacological Stents")
OUTCOMES	("Long-Term Outcome" OR "Follow-Up Studies" OR "Mortality" OR "Restenosis" OR "Major Adverse Cardiovascular Events" OR "Revascularization")

SOURCE: The Authors.

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The exclusion criteria used were: case reports, letters to the editor, editorials, studies without a direct comparative group between drug-eluting stents and conventional angioplasty, and experimental studies in animal or in vitro models. In total, 208 studies were found, these studies were evaluated by two blinded authors and conflicts were resolved by a third evaluator. After reading titles and abstracts, 24 studies were read in full and only 4 were included in this systematic review.

RESULTS

The present systematic review aimed to compare the long-term clinical outcomes between drug-eluting stents and conventional angioplasty, focusing on cardiovascular mortality, restenosis rate, incidence of myocardial infarction, acute luminal gain (ALG), minimum stent area (MSA), stent expansion (SE), and target vessel failure.

CHARACTERISTICS OF THE INCLUDED STUDIES

Four randomized clinical studies were analyzed, totaling 774 patients who underwent different coronary revascularization strategies. Approaches included drug-eluting stents, drug-eluting balloon angioplasty, and combined techniques, such as the use of a resorbable scaffold eluted with everolimus and the Rota-Cut technique, which associates rotational atherectomy with cut-balloon angioplasty. Follow-up times ranged from six to twelve months, with some studies looking at long-term outcomes.

CARDIOVASCULAR MORTALITY

None of the studies analyzed provided specific data on cardiovascular mortality as a primary outcome. This gap highlights the need for additional studies that evaluate the influence of different therapeutic approaches on patient survival.

RESTENOSIS RATE

The study by Varcoe et al. (2024) reported a significant reduction of the restenosis rate in the group treated with everolimus-eluted resorbable scaffold (26%) compared to the group undergoing conventional angioplasty (56%) ($p<0.05$). These findings reinforce the potential of bioresorbable stents to improve angiographic outcomes in the long term.

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MIOCARDIAL INFARCTION

The incidence of myocardial infarction was reported in two studies. The study by Xu et al. (2020) demonstrated that the occurrence of infarction was lower in the group submitted to drug-eluting stent implantation (1.9%) compared to the group treated with drug-eluting balloon (4.7%). The study by Fahrni et al. (2020) showed an identical incidence of myocardial infarction between the groups treated with drug-eluting stents and conventional metal stents (33 events in each group). These findings suggest a trend toward a lower risk of myocardial infarction with the use of drug-eluting stents than with other techniques.

ACUTE LUMINAL GAIN (ALG) AND MINIMUM STENT AREA (MSA)

The PREPARE-CALC-COMBO study evaluated atherosclerotic plaque modification strategies prior to stent placement and demonstrated that the group treated with the Rota-Cut technique had a significantly higher acute luminal gain (1.92 ± 0.45 mm) compared to the other strategies ($p < 0.001$). In addition, the minimum stent area was larger in this group (7.1 ± 2.2 mm^2) than in relation to conventional techniques. These results suggest that combined lesion preparation techniques can improve angiographic outcomes and optimize stent expansion.

STENT EXPANSION (SE)

The PREPARE-CALC-COMBO study also analyzed stent expansion and found no significant difference between the groups, suggesting that the plaque modification technique does not compromise adequate stent expansion.

TARGET VESSEL FAILURE

The target vessel failure rate was evaluated in the PREPARE-CALC-COMBO study, being approximately 8% in the group submitted to the Rota-Cut technique. This rate is comparable to conventional approaches, indicating that more aggressive plate preparation techniques do not increase the risk of complications.

DISCUSSION OF FINDINGS

The findings of this systematic review suggest that drug-eluting stents continue to be the most effective option for coronary revascularization, especially due to the lower rate of

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restenosis and lower incidence of myocardial infarction compared to drug-eluting balloons and bare-metal stents. In addition, advanced strategies such as resorbable scaffolds and plate preparation with rotational atherectomy and balloon cutting demonstrate significant luminal gains, with optimized stent expansion and failure rates comparable to traditional methods. However, the absence of data on cardiovascular mortality highlights the need for longitudinal studies that evaluate this outcome in a more robust way.

DISCUSSION

Percutaneous coronary intervention (PCI) has evolved significantly in recent decades, especially with the development of drug-eluting stents and resorbable scaffolds. These innovations aim to improve clinical outcomes in patients with coronary artery disease (CAD). In this review, we analyzed the main findings related to these technologies, comparing them with conventional angioplasty.

Drug-eluting stents have shown superiority over conventional bare-metal stents, especially in reducing the restenosis rate. Studies indicate that the controlled release of antiproliferative drugs by drug-eluting stents significantly decreases neointimal proliferation, which is the main cause of restenosis. For example, a meta-analysis revealed that everolimus-eluting stents had significantly lower restenosis rates compared to uncoated metal stents (Smith *et al.,* 2019).

In addition, the incidence of major adverse events, such as myocardial infarction, was also reduced with the use of drug-eluting stents. A randomized trial demonstrated that patients treated with sirolimus-eluting stents had a lower rate of myocardial infarction compared to those who received bare-metal stents , 2020). These findings reinforce the efficacy of drug-eluting stents in preventing adverse cardiac events.

However, despite the benefits, drug-eluting stents are not without limitations. Complications such as late stent thrombosis remain a concern, especially in patients with inadequate adherence to dual antiplatelet therapy. Studies suggest that prolonged duration of antiplatelet therapy may mitigate this risk, although it increases the chance of bleeding events (Lee *et al.,* 2018).

Resorbable scaffolds have emerged as a promising alternative, with the theoretical advantage of restoring natural vasomotricity after their complete absorption. However, clinical results have been mixed. The ABSORB III study, for example, did not demonstrate

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superiority of resorbable scaffolds over drug-eluting metal stents in terms of clinical outcomes, in addition to having a higher rate of device thrombosis (Ellis *et al.,* 2015).

Additionally, the technical complexity associated with the implantation of resorbable scaffolds and the need for intracoronary imaging to optimize device expansion are challenges that limit their widespread adoption in clinical practice (Galiffi *et al.,* 2017). Therefore, although the idea of temporary vascular support is attractive, current data do not support its superiority over traditional drug-eluting stents.

Drug-eluting balloon angioplasty has also been explored as a therapeutic option, especially in small vessel lesions or in-stent restenosis. Studies indicate that, in certain populations, drug-eluting balloons can offer results comparable to drug-eluting stents, with the advantage of not leaving a permanent implant (Ungern-Sternberg *et al.,* 2016). However, the lack of immediate mechanical support and the risk of recoarctation limit its use in more complex lesions.

Regarding lesion preparation prior to stent implantation, techniques such as rotational atherectomy and the use of cutting balloons have shown benefits in modifying calcified plaques, facilitating adequate stent expansion, and improving angiographic outcomes (Kawaguchi *et al.,* 2017). However, these approaches are associated with increased procedure time and potential complications, requiring careful evaluation in patient selection.

CONCLUSION

This study concludes that drug-eluting stents remain the preferred revascularization strategy in most clinical scenarios, due to their proven efficacy in reducing restenosis and adverse cardiac events. Although alternatives such as resorbable scaffolds and drug-eluting balloons offer theoretical advantages, current data do not demonstrate a clear superiority over traditional drug-eluting stents. The choice of the ideal strategy should be individualized, considering the specific characteristics of each patient and lesion, as well as the experience of the interventional team.

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SUPPLEMENTARY

Table 2. Outcomes of the different included studies.

Denouement	Landmark study	Intervention Group	Control Group
Restenosis rate	Varcoe et al., 2024	26%	56%
Myocardial infarction	Xu et al., 2020	4,7%	1,9%
Myocardial infarction	Fahrni et al., 2020	33 cases	33 cases
Acute luminal gain (ALG)	PREPARE-CALC-COMBO	1.92 ± 0.45 mm	1.74 ± 0.45 mm / 1.70 ± 0.42 mm
Minimum Stent Area (MSA)	PREPARE-CALC-COMBO	7.1 ± 2.2 mm²	6.1 ± 1.7 mm² / 6.2 ± 1.9 mm²
Stent Expansion (SE)	PREPARE-CALC-COMBO	No significant difference	No significant difference

Source: authors' own 2025.

Table 3. Comparative analysis of review outcomes.

Author and Year	Total Number of Patients	Intervention Group (No. of Patients)	Control Group (No. of Patients)	Restenosis Rate	Myocardial Infarction	Acute Luminal Gain (ALG)	Minimum Stent Area (MSA)	Stent Expansion (SE)	Target Vessel Failure
Varcoe et al., 2024	261	Everolimus-Eluted Reabsorbable Scaffold (173)	Angioplasty (88)	26%	-	-	-	-	-
Xu et al., 2020	230	Drug-eluting balloon angioplasty (115)	Drug-eluting stent implantation (115)	-	4.7% vs. 1.9%	-	-	-	-
Fahrni et al., 2020	173	Drug-eluting stent (89)	Conventional Metal Stent (84)	-	33 x 33	-	-	-	-
PREPARE-CALC-COMBO	110	Rotational Atherectomy + Balloon Cut (Rota-Cut)	Historical cohort with modified balloon or rotational atherectomy	-	-	1.92 ± 0.45 mm	7.1 ± 2.2 mm²	No significant difference	Average of 8%

Source: authors' own 2025.