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Percutaneous Coronary Intervention Literature Review

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ABSTRACT

This literature review examines the advancements and outcomes associated with Percutaneous Coronary Intervention (PCI), a minimally invasive procedure widely utilized to treat coronary artery disease. The review highlights key studies that evaluate the efficacy and safety of PCI, comparing it to traditional surgical options such as coronary artery bypass grafting (CABG). It explores the evolution of PCI techniques, including drug-eluting stents and optical coherence tomography, and their impact on patient outcomes, including rates of restenosis and major adverse cardiovascular events. Stents should be deployed to attain minimal residual stenosis, referred to as optimum stenting. The achievement of a substantial luminal diameter reduces the likelihood of stent thrombosis and restenosis. Patients receiving elective stent therapy are often discharged within 24 hours post-implantation, following overnight observation and monitoring. Same-day discharge may be suitable for elective patients who have an easy operation and possess a minimal risk of post-discharge complications.

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INTRODUCTION

Percutaneous coronary intervention (PCI) is a minimally invasive, nonsurgical technique conducted to enhance blood flow in one or more areas of the coronary circulation. Coronary revascularization with PCI predominantly utilizes balloon angioplasty and intracoronary stenting with drug-eluting stents (DES); additional methods to enhance coronary blood flow encompass plaque modification techniques like atherectomy and lithoplasty.

BENEFITS OF STENTING

Subsequent lumen loss and restenosis following non-stent procedures like balloon angioplasty result from a confluence of acute recoil, negative remodeling (arterial contraction) of the treated segment, and localized neointimal hyperplasia (tissue proliferation within the stent). Conversely, late lumen loss following stenting is predominantly attributable to in-stent neointimal hyperplasia, as the primary advantage of stents is to avert vascular recoil and adverse remodeling. Stents maintain an increased acute lumen diameter that compensates for the decrease in lumen diameter caused by neointimal hyperplasia. Stents exhibit a little occurrence of recoil. Drug-eluting stents (DES) diminish local neointimal hyperplasia [1,2].

DRUG-ELUTING STENTS

Drug-eluting stents (DES) diminish the incidence of restenosis and target lesion revascularization in comparison to bare metal stents (BMS), which are now hardly utilized. Drug-eluting stents (DES) primarily

comprise three elements: a metallic alloy stent, mainly composed of cobalt chromium; a polymer coating, which can be either durable or bioabsorbable; and an antirestenotic drug incorporated within the polymer, released over several weeks to months post-implantation to mitigate neointimal hyperplasia, the localized proliferative healing response.

Robust evidence from randomized trials and extensive PCI registry databases indicates that drug-eluting stents (DES) markedly reduce the incidence of target lesion revascularization in comparison to bare-metal stents (BMS). Concerning safety, most of the research indicates that contemporary drug-eluting stents (DES) exhibit comparable rates of mortality and myocardial infarction (MI) to bare-metal stents (BMS). The risk of stent thrombosis with contemporary drug-eluting stents (DES) is comparable to or perhaps lower than that associated with bare-metal stents (BMS) [3-5].

Sirolimus is a macrocyclic triene antibiotic with immunosuppressive and antiproliferative characteristics, which inhibits the intracellular mammalian target of rapamycin, therefore influencing cell cycle regulation. Sirolimus-eluting stents were initial-generation devices designed to inhibit the growth of smooth muscle cells and other cell types associated with restenosis following percutaneous coronary intervention (PCI). Sirolimus is integrated into experimental stents, encompassing polymer-free and bioabsorbable polymer devices.

The biological properties of the four commercially available antirestenotic medicines, all derivatives of sirolimus, utilized in drug-eluting stents (DES) are: (1) Everolimus is a semi-synthetic derivative of sirolimus, characterized by the alkylation of the hydroxyl group at position C40 with a 2-hydroxyethyl group, which has demonstrated efficacy in preventing restenosis in preliminary small-scale investigations. It has more lipophilicity than sirolimus, resulting in faster absorption into the artery wall. Everolimus is utilized in both durable polymer and bioabsorbable polymer devices. (2) Zotarolimus is a sirolimus derivative, characterized by a modification at the C40 position with a tetrazole ring, leading to a reduced circulation half-life of the drug. It is an equipotent counterpart of sirolimus both in vitro and in vivo, specifically designed for distribution from drug-eluting stents (DES). Like everolimus, the molecule has high lipophilicity, facilitating cellular absorption. (3) Ridaforolimus is a lipophilic homologue of sirolimus. (4) Biolimus A9 is a highly lipophilic derivative of sirolimus.[6,7]

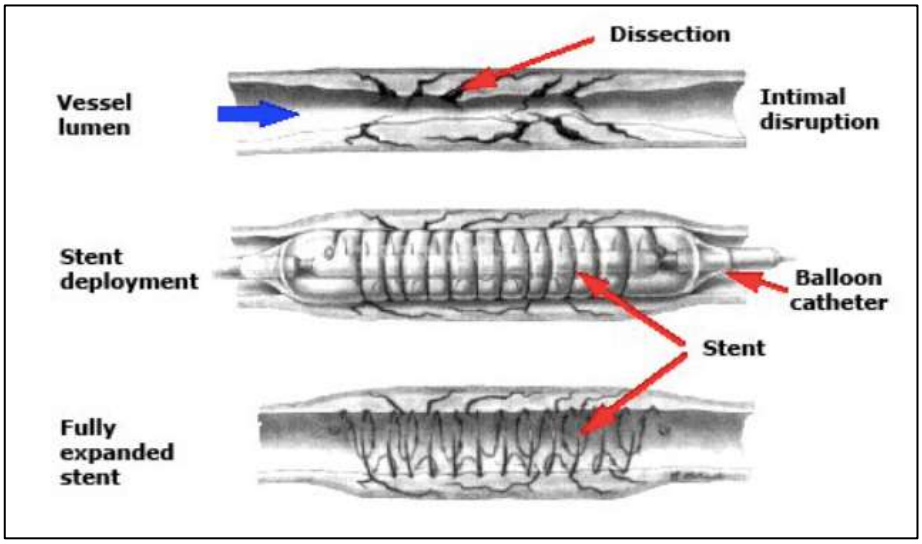

Figure 1. Deployment of coronary stent

OPTIMAL STENTING TECHNIQUE

Coronary stents are administered and positioned using balloon catheters (figure 1), which are introduced through the femoral, radial, or, less frequently, the brachial artery. Effective stent deployment is essential to reduce the risk of procedural difficulties and stent restenosis. Restenosis following drug-eluting stent (DES) placement frequently results from balloon barotrauma to the artery in regions not encompassed by the stent,

deficiencies in stent coverage, insufficient stent expansion, or the drug's ineffectiveness in inhibiting neointimal hyperplasia [8-14].

Characteristics of coronary arteries may hinder optimal stent deployment.

1. Arterial diameter. Vessels with a diameter less than 2 mm are unsuitable for stenting.
2. Tortuous, angulated, calcified, and chronically obstructed arterial segments. These factors may obstruct the delivery of the stent to the target lesion, and significant calcification may hinder optimal stent growth.

The paramount factor in stenting success is the complete extension of the artery lumen, referred to as optimum stenting. The achievement of a substantial luminal diameter reduces the likelihood of stent thrombosis and restenosis [15,16]. Insufficient balloon expansion results in suboptimal luminal dilation. This may pertain to plaque features, inadequate technique, or stent elastic recoil, which is linked to stent design and resistance [17]. Stent expansion is assessed angiographically but can be measured using intracoronary imaging methods. Another principle in the application of DES is to encompass the entire lesion, including areas subjected to balloon predilation, to address all regions of balloon barotrauma. Multiple overlapping stents may be necessary for extensively diseased segments that cannot be sufficiently addressed with a single stent. Conversely, overlapping stents and an extended total stent length correlate with a heightened risk of restenosis.

OPTIMAL STENTING METHODOLOGY

1. Predilation - While direct stenting offers certain benefits, predilation is advised for the majority of lesions (figure 1).
2. High-pressure balloon dilation — Typically, we execute high-pressure stent deployment or post-dilation at 12 to 16 atm to attain complete stent expansion.
3. Intravascular ultrasonography or optical coherence tomography may serve as valuable adjuncts for guiding stent insertion. The routine application of one of these imaging modalities, alongside high-pressure balloon postdilation, following second-generation drug-eluting stent (DES) deployment, should be contemplated in light of an expanding corpus of evidence, especially in complex percutaneous coronary interventions (PCI) and when there are uncertainties regarding optimal outcomes or instances of stent failure, such as thrombosis or restenosis.
4. Statin therapy enhances the prognosis of individuals with both stable and unstable coronary disease undergoing medical treatment. Nearly all patients receiving percutaneous coronary intervention ought to be on long-term statin medication. The function of statin reloading is ambiguous.

DECLARATIONS

None

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The authors declare that there is no conflict of interest in this report.

AUTHORS' CONTRIBUTIONS

Author contributed to the preparation of the manuscript in this review.

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