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PAPER

MODERN APPROACH TO CORONARY ARTERY STENTING

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Abstract

Coronary artery stenting is a surgical and minimally invasive method used to treat patients with coronary artery disease (CAD). The cause of CAD is the formation of atherosclerotic plaques in the lumen of the heart's arteries (coronary arteries), which supply the heart with oxygen-rich blood. As a result, blood flow to the heart is reduced or completely blocked, leading to the development of ischemia. During the procedure, special medical devices called stents are implanted into the artery to restore its patency and prevent re-narrowing.

Key words: coronary artery stenting, angina, myocardial infarction.

Introduction

A stent is an intravascular prosthesis designed to support the wall of a diseased vessel and maintain the diameter of its lumen. The stent structure is a thin, mesh-like framework made from a high-quality inert metal alloy, which is expanded by a balloon inside the vessel to the required diameter. Coronary artery stenting, or percutaneous coronary intervention (PCI), is a procedure that restores blood flow in the heart's arteries (coronary arteries) by implanting stents at the site of arterial narrowing. This procedure helps relieve symptoms of coronary artery disease, such as angina (chest pain)[2].

Nowadays, a large variety of stents have been developed. Stents differ in several aspects:

• **Presence of drug coating:**

There are drug-eluting stents (which have a special medication coating applied to the stent) and bare-metal stents (without drug coating).

• **Material alloy:**

Stents can be made from cobalt-chromium alloy, platinum-chromium alloy, and we also have stents made from polylactic acid — so-called bioresorbable scaffolds (stents that completely dissolve over several years, typically 3–5 years).

• **Cell design:**

Stents may have an open-cell design, closed-cell design, and other variations.

In recent years, the use of drug-eluting stents (DES) has demonstrated a clear advantage in combating restenosis. In clinical practice, the use

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of bare-metal stents (BMS) was associated with a relatively high rate of restenosis in the long term. This led to the consideration of polymeric coatings as a vehicle for local drug delivery. The goal of such coatings is to enable controlled release of the required medication from a durable polymer layer directly into the affected area of the vessel wall. The drug is released in a precisely dosed and uniform concentration over a defined time period. The drug delivery system retains its properties during sterilization, adapts its geometry and volume in line with the stent during implantation, and remains resistant to mechanical damage caused by balloon inflation. All of these properties of the local drug delivery system are made possible through various polymeric structures, which maintain the integrity of the system during clinical application.

Indications for Coronary Artery Stenting

• Acute myocardial infarction – in the first hours after the development of the infarction, or in case of angina occurring within the first week of the disease.

• Stable angina pectoris of functional class III–IV, or angina at rest.

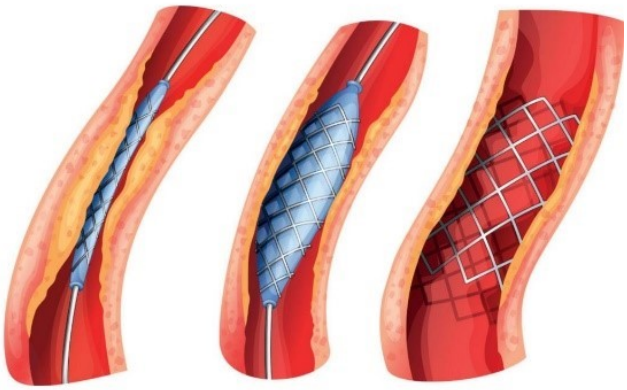
• Asymptomatic myocardial ischemia detected by additional diagnostic methods.

• Recurrent stenosis (restenosis) at the site of a previously placed stent.

• Acute stent thrombosis after stenting.

• After coronary artery bypass surgery, in case of recurrent angina.

Currently, coronary artery stenting is considered an alternative method of treatment to coronary artery bypass surgery.



ST-Elevation Myocardial Infarction (STEMI)

Invasive coronary angiography followed by percutaneous coronary intervention (PCI) is indicated for all patients (AHA/ACC, 2011, Class I level of evidence).

Unstable Angina and Non-ST-Elevation Myocardial Infarction (NSTEMI)

The presence of refractory angina, hemodynamic instability, or electrical instability is an indication for invasive coronary angiography followed by PCI (AHA/ACC, 2011, Class I level of evidence).

Stable Coronary Artery Disease (Stable CAD)

Advancements in technique, equipment, stents, and drug therapy have made PCI a routine and safe procedure for patients with stable CAD, provided the coronary artery anatomy is suitable. The procedure-related mortality risk for PCI in chronic CAD is approximately 0.5% (ESC, 2013).

Main indications include:

• Angina resistant to medical therapy

• Prognostically unfavorable coronary lesions, such as hemodynamically significant proximal stenoses (≥75% narrowing) in major coronary arteries.

Absolute Contraindications

• There are no absolute contraindications to coronary stenting except for the patient's refusal to undergo the procedure.

Relative Contraindications:

• Diffuse lesions of the coronary arteries – in cases of extensive damage to the main coronary vessels.

• Severe respiratory failure.

• Severe renal failure.

• Coagulation disorders (blood clotting system pathology).

• Allergy to iodine-containing contrast agents (in such cases, special pre-procedural medication is administered to allow the operation to be performed without risk to the patient).

Risks of Percutaneous Coronary Intervention (PCI)

Despite the low complication rate, PCI is an invasive procedure and carries certain risks.

The main complications associated with PCI include:

• Cerebrovascular complications – 0.22%

• Vascular complications – from 2%

• Mortality rate – 1.27%

• Allergic reaction to contrast agent – 0.37%

The mortality rate among patients undergoing elective PCI is approximately 1.27%[1].

Factors that increase the risk of death from PCI include:

• Advanced age

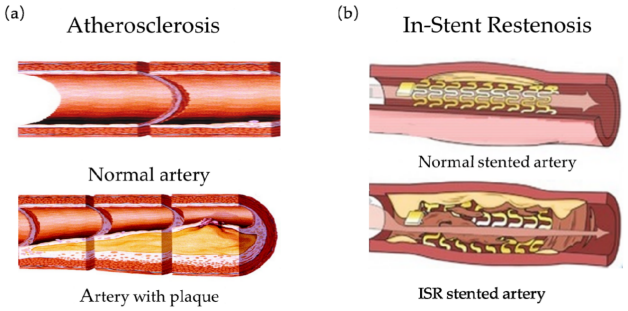
• Comorbidities such as diabetes mellitus, chronic kidney disease, chronic heart failure

• Multivessel coronary artery disease

In emergency PCI for ST-elevation myocardial infarction (STEMI) combined with cardiogenic shock, the risk increases to 4.81%.[1]

Restenosis – the Main Limiting Factor of Coronary Stenting

Restenosis is the re-narrowing of the vessel lumen, leading to reduced blood flow. In-stent restenosis refers specifically to the re-narrowing of a coronary artery inside the stent.



Risk factors for restenosis include:

• Genetic predisposition to excessive neointimal proliferation

• Diabetes mellitus

• Characteristics of the affected segment:

o Small vessel diameter

o Long lesion length

o Type of stenosis

• **Procedure-related factors:**

o Extent of arterial damage

o Residual dissection

o Number of stents implanted

o Stent diameter and the ratio between stent surface area and vessel wall surface

The implantation of a drug-eluting stent into the area of a hemodynamically significant coronary artery lesion is a globally recognized and widely used method for the treatment of coronary artery disease (CAD). However, the presence of a rigid metallic framework within the artery lumen can disrupt the vascular biomechanics and provoke neointimal proliferation in response to the foreign material. These processes may lead to restenosis and/or late stent thrombosis, potentially resulting in the recurrence of clinical symptoms of CAD and the development of adverse cardiovascular events. One approach to addressing these issues is the use of bioresorbable stents. This technique already has an established evidence base and is increasingly being adopted into routine clinical practice for selected patient groups, provided that technical aspects of implantation are carefully followed.[3]

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