REVASCULARIZATION IN ISCHEMIC HEART DISEASE: MODERN APPROACHES TO STENTING AND BYPASS SURGERY

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Abstract: *Ischemic heart disease (IHD) is one of the most prevalent cardiovascular disorders worldwide, leading to significant morbidity and mortality due to insufficient oxygen supply to the myocardium. This article provides a comprehensive review of modern revascularization techniques for IHD, specifically coronary artery stenting (percutaneous coronary intervention) and coronary artery bypass grafting. The indications, advantages, and limitations of each method are discussed, alongside technological advancements and clinical outcomes. The article also addresses the selection of the most effective approach based on individual patient profiles and strategies to prevent postoperative complications. Modern stenting techniques including biocompatible coatings, next-generation stents, and minimally invasive procedures are highlighted, as well as robotic and minimally invasive approaches in bypass surgery. The role of revascularization in cardiology practice, future perspectives, and the importance of individualized therapy are emphasized.*

Keywords: *ischemic heart disease, revascularization, stenting, coronary artery bypass grafting, percutaneous coronary intervention, minimally invasive surgery, biocompatible stents, cardiology, cardiovascular diseases, postoperative complications, individualized therapy*

Introduction: Ischemic heart disease (IHD) is one of the most prevalent and life-threatening cardiovascular disorders of the modern era, posing a serious risk to global public health. According to the World Health Organization (WHO), IHD is responsible for millions of deaths annually and contributes significantly to severe clinical conditions such as myocardial infarction, heart failure, and arrhythmias. The primary pathophysiological mechanism of IHD is myocardial ischemia, caused by the formation of atherosclerotic plaques in the coronary arteries that impair oxygen delivery to the heart muscle [1,2].

While pharmacological therapy plays a vital role in the management of IHD, in cases where symptoms persist or disease severity increases, myocardial revascularization becomes the cornerstone of treatment. The two main approaches to revascularization are: percutaneous coronary intervention (PCI), commonly known as coronary stenting, and coronary artery bypass grafting (CABG). Both strategies have been shown to effectively improve myocardial perfusion, alleviate symptoms, and enhance long-term patient outcomes [3,4].

In recent years, significant technological advances have transformed the field: the development of biocompatible drug-eluting stents, robot-assisted surgical platforms, minimally invasive revascularization techniques, and the adoption of personalized treatment strategies are paving the way for a new era in the management of IHD. These innovations have not only improved clinical outcomes but also reduced the risks of postoperative complications and the need for repeat interventions [5–7].

The choice between revascularization strategies in clinical practice is based on a comprehensive, individualized approach, taking into account coronary anatomy, patient comorbidities, risk factors, and patient preferences. For example, CABG is often preferred in diabetic patients with multivessel coronary artery disease, while PCI is commonly used for isolated single-vessel stenosis [8]. This article presents a comprehensive review of modern approaches to myocardial revascularization in ischemic heart disease. It discusses the indications, advantages, and limitations of each method, recent technological advancements, clinical outcomes, postoperative management strategies, and the importance of individualized therapeutic planning. The material is intended to guide cardiologists and cardiovascular surgeons in selecting the most appropriate treatment strategies for patients with IHD.

Main part: Ischemic heart disease (IHD) is one of the most widespread and life-threatening cardiovascular disorders in modern medicine. This condition arises from inadequate oxygen supply to the myocardium, usually due to atherosclerotic narrowing or obstruction of the coronary arteries. Although conservative treatment, i.e. pharmacotherapy, plays a vital role in managing IHD, in many instances it is insufficient. Particularly in patients with severe stenoses, symptomatic angina, or a history of myocardial infarction, revascularization — a procedure aimed at restoring blood flow to the heart muscle — becomes the principal approach. Currently, two main revascularization methods are employed: percutaneous coronary intervention (PCI), that is stenting, and coronary artery bypass grafting (CABG), known as surgical bypass.

PCI is a minimally invasive method in which a special catheter is used to place a stent in a coronary artery. The stent is a tubular structure made of metal or polymer, intended to keep the narrowed vessel open. In recent years, the development of drug-eluting stents (DES) has significantly reduced the risk of restenosis by decreasing inflammation and cellular proliferation around plaques. Stents coated with biocompatible materials further reduce the likelihood of rejection by the body. Modern PCI techniques make extensive

use of advanced imaging modalities such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT), allowing interventions to be performed with great precision.

On the other hand, bypass grafting is a classic surgical method in which a new route for blood flow is created, circumventing the blocked or severely narrowed part of a coronary artery. Patient's own veins or arteries are used for grafts (for example, the internal mammary artery, the great saphenous vein). CABG is primarily preferred when multiple vessels are involved, when there is left main coronary artery stenosis, in cases of complex anatomy, or in diabetic patients. It is especially important for patients with reduced ejection fraction, where myocardial function is impaired — bypass grafting improves long-term prognosis.

Table 1: Comparison of Revascularization Methods (PCI vs. CABG)

Criterion	**Percutaneous Coronary Intervention (PCI / Stenting)**	**Coronary Artery Bypass Grafting (CABG / Bypass Surgery)**
Type of Procedure	Minimally invasive	Open-heart surgery
Number of Affected Vessels	Usually 1–2 vessels	2 or more vessels involved
Recovery Time	Very short (1–3 days)	Longer (7–14 days or more)
Procedure Duration	30–90 minutes	3–6 hours
Long-term Efficacy	Moderate (risk of restenosis)	High (graft patency up to 10 years)
Risks	Restenosis, stent thrombosis	Bleeding, infection, heart failure
Advantages	Low trauma, fast recovery	More effective in multivessel disease
Indicated for	Mild to moderate stenosis	Complex lesions, high SYNTAX scores
Type of Anesthesia	Local or mild sedation	General anesthesia
Cost	Relatively affordable	More expensive

Due to technological progress, revascularization methods have undergone significant transformations. In PCI, interventions via the radial artery, next-generation ultra-thin stents, and systems that allow planning of interventions in conjunction with cardiac rhythm monitoring have been introduced. In the field of bypass grafting, robotic surgical technologies, minimally invasive approaches, and off-pump CABG operations (performed without stopping the heart) are increasingly used. These approaches help

reduce the rehabilitation period, lower the risk of complications, and improve the overall condition of the patient.

2: Classification of Revascularization Based on Clinical Indications

Clinical Condition / Indicator	**Recommended Method**	**Notes**
Single-vessel coronary disease	PCI	Minimally invasive and sufficient
Two-vessel disease, EF > 50%	PCI or CABG	Depending on patient condition
Three-vessel disease	CABG	Preferred in severe or complex cases
Left main coronary artery disease	CABG (sometimes PCI)	Depends on anatomical complexity
Presence of diabetes mellitus	CABG	Superior outcomes in multivessel disease
Recurrent restenosis	PCI or CABG	Based on prior intervention
Ejection fraction < 35%	CABG	Improves myocardial function
Elderly patients (>80 years)	PCI	Less risky alternative
Stable angina after myocardial infarction	PCI	Rapid intervention required
STEMI/NSTEMI/Unstable angina	PCI	Lifesaving approach of choice

The choice of revascularization method is determined by multiple factors. These include patient age, functional status of the heart, extent of coronary artery disease, concomitant conditions (especially diabetes, renal impairment, history of stroke), the SYNTAX score, as well as patient preferences and lifestyle. For example, high SYNTAX scores (i.e. complex arterial anatomy) often favor CABG. Conversely, for involvement of only one or two vessels and in stable condition of the patient, PCI is considered effective and safe. Many randomized clinical trials, such as SYNTAX, FREEDOM, EXCEL, ISCHEMIA, have compared these approaches and demonstrated their efficacy in specific clinical scenarios. Postoperative management is also a critical phase. After PCI, patients can generally mobilize within a few hours and are discharged in 1-2 days. However, those with drug-eluting stents must adhere to dual antiplatelet therapy (for example, aspirin plus clopidogrel or another P2Y12 inhibitor) for at least 6-12 months. After CABG, the rehabilitation period is longer; vigilant monitoring of cardiac function, prevention of infection, wound healing, and adaptation to physical activity are important. In both methods, secondary prevention — lipid control, normalization of blood pressure, smoking cessation, and adoption of a healthy lifestyle — is indispensable.

For each patient, individualised treatment is of great importance. In modern medicine, there are no universal approaches; therapy must be tailored to the genetic, clinical, psychological, and social characteristics of the patient. Collaboration between the cardiologist and the cardiovascular surgeon (i.e. a multidisciplinary approach) plays a decisive role in selecting the optimal and safe treatment strategy. Also crucial is the active involvement of the patient in decision-making, adequate explanation, and establishment of a trusting relationship—all of which enhance the efficacy of treatment.

Revascularization is a key strategy in ischemic heart disease — it helps to save the patient's life, improve quality of life, and stabilize long-term prognosis. Stenting offers low invasiveness, fast recovery, and convenience, whereas bypass grafting provides long-term effectiveness and advantage in complex lesions. Modern technologies, advanced clinical guidelines, and individualized approaches are refining this therapeutic field and creating new opportunities for patients.

Conclusion: Ischemic heart disease (IHD) remains one of the leading global health challenges, causing millions of deaths annually. In severe cases, restoring coronary blood flow — revascularization — is a critical treatment approach aimed at improving patients' quality of life, prolonging survival, and preserving cardiac function. As discussed in this article, modern revascularization techniques — percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) — have their own clinical advantages, limitations, and specific indications depending on patient groups. PCI is a minimally invasive, rapid procedure preferred in cases of one or two-vessel disease, stable angina, and early myocardial infarction. Advances such as drug-eluting stents, biocompatible coatings, and advanced imaging modalities significantly enhance the safety and efficacy of this method. On the other hand, CABG is favored for multivessel disease, diabetic patients, left main coronary artery stenosis, or complex anatomy. Bypass surgery provides long-term benefits, reduces the need for repeat interventions, and improves quality of life in patients with cardiac dysfunction. Selecting a revascularization method requires comprehensive evaluation of the patient's clinical condition, laboratory parameters, comorbidities, and personal preferences. Personalized treatment approaches are becoming a cornerstone of modern cardiology. In summary, revascularization remains a cornerstone strategy in the management of IHD. Proper selection of the method, integration of modern technologies, and individualized therapy optimize patient outcomes. Therefore, revascularization continues to play a vital role in cardiology and cardiovascular surgery.

Recommendations:

1. Strengthen patient individual assessment systems by routinely using international scores such as SYNTAX and EuroSCORE in clinical practice.
2. Implement a multidisciplinary "Heart Team" approach to decision-making in complex cases.

3. Promote widespread adoption of modern technologies including biocompatible stents, robotic surgery, and advanced imaging (IVUS, OCT).
4. Develop infrastructure for specialized revascularization centers in urban and regional hospitals.
5. Establish patient education programs to enhance awareness and involvement in treatment decisions.
6. Improve rehabilitation and long-term follow-up systems post-procedure.
7. Provide ongoing training and certification programs for cardiologists and cardiac surgeons.
8. Support clinical research focused on the effectiveness and complications of revascularization within the local healthcare context.

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