Investigation of Surface Coating Biomaterials to Enhance Function of Stainless Steel Coronary Stents

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Abstract

Coronary heart disease (CHD) claims one life every minute in the United States. CHD is caused by atherosclerosis of coronary arteries, a condition in which plaque deposits prevent blood flow to the heart. Coronary stents are commonly used to restore vessel diameter and reestablish blood flow within the vessel, though a universal material for stent fabrication has yet to be identified. Stainless steel is the most commonly used material in cardiovascular stents due to desirable mechanical stability and flexibility. However, stainless steel stents demonstrate poor biocompatibility and restenosis remains a challenge to their implementation. Surface coating materials can enhance the biocompatibility of stainless steel stents while maintaining their adequate mechanical properties. This review discusses various coating materials and the properties required to reduce clotting and restenosis of stainless steel cardiovascular stents.

1. Introduction

1.1 Clinical Relevance

Cardiovascular disease (CVD) accounts for approximately 2300 deaths per year in the United States, and consumes 17% of the country's national health budget [1]. Coronary heart disease (CHD) is a specific type of CVD that results in one death per minute in the United States [1]. CHD is caused by plaque deposition within the coronary arteries, leading to blockages that prevent blood from nourishing the body [2]. The build-up of plaque in the coronary arteries is known as atherosclerosis, and is an inflammatory disease due to dysfunction of endothelial cells lining the interior of the vessel [2]. Several factors including elevated low-density lipoprotein (LDL) levels, cigarette smoking, hypertension, genetic mutations, and infections can contribute to atherosclerosis [2]. Injury of the endothelium leads to permeability changes along the cell layer, and change the adhesiveness of the cells to leukocytes and platelets in the blood [2]. The adhesiveness creates plaque deposition, or fatty streaks, that eventually become capped by fibrous tissue and isolated from the vessel lumen [2]. When the lesions become unstable, the fibrous cap ruptures, releasing the plaque to the bloodstream (Fig. 1) [2]. Plaque in coronary arteries reduces blood flow to the heart, which can cause thrombosis in the vessel [2]. Even worse, the plaque can lead to heart tissue infarction, more commonly known as a heart attack [2]. CHD is the number one cause of death in America [2], making research on its treatment and prevention crucial for advancing medicine and promoting health.