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REVIEW

Hydrogel advancements in vascular tissue regeneration: a comprehensive review and future prospects

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Abstract
Vascular tissue regeneration has gained a lot of interest, especially in addressing the challenges associated with vascular-related diseases and injuries. Hydrogels have shown great promise in the field of vascular tissue regeneration because of their special features, which include biocompatibility and mechanical characteristics that may be adjusted, as well as their likeness to the natural extracellular matrix. The fabrication techniques for vascular scaffolds have been the subject of much investigation due to the effectiveness of scaffold-based tissue engineering in producing new blood vessel tissues. The creation of vascular scaffolds has been greatly aided by recent developments in 3D printing, which presents an encouraging concept for the vascularization of tissues. This review covers the various cutting-edge hydrogel formulations, fabrication techniques, and strategies for the development of functional and biocompatible vascular scaffolds. The review also reveals these novel hydrogel-based techniques' possible uses, difficulties, and possibilities for the future of vascular tissue regeneration.

Keywords Vascular tissue engineering · Hydrogels · Biomaterials · Nanofibrous scaffolds · Cardiovascular diseases · 3D-printing

1 Introduction

A variety of disorders that impact the heart and vessels are referred to as cardiovascular diseases, or CVDs. In addition to being the leading cause of death worldwide, CVDs include hypertension, coronary heart disease, cerebrovascular disease, heart failure, and other heart diseases with significant morbidity and mortality. It is worth mentioning that cardiovascular illnesses account for one-third of global mortality, and their prevalence is rising as the population ages and their conditions worsen, as they are responsible for over 17.3 million deaths per year [1]. With a less than 50% 5-year survival rate, systolic heart failure that follows myocardial infarction, which is frequently caused by macrovascular disease, is extremely deadly. So, it is becoming more widely acknowledged that CVDs are the major cause of chronic cardiac failure and contribute significantly to healthcare expenses, illness, and death rates [2–4]. The cardiovascular system is responsible for the distribution of necessary nutrients and oxygen throughout the body, which is made up of arteries, veins, and capillaries and plays a crucial role in preserving the balance of tissues [5]. One of the most important struggles in reconstructing large-scale tissues is providing enough nutrition to the cells, which is frequently hampered by diffusion-driven oxygen and nutrient transport [6]. Blood vessels are necessary for the transportation of nutrients and the metabolism of tissues, which is why tissues and organs need them [7]. Thus, vascular disorders continue to be a major cause of death, highlighting the importance of vascular regeneration in repairing injured

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