

Directional Pressure Pump Hydrogel Transmission Platform Provides Bionic Contractile Force and Remodels the Healing Process for Diabetic Mechanically Dynamic Wounds

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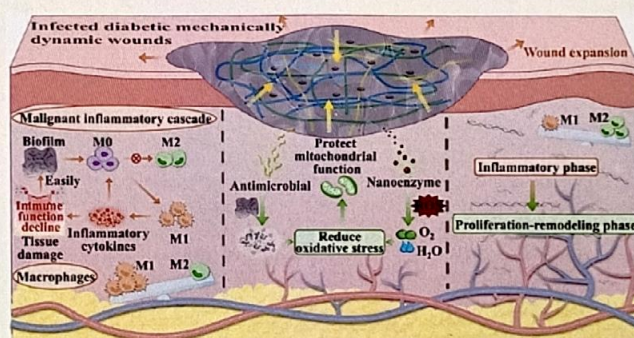
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ABSTRACT: Diabetic mechanically dynamic wounds colonized by biofilms often present with accumulated reactive oxygen species, a fragile immune defense line, and frequent mechanical stress stimulation. This results in diminished peripheral skin contractility, thereby prolonging the inflammatory phase of wound healing. Here, we designed and developed a directional pressure-pump hydrogel delivery platform. The directional pressure pump's differential pressure behavior can deliver antibacterial agents and nanozymes specifically to the lesion site. This not only disrupts bacterial biofilms and eradicates bacterial communities, thereby establishing a robust infection defense barrier, but also mitigates secondary tissue damage to reprogram the wound healing microenvironment. In addition, the temperature-sensitive self-shrinkage behavior of the hydrogel delivery platform can regulate the normal activation of myofibroblasts in the early stage of wound healing, thereby ensuring the orderly closure of the damaged skin. Animal experiments demonstrate that the directional pressure-pump functionality and autonomous biomimetic contraction behavior collectively accelerate epidermal wound closure and guide functional remodeling of the nascent vascular network and collagen fiber architecture. Accordingly, the directional pressure-pump hydrogel delivery platform offers a biomimetic guidance strategy for pathological wounds characterized by imbalanced epidermal edge contraction.



KEYWORDS: nanoenzymes, directional pressure pump, antiexpansion hydrogel, diabetic mechanically dynamic wound, thermosensitive self-shrinking hydrogel

1. INTRODUCTION

Diabetic wounds are highly susceptible to bacterial invasion due to their rich nutrient matrix and weak immune defense.¹ With the global evolution of bacteria, drug-resistant strains not only increase the risk of infection in diabetic wounds but also multiply to form structured colonies, thereby creating stubborn biofilms.² This will inevitably deteriorate the open and damaged tissues of diabetic patients into chronic wounds with immune disorders and may even lead to systemic infections such as sepsis.³ This not only seriously impairs the health of diabetic patients but also causes excessive anxiety in their daily lives and imposes a heavy economic burden on the global healthcare system.⁴ Inevitably, due to the complexity

and flexibility of the human body structure, trauma often occurs on the skin of mechanically dynamic sites.⁵ However, the frequent mechanical movements can cause stress concentration at the edges of the injured skin, leading to repeated tearing and bleeding of the new tissue, which greatly

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