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Advances in Regenerative Medicine: from Bioengineered Human Skin Models to Clinical Therapies

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Abstract

Ongoing advancements in regenerative medicine, coupled with the development of tissue-engineered skin products, present new avenues for treating diseases with elusive permanent cures. Our laboratory has successfully engineered a fibrin-based human skin, demonstrating efficacy in permanent regenerative therapies. Through orthotopic grafting onto immunodeficient mice, we established a unique skin-humanized mouse model, enabling the study of various monogenic skin diseases. The model system has proven instrumental in testing gene therapy approaches for cell correction, particularly in the case of psoriasis, a chronic inflammatory condition. This development addresses the critical need for reliable humanized animal models in understanding disease pathogenesis and innovating therapeutic strategies.

Introduction

The skin, constituting about 15% of adult body weight, plays a crucial role in protecting against external threats and maintaining homeostasis. Skin-related diseases often necessitate advanced treatments, and tissue-engineered skin products have emerged as promising solutions. Our focus lies in developing bioengineered human skin to address conditions where conventional treatments only alleviate symptoms, aiming for lasting regenerative effects. The skin-humanized mouse model we've established offers a versatile platform for modeling various skin diseases and evaluating potential therapeutic interventions[1].

In recent years, the dynamic field of regenerative medicine has undergone unprecedented advancements, opening novel frontiers in the quest for more effective and lasting treatments. At the forefront of these breakthroughs is the development of bioengineered human skin, a transformative approach that holds immense promise for addressing diseases where current treatments fall short of providing permanent solutions[2]. This paradigm shift towards regenerative therapies is particularly significant in instances where symptomatic relief remains the primary focus, leaving the quest for a definitive cure unmet[3].

Within this transformative landscape, our laboratory stands as a beacon of innovation, spearheading the creation of a fibrin-based bioengineered human skin that has transcended the confines of conventional treatments. This bioengineered skin not only marks a departure from traditional approaches but has also demonstrated resounding success in the realm of permanent regenerative therapies[4]. The realization of these therapies has been made possible through

meticulous efforts to establish a skin-humanized mouse model, an instrumental platform that facilitates the translation of preclinical insights into tangible clinical solutions[5].

As we embark on this journey through the intricacies of regenerative medicine, this paper unveils the multifaceted dimensions of our research. From the intricacies of our bioengineered skin to the groundbreaking applications of the skin-humanized mouse model, we delve into the intricacies of our methodologies, the compelling results they have yielded, and the far-reaching implications for the future of clinical regenerative therapies. This comprehensive exploration aims not only to showcase the achievements within our laboratory but also to contribute meaningfully to the evolving narrative of regenerative medicine[6].

Our commitment lies not merely in the creation of innovative solutions but in the establishment of a robust foundation for understanding and combating a spectrum of skin-related diseases. Through the lens of our research, we illuminate the path towards a future where bioengineered human skin stands as a cornerstone, transforming the landscape of regenerative medicine and redefining the boundaries of what is achievable in the treatment of complex skin conditions. Join us as we unravel the intricacies of this revolutionary journey, where the amalgamation of cutting-edge science and compassionate care propels us towards a future where regenerative medicine reigns supreme[7], [8].

Methods

We have refined bioengineered skin using a three-dimensional dermal scaffold based on clotted human plasma, demonstrating excellent keratinocyte growth support. Orthotopic grafting onto immunodeficient mice has resulted in a stable and mature human skin equivalent, crucial for studying disease models. The application of gene therapy approaches has proven effective in reverting phenotypes in this model, showcasing its versatility and reliability.

Results

Our laboratory has successfully modeled monogenic skin diseases, including Epidermolysis Bullosa and Netherton Syndrome, using the skin-humanized mouse model. Additionally, we've achieved a breakthrough in establishing a model for psoriasis, a common chronic inflammatory disease. These achievements highlight the model's efficacy in mimicking complex human skin conditions, providing valuable insights into disease mechanisms and therapeutic strategies.

Conclusion

The skin-humanized mouse model developed in our laboratory emerges as a pivotal tool bridging the gap between preclinical research and clinical regenerative therapies. The successful application of bioengineered human skin in diverse disease models underscores its potential for advancing the understanding of disease pathogenesis and fostering innovative therapeutic

approaches. While challenges persist, our work signifies a substantial step towards realizing the promise of regenerative medicine in treating a spectrum of skin-related conditions.

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