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RESEARCH ARTICLE

# Hair follicle stem cells combined with human allogeneic acellular amniotic membrane for repair of full thickness skin defects in nude mice

Fei Liu[1] | Huateng Zhou[1] | Weibin Du[1] | Xiaolong Huang[1] | Xuan Zheng[1] | Cui Zhang[2] | Huahui Hu[1] | Jinfu Wang[2] | Renfu Quan[1]

[1]Department of Orthopedic Surgery, Affiliated Jiangnan Hospital, Zhejiang Chinese Medical University, Hangzhou, China

[2]Institute Cell and Development, College of Life Science, Zhejiang University, Hangzhou, China

**Correspondence**
Renfu Quan, Department of Orthopedic Surgery, Affiliated Jiangnan Hospital, Zhejiang Chinese Medical University, Hangzhou 311201, China.
Email: quanrenfu@126.com

Jinfu Wang, Institute Cell and Development, College of Life Science, Zhejiang University, Hangzhou 310058, China.
Email: wjfu@zju.edu.cn

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## Abstract

Repair of large skin defects caused by burns, trauma, or tumor operations is a clinical challenge. Hair follicle stem cells (HFSCs) are involved in epithelialization of wounds, formation of new hair follicles and promote vascularization in the newly formed skin, and human acellular amniotic membrane (hAAM) is a promising scaffold for skin substitute. Here, we investigated the ability of rat HFSCs (rHFSCs) combined with an hAAM to repair full thickness skin defects in nude mice. The effect of the rHFSC-hAAM composite on the repair of skin defects in nude mice was assessed by hematoxylin and eosin staining, immunohistochemistry, and EdU-labeled cell tracking. Isolated and cultured rHFSCs had strong cloning and proliferation potentials. Immunofluorescence staining and flow cytometry assays showed that rHFSCs expressed high levels of integrin α6, CK15, p63, and Sox9. Cells cultured in hAAM showed flaky and cluster-like morphology and were able to adhere and grow effectively. After transplantation, the rHFSC-hAAM composite promoted wound healing in nude mice. Moreover, cells in the rHFSC-hAAM composite were directly involved in hair follicle formation and angiogenesis of tissue around the hair follicle. These results provide an experimental and theoretical basis for the clinical application of HFSCs in repair of human skin defects and a new approach for skin tissue engineering.

**KEYWORDS**

acellular amniotic membrane, hair follicle stem cells, skin defects, tissue engineering

## 1 | INTRODUCTION

According to the World Health Organization, approximately 9 million patients in China have skin defects caused by burns or accidents, and more than 3.2 million patients require skin transplantation (Peck, 2011). Approximately 10% of these patients cannot be cured because of large skin burns and scarcity of skin source (Peck, 2011). Moreover, repair and reconstruction of skin defects caused by trauma or disorders are a challenge. In therapeutic regimens for skin defects, the skin autograft is considered as the gold standard (Gurtner, Werner, Barrandon, & Longaker, 2008). For healthy patients with small skin defects, self-repair and autografting of skin are often used for wound healing in the clinic. For patients with large skin defects, however, the wound cannot be healed by self-repair. Deficient autologous skin leads to difficulty in wound repair, influencing the treatment or even resulting in death (Horch, Kopp, Kneser, Beier, & Bach, 2005). In addition, the source of skin autograft is the same patient. Skin autografting can be a painful procedure and is associated with risk of complication such as infection in the skin donor area and nonhealing (Dreifke, Jayasuriya, &

  