Regenerating Hair In Prevascularized Tissue Space Formed By A Controllable Foreign Body Reaction

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Introduction

- Tissue engineering is an important field that has allowed for the engineering of functional tissues in vitro and subsequent transplantation in vivo as a clinical strategy. One of the challenges in this field is tissue engineering of hair follicles (HF). An ideal site for hair transplant should have enough tissue volume to support graft survival, quickly create a functioning anastomosis between the host and graft vasculature, aid communication for circulation between the graft and the host. The most challenging part is ensuring there is enough vascularization.
- Prevascularization is a promising strategy that can be used to overcome this obstacle. This process creates a performed microvasculature to quicken anastomosis with the host's vasculature. In situ foreign body reaction (FBR) can generate a transplant site with large tissue volume and adequate vascular connection. The inflammatory response will be stimulated by instant contact with host circulation, which will cause the generation of collagen fibres and the formation of new blood vessels that envelop the implanted materials.
- Further studies need to focus on the FBR process performed under great control. This study constructed a preprogrammed transplant site called prevascularized collagen fibres (PVCF) matrix by temporarily implanting a catheter on the dorsum of mice. To observe the optimal duration of FBR, various different time points were selected for implant withdrawal.
- The separated trichogenic were then transplanted into the PVCF matrix once the process of implant withdrawal was completed to regenerate HF. This is a novel strategy to generate an altered transplant site by engineering and altering the FBR process.

Experimental

- Newborn mice that were 0-2 mice and adult nude mice (4-6 weeks) were used. A silicone catheter was used to create a subcutaneous transplant on adult mice, the incision was closed with a 4-0 nylon suture.
- The morphological characteristics of PVCF matrix was examined before the catheter was removed, creating a hollow capsule around a vascularized matrix.. For observation of rheology characteristics, a TA Discovery Hybrid Rheometer with steel parallel plate of 8 mm was used at 25 °C.
- Histological assessment was also performed on the tissue samples by embedding the new PVCF in paraffin wax and then stain it with Masson's trichrome. In order to observe macrophage and endothelial cells, immunohistochemistry and immunofluorescence staining were performed by first incubating with antibody at 4 °C and then 25 °C for 30 min.
- The in-situ hair regeneration was evaluated from 12 days harvested groups using regenerated hairs and histological test

Results

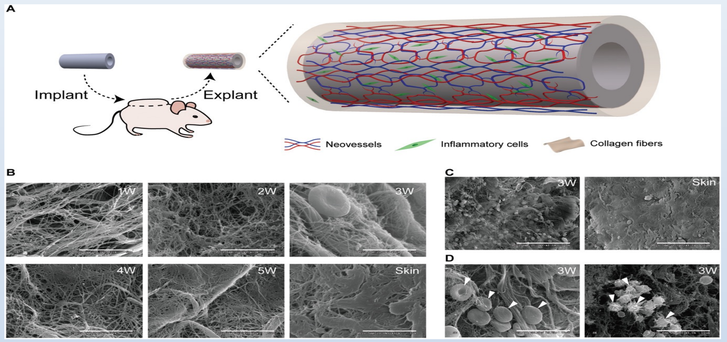

Figure 1. A) Preparation of the PVCF . B) The PVCF matrix generated . C) The PVCF matrix was generated after 3 weeks of FBR and skin under the same magnification. D) The PVCF generated after 3 weeks of FBR demonstrated the red blood cells (left) and activated platelets (right)

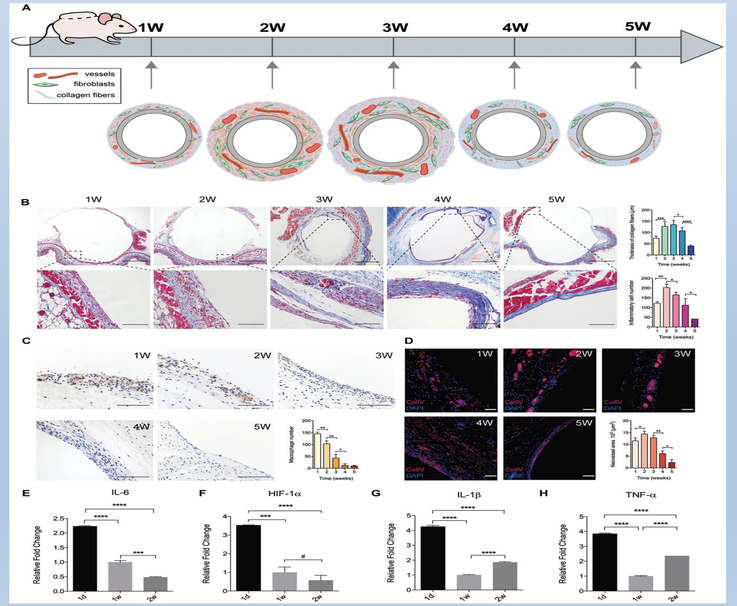

Figure 2. A) Schematic illustration of PVCF matrix generated . B) cross-sections of VCF generated at different time points. C) Immunostaining of the cross-section for macrophage (brown). D) Fluorescent staining of the cross-sections for CD31. The inflammatory response concentration of IL-6 (E), HIF-1a (F), IL-1b (G), and TNF-a (H) -detected by quantitative PCR

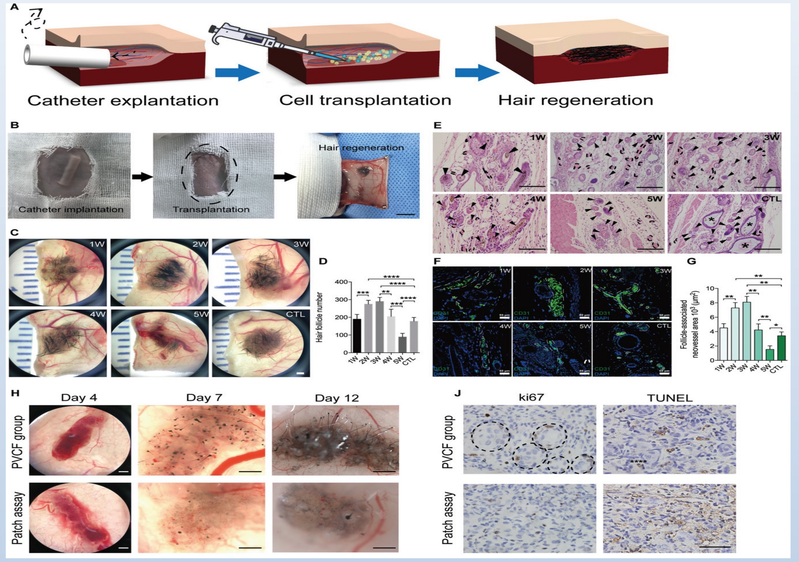

Figure 3. A) Schematic of in situ cells transplantation into the PVCF. B) Suspensions of neonatal transplanted into the PVCF. C) hairs. D) hair follicles. E) H&E staining of the transplant sites. F) Fluorescent staining of the neovessels. G) mean neovessel area. H) observation of the hair at 4, 7, 12 days.

Discussion and Conclusion

- This study has generated a preprogrammed transplant site that uses controlled FBR to improve hair regeneration.
- The PVCF matrix is an efficient modified transplant site that supports graft survival under a modified FBR duration.
- Transplanting trichogenic cells into this preprogrammed space would inhibit excess apoptosis and cause increased hair growth.
- PVCF is not only beneficial in the bioengineering application of hair transplant, but it is also useful in other fields that need vascularized tissue space

Future work

- Promising strategy that improves graft site microenvironment, significant for future organ transplant regenerative therapy

References

- Yang, L., Miao, Y., Liu, Y., Chen, S., Chen, Y., Liu, W., Wang, J., Zhong, W., Wang, Q., Hu, Z., & Xing, M. (2020). Regenerating Hair in Prevascularized Tissue Space Formed by a Controllable Foreign Body Reaction. *Advanced Functional Materials*, *31*(8), 2007483.

Acknowledgement

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