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Evaluating Functional Dynamic Hydrogels for Improved Healing in Porcine Wound Models

Johanna Einsiedler, Maximilian Moshammer, Anna Schwarz, Manuel Prevedel, Lena Tatschl, Manfred Bodenlenz, Reingard Raml, Manuel Alejandro Fernandez, Helena Herrada-Manchon, Beatriz Palla, Oliver Etzold, Juliana Nunes, Thomas Birngruber, Damien Dupin, and Petra Kotzbeck

Clinical challenges drive chronic wound innovation

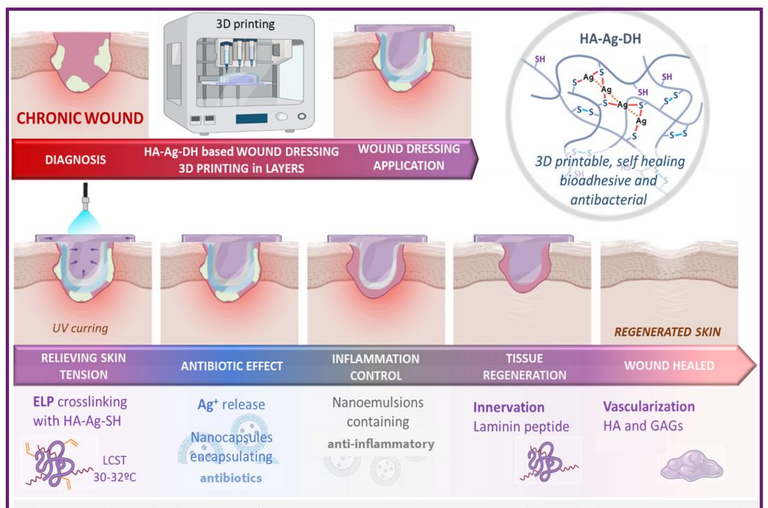

Figure 1: The „FORCE REPAIR" approach. The main objective of the FORCE REPAIR project is to develop a smart, multifunctional and cost-effective 3D printed wound dressing for the treatment of chronic wound, that will fight bacterial infection and control inflammation while relieving skin tension and stimulate healing.

Study design & experimental approach of porcine acute and chronic wound models

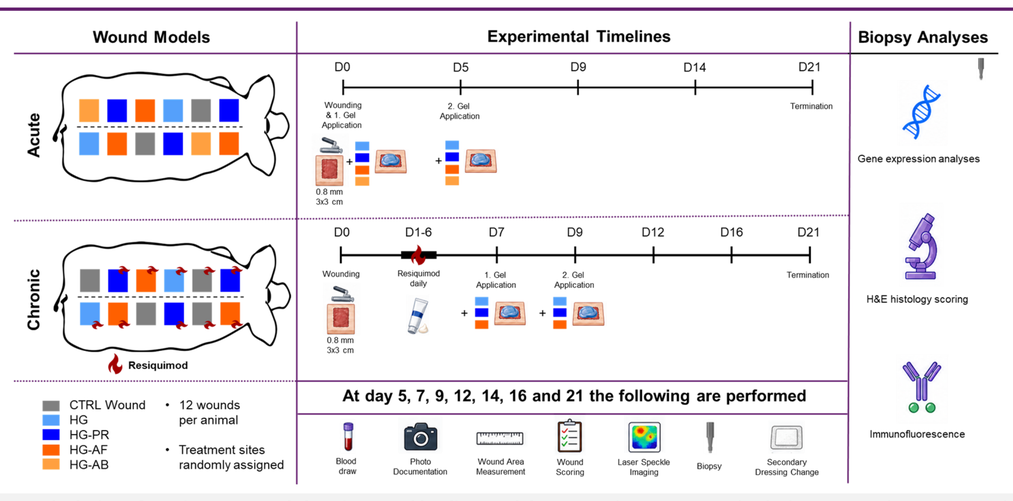

Figure 2: Study design of porcine acute and chronic wound healing model. 0.8-mm deep, 3x3 cm split-thickness wounds were created on the back of female landrace pigs (29.9 ± 4.2 kg; n_{acute}= 6, $n_{chronic}$= 2). Wounds were treated with hydrogel alone (HG), anti-bacterial (HG-AB), anti-inflammatory (HG-AF), or pro-regenerative hydrogel (HG-PR), with applications at baseline and day 5 for acute wound healing. To induce hyerinflammation of the chronic wounds, resiquimod was applied for 6 consecutive days. Then, hydrogels were applied at day 7 and day 9 in the chronic model. Untreated wounds (acute and chronic) covered only with secondary dressing served as controls (CTRL).

Hydrogels may facilitate acute and chronic wound healing

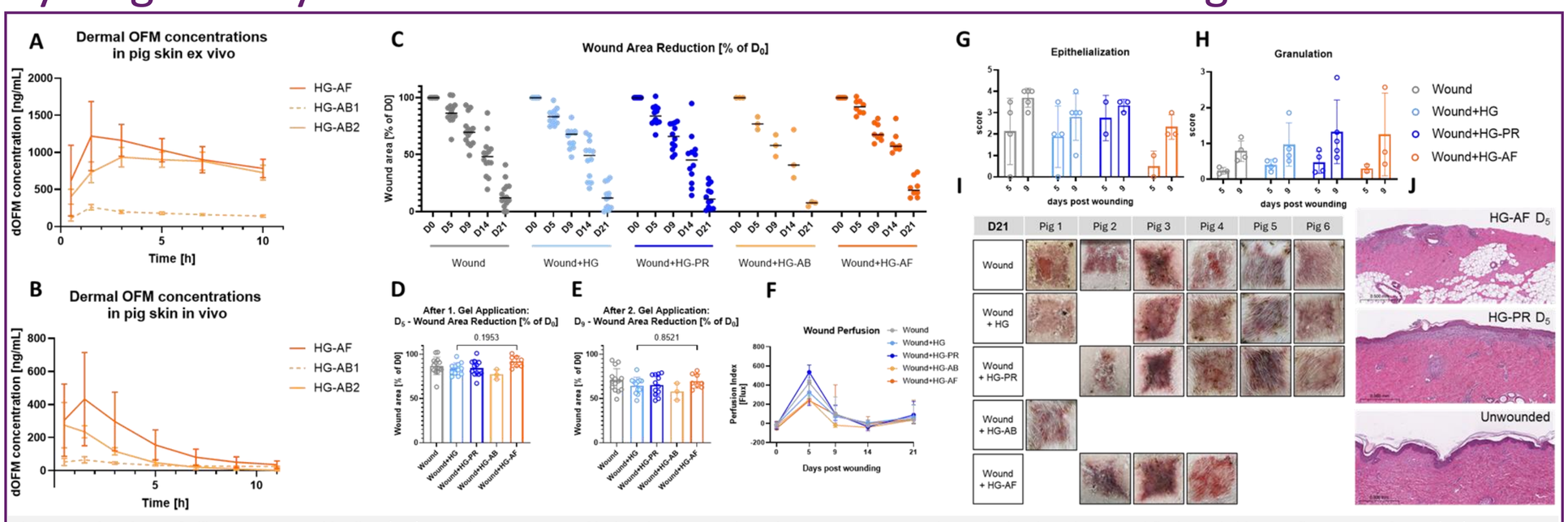

Figure 3: Hydrogels may facilitate acute wound healing. (A-B) Dermal concentrations of hydrogel active ingredients (HG-AF, HG-AB1, HG-AB2) measured in dermal interstitial fluid sampled by openflow microperfusion. **(C-E)** Wound area reduction [% of D0] after treatment of acute split-thickness wounds with either HG, HG-AF, HG-AB or HG-PR (Wounds are untreated control wounds). **(F)** Wound perfusion measured by Laser Speckle Imaging. **(G, H, J)** Epithelialization and granulation scored by analysis of H&E stained wound tissue sections. **(I)** Representative wound images of all wound groups of all six pigs on day 21.

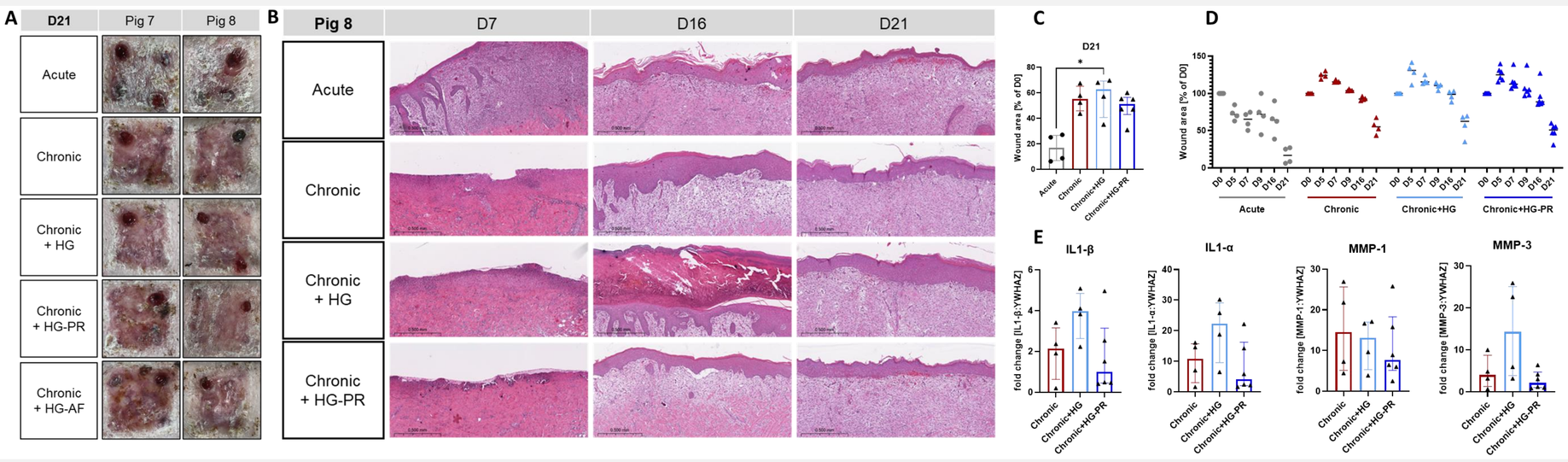

Figure 4: Hydrogels modulate inflammation in chronic wounds. (A) Representative wound images of all wound groups of both pigs on day 21. **(B-D)** Epithelialization and granulation scored by analysis of H&E stained wound tissue sections. **(E-F)** Wound area reduction [% of D0] after treatment of chronic split-thickness wounds with either HG, HG-AF or HG-PR (Wounds are untreated acute and chronic control wounds). (G) Gene expression of IL1-β, IL1-α, MMP1 and MMP3 in wound biopsies sampled on day 9, 48 h after the 1. hydrogel application.

Conclusions

- Dermal drug levels reflect hydrogel concentrations, confirming **effective local delivery**.
- **All hydrogels** were **well tolerated** with **no adverse effects** on wound healing.
- **HG-PR showed** the **most promising healing** trend (acute + chronic), including **faster closure and reduced inflammation**.
- **HG-AF** showed a trend toward **attenuated healing**, indicating formulation-dependent effects.
- **Chronic wound model** was successfully **validated**, and further chronic studies will clarify therapeutic potential.

Contact

JOANNEUM RESEARCH Forschungsgesellschaft mbH

COREMED
Centre for Regenerative Medicine and Precision Medicine

Johanna Einsiedler

Neue Stiftingtalstraße 2,
8010 Graz

Phone +43 316 876-6017
johanna.einsiedler@joanneum.at
www.joanneum.at/coremed

Medizinische Universität Graz

PLASTISCHE, ÄSTHETISCHE UND REKONSTRUKTIVE CHIRURGIE GRAZ

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