Lactate-Mediated Healing in Burns: Mechanistic Insights Into the Bioactivity of PLA-Based Membranes

Jose L. Ramirez-Garcialuna[1,2]; Mario A. Martinez-Jimenez[2], Ana Lorena Novoa Moreno[2]

1 McGill University, Montreal, QC, Canada. 2 Division of Surgery, Universidad Autonoma de San Luis Potosi, Mexico

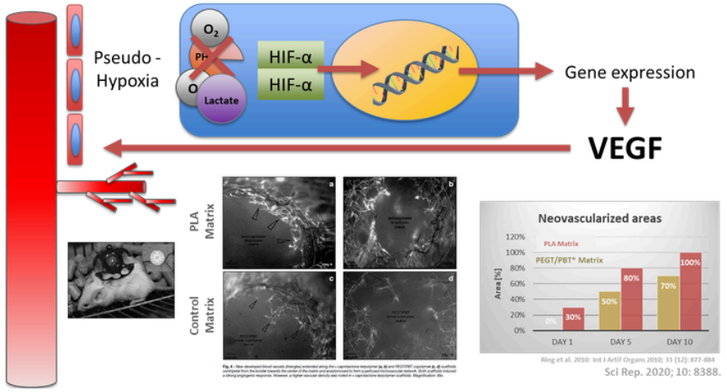
Background

- **Burns** are not simple wounds.
- They are **dynamic, hostile environments** marked by:
  - Exquisite pain and risk of infection.
  - Tissue hypoxia and cell death.
  - Uncontrolled inflammation, which delays healing and worsens scarring.
- For decades, **standard dressings** have been designed primarily to cover and protect, but they do not actively address these **biological problems.**
- **Cellular, acellular and matrix-like products (CAMPs**) are advanced wound care products that exert biological effects.
- **Polylactic-acid (PLA) membranes** * are alloplastic CAMPs have demonstrated excellent outcomes in burn care by r**estoring the interplay of the key elements of wound healing.**
- This is achieved because the **lactate** released by the PLA membrane acts as a paracrine agent (lactormone) with potent signaling effects that include:
  - **Hypoxia mimicking and triggering of neo-angiogenesis**
  - **Cell survival and proliferation**
  - **Anti-inflammation**
  - **Wound pH acidification**
  - **Pain modulation**
- This transforms the dressing from a passive cover into an **active therapeutic platform.**

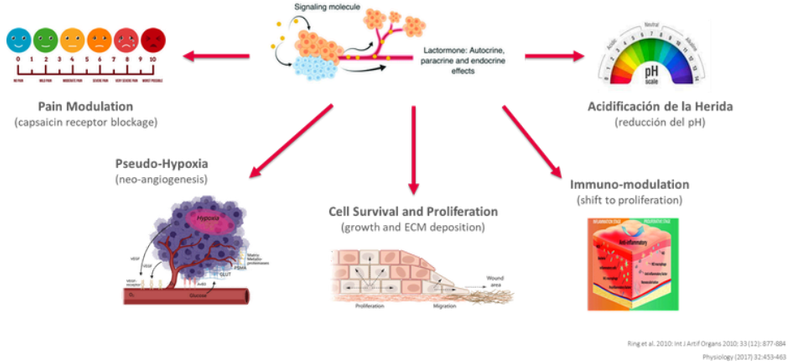
Methods

- **Design:** mechanistic review of the clinical and biological evidence of polylactic acid (PLA) membranes in burn care.
- **Sources:** Studies were identified through targeted searches of PubMed and Embase.
- Evidence was drawn from three main sources:
  - **Randomized clinical trials (RCTs)** and non-randomized clinical studies.
  - **In vivo experimental models** exploring the effects of PLA degradation products, particularly lactate, on inflammation and nociception.
  - **Molecular and cellular studies** examining the pathways of inflammatory modulation, neuroreceptor signaling, and microenvironmental changes relevant to wound healing.
- The findings were organized along **two dimensions:**
  - **Clinical outcomes:** time to heal, pain reduction and cosmetic outcomes.
  - **Mechanistic insights:** lactate-driven effects on neoangiogenesis, cell activity, cytokine expression, and pain.

Results



Sci Rep. 2020; 10: 8388.



Physiology (2017) 32:453-463

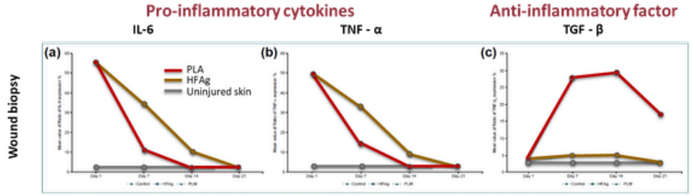
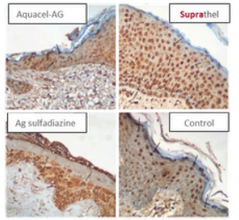


Figure 4. Change over time in skin tissue **(a)** IL-6, **(b)** TNF-α and **(c)** TGF-β_1 expression across the three groups.

Ulus Travma Acil Cerrahi Derg 2021;27(1):122-131.



J Burn Care Res 2019;40(3):302-311.

Int J Mol Sci 2022;23(3):1328.

Conclusions

Why Routine Use? – Dual Mechanism
Membrane: protects, adheres, reduces dressing trauma.
Bioinductor: lactate release triggers biological cascades.

Unique to PLA membranes: synthetic reproducibility + bioactivity.

Burns require more than coverage.
They require biological support.

PLA membranes provides both.