WHS-P11

INNOVATIVE PEPTIDE-BASED TECHNOLOGY PROVIDES ANTIBACTERIAL AND ANTIBIOFILM PROTECTION, FACILITATING RAPID AND SUSTAINED CLOSURE OF SURGICAL INCISIONS

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Introduction

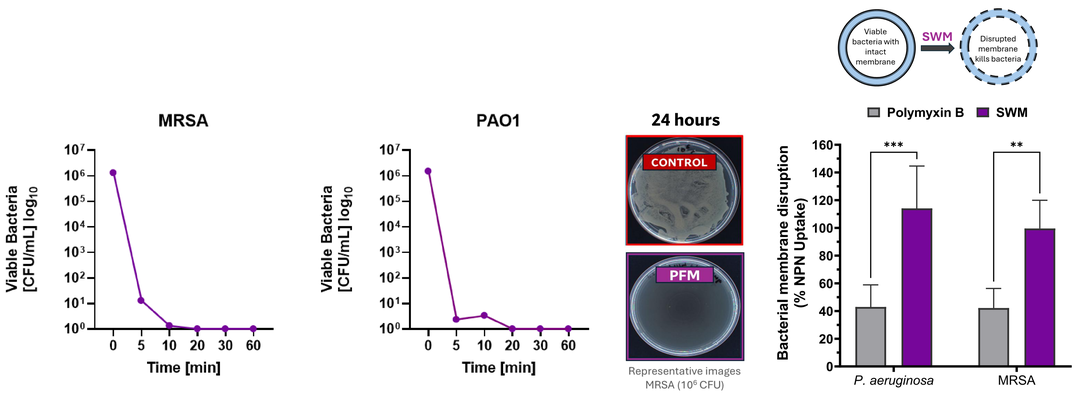
Surgical wound complications, including surgical wound dehiscence (SWD) and surgical site infections (SSIs), represent leading causes of morbidity after surgery[1]. SWD involves the separation of the margins of a closed incision and is often linked to SSIs[2]. Prone to occur in patients with major comorbidities and complications, SSIs are a leading cause of hospital readmissions, with approximately 20-30% due to antibiotic-resistant bacteria[3]. To tackle these challenges, we developed a synthetic peptide-based **surgical wound matrix (SWM)** designed for high-risk surgical wounds, aiming to simultaneously support healing and control bioburden.

Methods

The broad-spectrum antibacterial efficacy of SWM was evaluated in vitro using time-kill assays and membrane permeabilization. Pathogens commonly associated with SSIs were employed to assess SWM's ability to inhibit multispecies biofilms in vitro. SWM wound healing performance was tested in a full-thickness incisional wound swine model infected with Methicillin-resistant Staphylococcus aureus (MRSA). After the bacterial inoculation, the incisions were treated with either SWM or an antibiotic-infused collagen surgical wound product, followed by closure. The wound sites were excised on days 3, 7, and 21 post-incisions for histopathological evaluation.

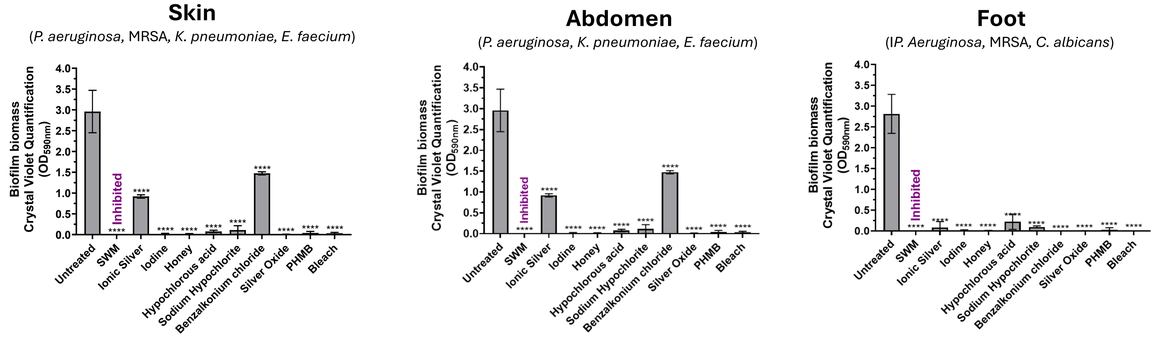
Results

SWM exhibited **rapid and strong bactericidal efficacy** against 6 log10 CFU of PAO1 and MRSA at 5, 10, 15, 30, and 60 minutes, and after 24 hours ($p<0.0001$, n=3). Its efficacy in disrupting bacterial cell membranes was shown to be superior to Polymyxin B.



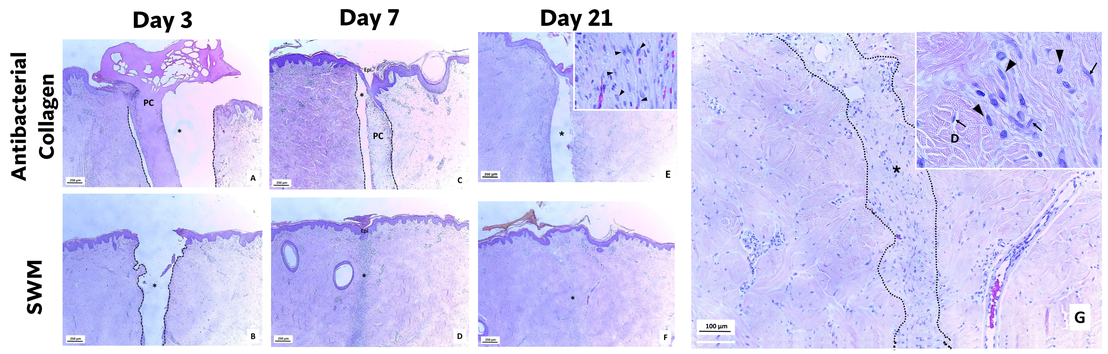
Antibacterial Activity. (Left) Time-Kill assays of MRSA and PA01. (Right) SWM demonstrates increased disruption of bacterial cell membranes compared to the antibiotic drug Polymyxin B. ****p<0.0001, *two-way ANOVA followed by Tukey's multiple comparisons test.*

SWM shows strong inhibition of multispecies biofilm formation (n=3) across skin, abdomen, and foot models when compared to commercially available antimicrobial dressings.



Inhibition of multispecies biofilm. Performance of SWM compared to commercial antimicrobial dressing. **p=0.001 and ***p=0.0008. One-way ANOVA followed by Dunnett's multiple comparison test.

SWM achieved incisional wound healing with full reepithelialization, no signs of infection, and total material resorption with complete tissue apposition by day 7. In contrast, wounds treated with antibacterial collagen showed exuberant incision lines and residual material, resulting in incomplete tissue apposition on day 21. On day 21, wounds treated with SWM remained fully closed, exhibiting complete tissue apposition and minimal inflammation along the incision line (n=5).



Incisional Wound Healing. MRSA-infected wounds treated with SWM show full closure, tissue apposition, and complete resorption by day 7, with increased collagen deposition at the incision site, while wounds treated with antibacterial collagen show the presence of occlusive material and incomplete tissue apposition by day 21. **PC**: positive control, antibacterial collagen. ***incision site; **dotted lines**: incision line; **D**: dermis; **arrows**: fibroblasts; **arrowheads**: macrophages.

Discussion

In vitro, SWM showed **strong antibacterial activity and superior biofilm inhibition** compared to other antimicrobial surgical wound products. In a swine model of infected incisional wounds, **SWM achieved rapid tissue integration, complete tissue apposition, and full re-epithelialization within 7 days,** sustained after 21 days. The data collectively support the SWM potential to improve the healing of surgical incisions and mitigate surgical wound complications. Clinical studies are necessary to validate these findings.

References

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3. Rezaei AR, Zienkiewicz D, Rezaei AR. Surgical site infections: a comprehensive review. J Trauma Inj. 2025 Jun;38(2):71-81.

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