On-demand Dissolution of a Hydrogel Burn Dressing for Facile and Pain-Free Dressing Changes

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Statement of Purpose: Millions suffer from burn-related disabilities and more than 300,000 people die from fire-related burn injuries each year with significant economic, psychological, and emotional consequences. Burn injuries (e.g., caused by fire, chemicals, radiation, electricity,) are among the most difficult to manage.[1,2] Today, second-degree burn wound dressings absorb wound exudate, maintain a moist environment for healing, and reduce bacterial infections, but are surgically or mechanically debrided from the wound, causing additional trauma to the newly formed tissues. In fact, repeated dressing changes cause significant pain. We have designed, prepared, and evaluated an on-demand dissolvable dendritic thioester hydrogel burn dressing for second-degree burns.

Methods: The hydrogel dressing was composed of PEG-based crosslinker and a lysine-based dendron, both of which were synthesized in high yield.[3] The experimental details for the, rheology, ex vivo tissue, and in vivo murine testing were recently published. [3,4]

Results: The hydrogel dressing is elasticity, soft to the touch, and transparent. At frequencies between 0.1 and 10 Hz, the hydrogel dressing exhibited gel character as G' > G". At a frequency of 1 Hz, the G' and G" values for the hydrogel were ~13,000 and 500 Pa, respectively. A rheological time sweep measurement showed that the thioester-containing hydrogel dissolved when exposed to cysteine methyl ester (CME, 0.3 M, pH 8.6) after 30 minutes. When exposed to a solution of lysine methyl ester (LME, 0.3 M, pH 8.5), the mechanical properties of the hydrogel remained unchanged and no hydrogel dissolution was observed. Animal experiments in this study were approved by the Animal Care and Use Committee (IACUC) at Beth Israel Deaconess Medical Center and Boston University. Second-degree burns, covering approximately 5% of total body surface area, were created on 30 adult female Sprague-Dawley rats. The animals were then divided into three groups: 1) burn only (negative controls, n = 10), 2) burn + bacterial contamination (positive controls, n = 10), or 3) burn + hydrogel + bacterial contamination (hydrogel-treated group, n = 10). Bacterial contamination in the positive controls and hydrogel-treated group was achieved by covering the burn and the burn + hydrogel wounds with a gauze containing $2x10^8$ CFU (colony forming units) of log-phase Pseudomonas aeruginosa (Strain PAO1). The rats were euthanized 72 h later, and bacterial counts were taken from the burn wound and from the spleen. The hydrogel prevented local infections (defined as those with >100 CFU/g of tissue) as the results were similar to the negative controls (20 ± 17% v. 0 ± %; P = 0.29), but significantly decreased compared to positive controls (20 ± 17% v. 100 ± 0%; P = 0.001). The hydrogel also prevented detectable systemic infections (sepsis) when compared to positive controls (0 ± 0% v. 60 ± 21%; P = 0.038).

Conclusions: The hydrogel burn dressing covers the wound and acts as a barrier to bacterial infection in an *in vivo* second-degree burn wound model. Importantly, the hydrogel's unique feature to be dissolved on-demand, via a thiol-thioester exchange reaction, allows for facile burn dressing removal.

References:

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