

POSS-KAOLIN HEMOSTAT HISTOCOMPATIBILITY

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ABSTRACT

Background: Uncontrolled hemorrhage remains a leading cause of preventable trauma-related mortality, particularly in cases of non-compressible bleeding where current hemostatic agents have limited efficacy. Polyhedral oligomeric silsesquioxane (POSS) gels, especially when combined with kaolin, offer a potential injectable solution for internal bleeding. However, their biocompatibility and local tissue response remain underexplored.

Methods: Standardized full-thickness dermal wounds were created in a porcine model and treated with POSS, POSS + kaolin, or saline (control). Wound healing and tissue compatibility were assessed by blinded histological scoring of inflammation and epithelialization at day 7. Inter-rater reliability was calculated using Cohen's kappa. Observations of wound bed characteristics were recorded.

Results: Histological analysis showed reduced inflammation and enhanced epithelialization in POSS-treated wounds compared to control, with POSS + kaolin wounds showing slightly higher inflammation. Inter-rater reliability among scorers was high ($\kappa = 0.89$ for inflammation; $\kappa = 1.0$ for epithelialization). Yellow discoloration of the scab was noted in POSS + kaolin wounds, likely reflecting the body's attempt to expel non-resorbable kaolin particles. These findings highlight the importance of evaluating both clotting efficacy and long-term biocompatibility.

Conclusion: POSS + kaolin composites provide effective hemostasis and demonstrate promising tissue compatibility, making them potential candidates for treating non-compressible bleeding. However, the observed foreign body response to kaolin and superficial migration from the wound bed emphasize the need for careful material selection and long-term biocompatibility studies. Future work should explore bioresorbable or modified kaolin alternatives to optimize clotting while minimizing chronic inflammation or material retention.

Keywords: POSS, QuikClot® Kaolin, pathophysiology

INTRODUCTION

Uncontrolled hemorrhage remains one of the leading causes of preventable death following traumatic injury, accounting for approximately 30–40% of all trauma-related fatalities worldwide [1]. Among these, non-compressible hemorrhages, particularly in the torso, junctional regions (groin, axilla, neck), and intracavitary sites, are especially lethal due to the inaccessibility to direct pressure, tourniquets, or rapid surgical intervention [2,3]. In both military and civilian settings, patients often succumb to exsanguination within the first six hours of injury, underscoring the narrow window for effective intervention [4].

Currently available hemostatic agents, such as kaolin-impregnated gauze (e.g., QuikClot®), fibrin sealants, and topical thrombin/collagen patches, are largely designed for external or intraoperative use but often require compression or surgical access to be effective [5,6]. These agents are ineffective in managing non-compressible internal bleeding, where hemorrhage occurs within the body cavity or from deep arterial sources under high shear stress and pulsatile flow [7]. Furthermore, while agents like tranexamic acid