

INJECTABLE POSS-KAOLIN HEMOSTAT FOR ACCELERATED CLOT FORMATION

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ABSTRACT

Background: Uncontrolled hemorrhage is a major cause of preventable trauma-related mortality, particularly in non-compressible injuries where traditional hemostats are less effective. Existing agents such as thrombin patches and kaolin-based gauze have limitations in applicability, cost, and field use.

Objective: To develop and evaluate a novel injectable hemostatic gel combining polyhedral oligomeric silsesquioxane (POSS) with kaolin for enhanced clot formation under physiologic and shear conditions mimicking non-compressible hemorrhage.

Methods: POSS was formulated with and without kaolin and compared against thrombin and QuickClot™ (kaolin-based gauze) using thermogravimetric analysis (TGA), microtiter-based turbidity assays for clot formation, and microscopy for blood-material interactions. Shear stress estimates were calculated based on arterial wound simulations to evaluate the relevance of POSS behavior under flow.

Results: POSS alone demonstrated minimal clotting ability. POSS + kaolin significantly accelerated clot formation (maximum OD 0.516 ± 0.007) and performed comparably to QuickClot™ and thrombin in clot density and formation kinetics. TGA revealed enhanced thermal stability in POSS-kaolin composites, suggesting improved structural integrity. Microscopy revealed POSS induced red blood cell aggregation under low shear, potentially enhancing initial clot anchoring. POSS-kaolin showed surface clot integration, comparable to QuickClot™.

Conclusion: POSS + kaolin is a promising injectable hemostatic agent with effective clot formation properties and thermal stability. The combination leverages the biological inertness and adhesive characteristics of POSS with the procoagulant activity of kaolin, offering potential utility for non-compressible or high-shear vascular injuries.

Keywords: POSS, POSS Kaolin, Polyhedral Oligomeric Silsesquioxane (POSS), injectable hemostat

INTRODUCTION

The urgent need for more effective blood clotting agents in trauma and critical care arises from the high incidence of hemorrhage-related fatalities. Uncontrolled bleeding remains one of the most significant causes of preventable death, accounting for an estimated 30–40% of trauma-related mortality. Notably, the majority of these deaths occur within the first six hours—often before definitive surgical intervention is feasible. Among the most challenging scenarios are non-compressible torso hemorrhages and junctional bleeds, which are difficult to manage in prehospital or austere environments and are associated with high morbidity and mortality rates [1]. In light of these challenges, rapid and effective hemorrhage control strategies are critical for improving survival outcomes, especially in