Injectable Hydrogel Hemostat for Non-Compressible Battlefield Wounds [1]
Internal bleeding is one of the leading causes of death for soldiers with traumatic injuries on the battlefield. Current hemostats (products which stop bleeding) are suitable only for surface wounds, where pressure must be applied, or else pose the risk of releasing clotting factors into the circulatory system. To combat these limitations, researchers have developed an injectable hydrogel composed of gelatin and synthetic silicate nanoparticles capable of rapid and local hemostasis, which is the process by which the body stops bleeding.
Hemostasis is triggered by ruptured blood vessels and is comprised of three phases: vascular, platelet, and coagulation. The vascular phase occurs when the blood vessels constrict to slow bleeding and enable clotting. The platelet phase is initiated when the blood vessel wall cells release a protein called von Willebrand’s factor which cause platelets to stick to the ruptured wall. The stuck platelets release signals to cause further clumping and simultaneously change shape from round to spiny resulting in a collection of stuck platelets called a platelet plug. The coagulation phase begins when a protein called thrombin converts fibrinogen to long strands of fibrin. This fibrin branches out from the platelets and forms a net which catches more platelets and also blood cells, forming a clot which blocks the opening in the blood vessel.

The synthetic silicate nanoparticle used in the hydrogel is a disc 20-30 nm wide and 1 nm thick that degrades naturally into non-toxic components and is cytocompatible, meaning it safely interacts with cells and their contents. The disc shaped particle exhibits a strong negative charge on its top and bottom and a positive charge along the edge, resulting in dynamic forming and breaking. The charge affects the platelet phase of hemostasis by inducing platelets to stick to it and thus generating more clotting factors. It also interacts electrostatically with the gelatin, improving the temperature range at which gel forms and shear thinning, defined as the ability to regain mechanical stiffness after being strained such as squeezing ketchup out of a bottle. Specifically, this reduces the risk of being washed away after injection into the body. These two interactions allow for the gel to be both injectable and a viable hemostat.

The gel is created by mixing exfoliated silicate nanoparticles with a gelatin stock while being vigorously agitated (vortexed). Researchers believe it will take 5-7 years to come to market resulting in pre-filled hydrogel syringes in emergency medical kits. It is also a goal to make the hydrogel ?bioactive? by having it promote the healing process in addition to hemostasis.

References


Author:

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Product Name:

- Nanocomposite Hydrogel Hemostat

Development Stage:

- Scientific

Key Words:

- Nanocomposite
- hydrogel
- Synthetic Silicate Nanoplatelet
- Shear Thinning
- Hemostasis

Mechanism:

- Passive Nanostructure

Summary:

The nanocomposite hydrogel developed in this study is an injectable, mechanically stable (demonstrates shear thinning), rapid, and local hemostat. These qualities are ideal for stopping internal hemorrhaging and are marked improvements over current technologies.

References


Material:
Benefit Summary:

Traditional hemostats are only suitable for surface wounds where pressure must be applied for effectiveness. Gel hemostats consisting of clotting factors solve this issue, but pose a risk of entering the circulatory system. The nanocomposite hydrogel, specifically the synthetic silicate nanoplatelets, solve both of these issues by being injectable and demonstrating shear thinning while simultaneously accelerating hemostasis. The hydrogel was demonstrated to reduce clotting time by up to 77% in vitro. In vivo tests with rats stopped bleeding within a liver and there were no remnants of nanoparticles after a 28 day period.

References


Benefit:

- Health

Risk Summary:

Hydrogels without nanoparticles are already extensively used within the medical field with no known health risks. Synthetic silicate nanoplatelets are shown to degrade into nontoxic components within the body and have demonstrated cytocompatibility with animal cells. The ability to regain mechanical stability after injection mitigates the risk of clotting factors entering the circulatory system. In vivo tests have only been conducted with rats and therefore risks associated with human application are unknown.

References


Risk Characterization:

- Ambiguous[36]

Risk Assessment:

- Health Risks[36]

Facility:

- Health care[37]

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