Eye PATCH (Protection and Treatment for Combat Healing)

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PUBLIC ABSTRACT

Rationale and Objective: Battlefield injuries to the ocular surface caused by particulate matter (i.e., dirt generated by explosions) are very common and cause immediate, and usually excruciating, pain since the cornea is the most sensitive and highly innervated structure in the human body. Disruption in the front surface of the cornea can cause loss of vision lasting several days, limiting a soldier's functionality. Many injuries affecting only the ocular surface eventually heal without permanent loss of vision; however, there is significant risk of secondary infection and corneal scarring. Efforts to prevent battlefield ocular injury via use of eye protection have not been successful. Therefore, primary management of ocular injury remains of crucial importance. Thus, there is significant need for a battlefield "ocular bandage" to treat painful corneal abrasions and an ocular adhesive to quickly seal lacerations that would otherwise expose inner segments of the eye to infections.

The cornea is the outermost segment of the eye and therefore most likely to suffer battlefield trauma. Few corneal prosthetic devices exist and regenerative medicine strategies are significantly lacking. Extensive battlefield injuries may leave some parts of the cornea intact or its repair capacity preserved. Also, limbal stem cells may be available for transplantation from the other (sometimes uninjured) eye, providing a cell source for regeneration. Therefore, a biomaterial that can repair multiple layers of the cornea, treat corneal scarring, or repair full thickness injuries would be a significant advance in restoring native tissue architecture and function.

Penetrating ocular injury on the battlefield usually results from high velocity particles due to the fragmentary nature of modern weaponry. Definitive repair (i.e., suturing) of such injuries requires surgery by a trained ophthalmologist, using highly specialized microscopes and microsurgical equipment. However, there is often significant time that separates the injury from the definitive repair. Penetrating wounds that are not closed promptly are at much greater risk for severe infection and further disruption of important ocular structures (e.g., the retina). Furthermore, sutures can cause astigmatism and must be removed after the wound is sealed so even when a hospital is accessible, this is not always an ideal solution. Therefore, the ability to close a penetrating ocular wound on the battlefield without surgery soon after injury occurs would be a significant advance in treatment. An ocular adhesive could be used to stabilize wounds, promote wound healing, and prevent infections, thus improving a soldier's quality of life following this type of ocular injury.

Ultimate Applicability of the Research: Ocular injuries are prevalent among deployed soldiers due to the sporadic use of eye protection, the fragmentary nature of weaponry, and the presence of particulates from dirt, explosives, etc. Advancements in primary management of ocular trauma will be applicable to a large population of soldiers and can be extended to other professions (e.g., construction workers, miners) where eye injuries may be common and expert care inaccessible. Preliminary results have shown biocompatibility and enhanced wound healing in injured rabbit corneas upon application of a vitrified collagen membrane and/or ocular adhesive. These will be refined and optimized under the DRMRP to achieve sufficient mechanical and optical properties and incorporate antibiotics. It is expected that these ocular injury solutions will progress to clinical trials upon completion of the DRMRP, and transitioned to deployment 2 to 5 years after beginning clinical trials.

The envisioned bioengineered ocular bandage will be a "ready-to-apply" field product that can be placed directly on the ocular surface by a non-expert provider to treat abrasions or corneal damage due to chemical exposure. The bioengineered membranes...
are expected to enhance ocular surface wound healing and will have the capability to deliver ocular antibiotic and analgesia in a controlled, sustained fashion. Application of a thicker, stronger biosynthetic membrane in a military hospital setting would replace the need for donor tissue and would support and guide corneal and scleral repair. This would be a significant advance in restoring native tissue architecture and function without risk of host rejection or infection and can be used to repair multiple layers of the cornea, treat corneal scarring, or even repair full thickness injuries.

An ocular adhesive designed specifically for battlefield stabilization and initial treatment of penetrating eye injuries via application by a non-expert provider will provide the ability to immediately seal penetrating wounds without sutures, while simultaneously enhancing tissue repair and preventing infection via delivery of antibiotics. The expected developments in primary management and subsequent reconstruction of battlefield ocular trauma as a result of the proposed research have the potential to improve the standard and ease of care of these injuries as well as significantly reduce vision complications arising from secondary infection.