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Short Communication

Diversity of Immune Cells in the Cornea and their Functions

Setia Han*

Department of Ophthalmology, University of Alberta, Edmonton, Canada

DESCRIPTION

The cornea is the part of an eye and it plays an important role in the vision of living being. While its primary function is to refract light, the cornea also plays a vital role in immune defense, acting as a barrier against pathogens and other foreign substances. Resident immune cells within the cornea contribute significantly to its homeostasis and health, maintaining a delicate balance between immune tolerance and responsiveness.

The cornea consists of several layers, each with distinct cellular compositions and functions. The epithelium, the outermost layer, provides a protective barrier, while the stroma, comprising collagen fibers and keratocytes, contributes to the cornea's structural integrity. The endothelium, the innermost layer, regulates fluid balance and maintains corneal transparency [1-4].

Dendritic cells are specialized antigen-presenting cells that serve as sentinels of the immune system. They are distributed throughout the corneal epithelium and play a vital role in immune surveillance. Dendritic cells continuously sample the environment for potential threats, such as pathogens or damaged tissues. When dendritic cells encounter foreign antigens, they undergo maturation and migrate to the regional lymph nodes. Here, they present the processed antigens to check T cells, initiating an adaptive immune response. This process is essential for mounting an effective defense against ocular infections. Interestingly, dendritic cells in the cornea also contribute to immune tolerance. Under non-inflammatory conditions, they can promote the differentiation of regulatory T cells (Tregs), which help to suppress excessive immune responses. This balance is vital to prevent unwanted inflammation and tissue damage in the cornea.

Macrophages are another important component of the resident immune landscape of the cornea. They can be found in both the epithelium and the stroma, where they perform various functions. Macrophages are efficient phagocytes, capable of engulfing and digesting pathogens, debris and apoptotic cells. This process helps to maintain a healthy corneal microenvironment by clearing potential sources of inflammation. Upon activation, macrophages release a range of cytokines and chemokines that can either promote inflammation or contribute to tissue repair. Depending on the context, macrophages can polarize into pro-inflammatory (M1) or anti-inflammatory (M2) phenotypes. M1 macrophages typically respond to infections, while M2 macrophages are involved in tissue repair and regeneration. Macrophages also interact with other immune cells in the cornea, providing signals that can influence dendritic cell function and T cell responses. This intercellular communication helps coordinate the overall immune response in the cornea [5-7].

Mast cells are tissue-resident immune cells that play essential roles in maintaining homeostasis and responding to injury or infection in the cornea. Mast cells are well known for their role in allergic reactions. When activated, they release histamine and other mediators, which can lead to vasodilation and increased vascular permeability. While this response can be beneficial in clearing infections, excessive activation may contribute to allergic conjunctivitis and other ocular surface diseases. Mast cells are also involved in the wound healing process. They release growth factors and cytokines that facilitate tissue repair, promoting the proliferation and migration of epithelial cells following corneal injury. Mast cells interact with dendritic cells, macrophages and T cells, further shaping the immune environment of the cornea. They can influence the balance between tolerance and immune activation, playing a role in both protective and pathological processes [8-10].

Although the cornea is primarily populated by resident innate immune cells, T cells can also be found in the cornea, particularly during inflammatory conditions. As mentioned earlier, dendritic cells can induce the differentiation of regulatory T cells, which help maintain corneal immune tolerance. These Tregs are essential for preventing excessive immune responses that could damage the cornea. In the case of viral infections, such as Herpes Simplex Virus (HSV), cytotoxic T cells can infiltrate the cornea to eliminate infected cells. This response is critical for controlling viral replication but can lead to corneal scarring and vision loss if not properly regulated.

Correspondence to: Setia Han, Department of Ophthalmology, University of Alberta, Edmonton, Canada, E-mail: setia@han.cn

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Some T cells can become memory cells after an initial immune response. These cells reside in the cornea and can quickly respond to re-infections, providing an adaptive immune defense.

CONCLUSION

The cornea is not merely a passive barrier; it is an active participant in immune responses, shaped by a variety of resident immune cells. Dendritic cells, macrophages, mast cells, T cells and innate lymphoid cells collectively form a dynamic cellular landscape that maintains corneal health while providing defense against potential threats. The delicate balance between tolerance and immune activation is essential for preserving corneal transparency and function. As research continues to unravel the complexities of corneal immunity, it may pave the way for novel therapeutic strategies aimed at managing corneal diseases and enhancing ocular health. Understanding the roles of resident immune cells in the cornea is vital for advancing treatments and improving patient outcomes in ophthalmology.

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