



Review Article

Unraveling The Impact: Mast Cells In Oral Pathology

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Abstract

Mast cells play a crucial role in the immune response, particularly in allergic reactions and inflammatory processes. In the context of oral diseases, mast cells have been implicated in various pathological conditions, including gingivitis, periodontitis, oral lichen planus, and oral cancer. This comprehensive review aims to explore the role of mast cells in the pathogenesis of these oral diseases, focusing on their activation, degranulation, and subsequent release of mediators such as histamine, cytokines, and growth factors. Furthermore, this review discusses the interaction between mast cells and other immune cells, as well as their involvement in angiogenesis, tissue remodelling, and pain modulation in the oral cavity. A thorough understanding of the role of mast cells in oral diseases may pave the way for the development of novel therapeutic strategies targeting mast cell activation and function, ultimately improving the management of these conditions.

Keywords: allergy, cytokines, pulpitis, fibrosis, mast cells

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INTRODUCTION

Mast cells are crucial components of the immune system, distributed widely in various tissues[1]. They play essential roles in immune responses against pathogens and in maintaining tissue homeostasis[2]. Originating from the extraembryonic yolk sac during early development, mast cells later derive from bone marrow hematopoietic stem cells[3][4]. These cells are involved in allergic reactions, anaphylaxis, and atopic diseases, but also contribute to normal tissue functioning through interactions with nerves[5]. Mast cells can influence tumor biology by modulating cell proliferation, angiogenesis, invasiveness, and metastasis. Their responses during tumorigenesis are complex, with the ability to both promote and inhibit tumor growth through the secretion of various factors. Understanding mast cell biology is crucial for developing therapies targeting their pathological conditions.

Mast cells can indeed be stimulated to degranulate through various mechanisms. Direct injury, such as physical or chemical damage caused by substances like opioids, alcohols, and specific antibiotics like polymyxins, can trigger mast cell degranulation[6][7]. Additionally, cross-linking of Immunoglobulin E (IgE) receptors is another pathway for inducing mast cell degranulation, as seen in allergic responses[8][9]. Moreover, the activation of complement proteins can also lead to mast cell degranulation, showcasing the diverse triggers for this process[10]. These different stimuli highlight the versatility of mast cells in responding to various signals, whether through direct injury, IgE receptor cross-linking, or complement protein activation, ultimately contributing to inflammatory responses and allergic reactions.

DEVELOPMENT OF MAST CELLS:

Mast cells originate from hematopoietic stem cells (HSCs)[11]. Mast cell-committed progenitors (MCPs) leave hematopoietic tissues, migrate, proliferate, and differentiate into mast cells, with their phenotype determined by the site of lodgement[12]. Mast cell development requires the KIT ligand and the KIT receptor tyrosine kinase, expressed throughout their developmental process. In humans, mast cells originate from CD34-positive progenitor cells in the bone marrow, with proliferation dependent on IL-3. Mast cells can persist in culture due to factors from fibroblasts, and their final phenotype is influenced by the local tissue environment[13]. Mast cells possess the unique ability to proliferate even after maturation and degranulation, aiding in their functional restoration. Understanding mast cell development is crucial due to their involvement in various disease processes, highlighting the potential for targeted interventions in treatment.

MAST CELLS IN ORAL TISSUES:

Mast cells are indeed present in oral mucosa and dental pulp, particularly in response to various conditions. In healthy dental pulp, mast cells are not typically found, but inflammation triggers their occurrence[14]. Reactive lesions in the oral mucosa, such as pyogenic granulomas and irritational fibromas, exhibit increased mast cell counts compared to normal gingiva, indicating their involvement in the microenvironment modification of these lesions[15]. Furthermore, recent studies suggest that burning mouth syndrome does not significantly alter the density of mast cells in the oral mucosa[16]. Overall, mast cells play crucial roles in oral health and disease, influencing inflammation, fibrosis, and angiogenesis in various conditions.

ROLE OF MAST CELLS IN DISEASES:**A) PULPITIS:**

Mast cells play a crucial role in pulpitis by contributing to the inflammatory process in dental pulp tissues. Mast cells are involved in the release of pro-inflammatory cytokines like tumor necrosis factor-alpha (TNF- α), which promote leukocyte infiltration and induce endothelial-leukocyte adhesion molecules, exacerbating inflammation[17][18]. Immunohistochemical analysis has shown an increased number of mast cells in inflamed pulp compared to noninflamed pulp, making them a potential diagnostic marker for pulp inflammation[19]. Additionally, mast cell stabilizers and antihistaminic agents could be utilized to manage pulpal pain and inflammation by targeting mast cell functions. Overall, mast cells' presence and activity in pulpitis highlight their significance in the immune response regulation network within dental pulp tissues.

B) PERIAPICAL INFECTION & GINGIVITIS:

Mast cells are a vital component of the immune system and play a crucial role in the inflammatory response to periapical infections, gingivitis, and granulomas. In periapical lesions, mast cells are involved in the regulation of the inflammatory micro-environment, which helps to control the progression of periapical granulomas and radicular cysts. Interestingly, mast cells are found in higher numbers in radicular cysts than in periapical granulomas, suggesting that they may play a more significant role in the development of radicular cysts. Mast cells are also implicated in the pathogenesis of gingivitis, where they serve to regulate the inflammatory response in gingival lesions. Studies have shown that the number of mast cells present in gingival tissues is inversely proportional to the severity of inflammation, indicating that mast cells may have a protective role in preventing tissue damage in gingivitis. In addition to their role in periapical infections and gingivitis, mast cells are also linked to the pathogenesis of periodontal diseases[20]. Inflammatory cytokines activate mast cells, leading to the release of histamine and other pro-inflammatory mediators, which contribute to local inflammation in the gingiva, culminating in tissue damage. Overall, mast cells are key players in the immune response and inflammation associated with periapical infections, gingivitis, and granulomas. Further research into the role of mast cells in the pathogenesis of these diseases may lead to new approaches to the diagnosis and treatment of these conditions.

C) ORAL CANCER:

Mast cells, a type of white blood cells, have been identified as significant players in the development and progression of oral tumors, specifically oral squamous cell carcinoma (OSCC) and head and neck squamous cell carcinoma (HNSCC). Research studies have found that the density of mast cells (MCD) increases significantly from normal oral mucosa to malignant lesions, indicating a potential correlation with tumor progression and prognosis[21]. The influence of mast cells on tumor cell proliferation and invasion rates has been established in OSCC, with CC chemokine ligand 2 (CCL2) identified as a possible mediator of this interaction. The presence of mast cells has also been associated with inflammation, which is a common initial pathogenic state in OSCC and oral potentially malignant disorders (OPMDs)[22]. Furthermore, mast cells expressing specific proteases like tryptase and chymase have been linked to tumor progression, angiogenesis (the formation of new blood vessels), and lymphangiogenesis (the formation of new lymphatic vessels) in OSCC, affecting clinicopathological characteristics and the activation of oncogenic genes like MIA and MIA2. Taken together, these findings suggest that mast cells play a significant role in the development and progression of oral tumors, and could potentially serve as a target for therapeutic interventions in OSCC and HNSCC.

CONCLUSION

The pathogenesis of oral diseases is significantly influenced by mast cells, which play a crucial role through their activation and release of inflammatory mediators. Their multifaceted involvement in angiogenesis, tissue remodeling, and pain modulation, as well as their interaction with other immune cells, highlights their significance in oral health and disease. The development of novel therapeutic strategies for oral diseases could benefit from the targeting of mast cells and their mediators. However, a more thorough investigation of the mechanisms underlying mast cell involvement in oral diseases is required to identify specific targets for therapeutic intervention. Moreover, the complex interplay between mast cells and other immune cells in the oral microenvironment necessitates careful consideration in the development of targeted therapies. Understanding the role of mast cells in oral diseases has the potential to significantly impact the management and treatment of these conditions, leading to improved outcomes for patients. Additional research is needed to fully comprehend the intricacies of mast cell involvement in oral diseases and to develop effective and targeted therapies.

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There are no conflicts of interest

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