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Analysis of Existing Treatment Methods for Cat Hair Allergy

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Abstract: Cat hair allergy is a common allergic reaction caused by Fel d 1, an allergen which can be found in the drooling, skin and sebaceous glands of cats. When allergic individuals inhale or come into contact with the protein, it triggers an immune system response that results in allergic reactions ranging from mild discomfort to severe respiratory symptoms. This paper explores three advanced approaches to address cat hair allergy, including analysis of the immunological role of Fel d 1, genetic engineering in order to reduce the production of the allergen in cats, and the application of monoclonal antibodies to neutralize Fel d 1. Immunotherapy is still the traditional treatment for desensitization, whereas genetically modifying cats through CRISPR technology can effectively reduce or eliminate the production of Fel d 1, thus providing a long-term solution to the allergy problem. Monoclonal antibodies like Omalizumab, as well as a number of antibody therapies specifically for humans, offer innovative solutions to alleviate allergy symptoms. While these treatments have great potential, they still face challenges, such as accessibility, cost and long-term effectiveness. More research is needed in the future to ensure the safety and efficacy of these approaches. With advances in treatment technology, it is expected that better solutions will be implemented to improve the well-being of allergy sufferers as well as make the human-cat relationship more harmonious.

Keywords: Fel d 1, Immunotherapy, Genetic modification, Monoclonal antibodies, Antigen

1. Introduction

All over the world, countless people deal with allergies, ranging from the ordinary to the extremely rare. Some are allergic to peanuts, others to eggs, and in rare cases, even water can trigger a reaction. For many, allergies can be a constant challenge in daily life. For many people around the world, cats are the ideal companions to have at home. They offer not only companionship but also emotional support, providing comfort to their owners during moments of sadness or stress. Their playful and affectionate nature can bring joy, while their independent temperament makes them low-maintenance pets compared to some other animals. Additionally, their soothing purring has been shown to have a calming effect, further strengthening the bond between cats and their owners. Despite these benefits, domestic cats are one of the most widespread sources of allergens, affecting a large number of people worldwide. Indeed, approximately 10% to 20% of global population are allergic to cats and dogs [1].

Fel d 1 is the primary allergen responsible for the cat hair allergy, which is responsible for up to 96% of human allergic reaction to cats and contributing to 60%-90% of the overall allergic properties of cats and their dander [2]. Fel d 1 is a secretoglobin which is produced in all cats no matter what the breed, age, sex, hair length, and housing are [2]. Fel d 1 is mainly secreted by a cat's salivary and

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sebaceous glands, with smaller portion coming from the lacrimal and anal glands. When cats groom themselves, the protein spreads across their fur and is then released into the environment through their hair and dander. Although the precise biological function of Fel d 1 in cats remains unclear, it's been suggested that it might function as a pheromone or play a role in chemical signaling [2]. This allergy, led by Fel d 1 significantly impacts the quality of life for many individuals, as it can cause discomfort and health issues, such as sneezing, itching, and difficulty breathing. It also limits human-cat interactions, making it challenging for those affected to enjoy the companionship and emotional support that cats typically provide.

With the advancement of technology, different types of treatments can be used for cat hair allergies, helping people manage their symptoms and enjoy their time with cats more comfortably. In detail, current treatments for cat hair allergies mainly involve antihistamines, corticosteroids, and immunotherapy. Antihistamines are medications that block histamine, a chemical released by cells when the body detects an invasion, like bacteria, viruses, or allergens (such as dust). These drugs work by competing with histamine for binding to receptors on cells, which helps reduce allergy symptoms. Corticosteroids, especially glucocorticoids, help treat cat hair allergies by reducing inflammation and controlling the immune system's response. These drugs work by attaching to receptors in the body, which changes gene activity to decrease substances that cause inflammation and increase those that reduce it. This process lowers the production of cells and proteins responsible for allergic reactions, like mast cells and cytokines, helping to lessen allergy symptoms. Immunotherapy is a sustained therapeutic approach designed to diminish or prevent allergic reactions by gradually desensitizing the immune system to specific allergens. Over time, it modulates the immune response, reducing hypersensitivity to substances such as pollen or pet dander. Immunotherapy can help reduce, or even get rid of, cat allergy symptoms by training the immune system to tolerate cat allergens. This treatment gives cat owners the chance to be around their pets without suffering from allergic reactions, improving their overall quality of life. Although these treatments are designed to relive symptoms and elevatechang the quality of life for those affected, their effectiveness and limitations can vary. To this end, the effectiveness and limitations of the existing methods need to be further analyzed.

This paper will focus on recent advancements in the development of vaccines for cat hair allergies. Key areas of research include Fel d 1 immunotherapy, which works to adjust the immune response to the primary allergen, and genetic modifications to reduce or even stop the production of Fel d 1 in cats. Another promising avenue is the use of monoclonal antibodies to target and neutralize Fel d 1 in the human immune system. This paper will explore how these new approaches could provide a long-term solution for managing cat allergies, potentially reducing or eliminating the reliance on traditional treatments.

2. Analysis of treatment methods

2.1. Fel d 1 immunotherapy

Before diving any deeper into the treatments of cat hair allergies, it is crucial to understand what a Fel d 1 is, and its impact on individuals. As the main allergen in the allergy, it is presented in the oral secretion, skin and dander of the cat and is the protein that initiate the allergy. The structure and biochemical properties of it play a significant role in how it affects individuals that are sensitive to cats.

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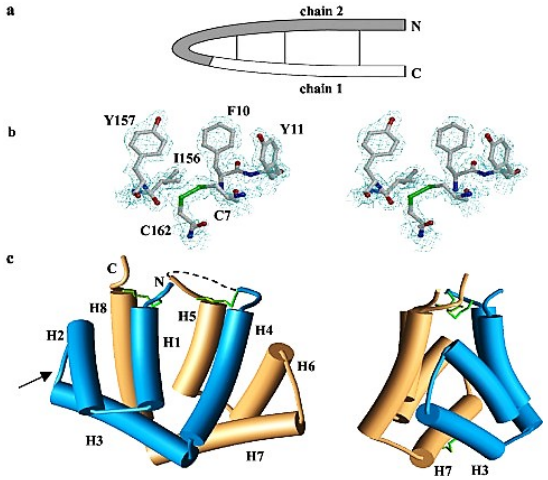

Figure 1: The overall structure of Fel d 1 [3].

As illustrated in Figure 1, Fel d 1 that made up of two protein chains Fel d 1-A (CH1) and Fel d 1-B (CH2) has a helix-shaped structure with eight helices. Although the sequences of the two halves are different, the shapes are near-identical. The configuration of Fel d 1 closely resembles uteroglobin which is a protein with anti-inflammatory properties. With these structures, Fe l d 1 express biochemical properties that helps itself spread in the environment, affecting those sensitive to cats, such as stability, allergenicity and so on [3]. As cats groom, they spread the allergen onto their fur. When the fur sheds and dries, Fel d 1 is released into the air, where it can be easily inhaled by those who are sensitive. During this process, its disulfide bonds play a key role in stabilizing the protein, ensuring its structural integrity is preserved across various environmental conditions [3]. The allergen's unique structural traits, for instance, its helix-shaped structure and glycosylation patterns, allows it to be a powerful allergen and identifies by human IgE antibodies, provoking an allergic response [3].

The allergic reaction of an individual starts as Fel d 1 come in to contact with the body, where the allergen is treated by immune cells and show to T cells. This triggers an immune response, resulting in the formation of Fel d 1-specific antibodies. During this process, a strong reaction of TH2 cells to help B cells generate IgE is involved. After sensitization, B cells produce antigen-specific IgE antibodies which circulates through the blood. These antibodies are attached to IgE receptors on mast cells and basophils in order to prepare them to activate relating cells when they come into contact with allergens again [4]. Even a low concentration of Fel d 1-specific IgE (15-30 kU/l) is enough to sensitize these cells [4]. The combination of IgE and Fell d 1 is incredibly specific, focusing on particular epitopes on the allergen's surface. Aallergens with varying properties can target distinct epitopes, making allergic reactions more complex. In addition, researchers found compounds containing Fel d 1 and IgE in the plasma of individuals allergic to cats, providing an explicit testimony of this interaction. The crosslinking of Fel d 1 and the IgE receptor on the mast cells and basophils sparks a signaling progression, causing the phosphorylation of various kinases, such as Syk, Lyn, and p38 MAPK. Subsequent to activation, mast cells and basophils release their stored mediators. These mediators stimulate the preliminary phase of allergic response, characterized by amplified permeability of blood vessels, smooth muscle tightening, as well as excessive mucus production, resulting in sneezing, rhinorrhea, and itching. Along with the early-phase response, primed immune cells yield cytokines and chemokines that regulate the late-phase allergic reaction. These inflammatory mediators attract and activate more immune cells, sustaining and intensifying the allergic inflammation.

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Current approaches to allergy management primarily focus on minimizing exposure to Fel d 1, alleviating symptoms, and modifying the immune response through various treatment options. Immunotherapy, which is also known as the allergy shot, remains the most common treatment for cat hair allergy in the United States [5]. The treatment starts with a low dose and gradually increases over time until maintenance level is reach so that the immune system can be effectively desensitized [5]. Sophisticated immunological changes are included in the mechanism behind the allergy shot. When patients are exposed to cat allergens in a controlled manner, their immune system gradually transitions from producing allergy-inducing antibodies (IgE) to producing protective antibodies such as IgG and IgA [6]. This regulation of the immune system can minimize allergic reactions in natural contact with cats. However, it necessitates prolonged treatment, generally requires three to five years to get an ideal result.

2.2. Genetic modification

Genetically modified cats are a potential method of treating cat allergies, which aims to target and reduce the generation of Fel d 1. The reason why Fel d 1 is the targeting molecule is that it is the main allergen that causes human allergic reactions and is not essential for cats [7]. CRISPR-Cas9 technology has shown great potential in accurately targeting and modifying the allergen gene. The analysis of the Fel d 1 sequence along with structure of 50 cats revealed the conservative coding areas in the CH1 and CH2 genes, making them suitable for CRISPR-based editing [8]. The allergen gene of editing cats using this technology has resulted in up to 55% successful editing. The researchers found no signals of unexpected editing of possible non-target sites, making these areas ideal targets for gene deletion or modification, minimizing the risk of non-target effects [8]. This accuracy is crucial to ensure that only the targeted genes are modified while maintaining the overall health of genetically modified cats. Current research has gone beyond ex vivo research, successfully utilizing the CRISPR-Cas9 system for modifying the Fel d 1 CH2, hence creating a genome-edited cat triumphantly. Notwithstanding the final results are still being gathering, the application of CRISPR to live cats marks a major milestone. Preliminary findings indicate that cats with edited CH2 genes are still healthy, marking that Fel d 1 may not be necessary for its biological function [7]. This method inhibited the production of Fel d 1, thereby reducing its spread into the environment and triggering allergies.

2.3. Monoclonal antibodies

Monoclonal antibody therapy presents an innovative way to control cat hair allergies by directly targeting and deactivating Fel d 1. Monoclonal antibody therapy for cat hair allergy uses laboratory-synthesized antibodies to identify and inactivate specific allergens, thus reducing allergic reactions. One method is to combine traditional allergy shot with monoclonal antibody Tezepelumab. Tezepelumab inhibits thymus matrix lymphocytopie (TSLP), which is a molecule that initiates excessive immune response when encountering allergens like cat dandruff. This combination therapy can not only relieve symptoms faster and more effectively, but also its effect can last even after ethe treatment. Another current monoclonal treatment is the Omalizumab which is a human-adapted antibody that targets circulating IgE antibodies, blocking their attachment to high-affinity receptors on mast cells and basophils. This mechanism disrupts allergic reactions at an early stage and alleviates various allergic symptoms [9]. Though it was originally endorsed for the treatment of allergic asthma and chronic urticaria, clinical studies have demonstrated that it also has a potential therapeutic effect on cat hair allergies [9]. A case report emphasized that in a 42 years old male patient, the combination of omalizumab and subcutaneous allergen immunotherapy effectively cured cat-related allergy rhinitis, conjunctivitis and intermittent asthma. This combined treatment resulted in symptom control

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in six months and no recurrence was observed during a three-year follow-up period [9]. Omalizumab is recently being investigated in the OUtMATCH trial, which focus on numerous food allergies, and its findings could offer insights into managing multiple allergic reaction, including sensitivities to animal dander. Despite the fact that monoclonal antibody therapy has showcased great potential in mitigating cat hair allergy, more research and clinical trials are still needed to ensure its ongoing impact and availability for allergic patients.

3. Conclusion

In a nutshell, although countless people around the globe suffer from cat hair allergies, advances in modern technology offer promising solutions. Therapies such as immunotherapy, genetic modification of cats and monoclonal antibodies offer significant opportunities to minimize or even eliminate allergic reactions, allowing people to spend their leisure time in the company of cats. However, there are limitations to these treatments, including accessibility, cost, ethical issues, and uncertainty about long-term efficacy. Immunotherapy, a traditional method, has achieved positive results in some cases by gradually making patients tolerant to Fel d 1. However, this approach requires long-term treatment with large individual differences and the effects are not permanent. Genetic modification technologies, such as CRISPR, offer a possible long-term solution for cutting down on the production of Fel d 1 in cats, but it faces technical limitations and ethical controversies, especially when the long-term effects of gene editing on cat health remain unclear. Monoclonal antibody therapies, such as Omalizumab and Fel d 1-neutralizing antibodies against humans, offer an innovative means of providing rapid relief of allergy symptoms, but further research is needed to investigate their long-term safety and efficacy. Overall, while these approaches show great potential for reducing cat hair allergy, there is not yet a completely ideal solution. In the future, more research and technological breakthroughs are needed to develop safer, more effective and easily accessible treatments that will allow allergy sufferers to live more freely with cats, while promoting a closer bond between humans and animals.

References

[1] *Nicole Cosgrove. 2025 January 7. How many people are allergic to pets?. https://www.dogster.com/statistics/pet-allergy-statistics*

[2] *Satyaraj, E., Wedner, H. J., & Bousquet, J. (2019). Keep the cat, change the care pathway: a transformational approach to managing Fel d 1, the major cat allergen. allergy, 74, 5-17.*

[3] *Kaiser, L., Gronlund, H., Sandalova, T., Ljunggren, H. G., van Hage-Hamsten, M., Achour, A., & Schneider, G. (2003). The crystal structure of the major cat allergen Fel d 1, a member of the secretoglobin family. Journal of Biological Chemistry, 278(39), 37730-37735.*

[4] *Pena-Castellanos, G., Smith, B. R., Pomés, A., Smith, S. A., Stigler, M. A., Widauer, H. L., ... & Aglas, L. (2023). Biological activity of human IgE monoclonal antibodies targeting Der p 2, Fel d 1, Ara h 2 in basophil mediator release assays. Frontiers in immunology, 14, 1155613.*

[5] *Jernigan, J. E., Staley, H. A., Baty, Z., Bolen, M. L., Gomes, B. N., Holt, J., ... & Tansey, M. G. (2025). RGS10 attenuates systemic immune dysregulation induced by chronic inflammatory stress. Journal of Neuroinflammation, 22 (1), 49.*

[6] *Leonard, C., Montamat, G., Davril, C., Domingues, O., Hunewald, O., Revets, D., ... & Ollert, M. (2021). Comprehensive mapping of immune tolerance yields a regulatory TNF receptor 2 signature in a murine model of successful Fel d 1-specific immunotherapy using high-dose CpG adjuvant. Allergy, 76(7), 2153-2165.*

[7] *Cleveland III, C. W., Davis, B. W., Khatri, K., Pomés, A., Chapman, M. D., & Brackett, N. F. (2024). Genetic diversity of the major cat allergen, Fel d 1. PNAS nexus, 3(11), pgae447.*

[8] *Brackett, N. F., Davis, B. W., Adli, M., Pomés, A., & Chapman, M. D. (2022). Evolutionary biology and gene editing of cat allergen, Fel d 1. The CRISPR Journal, 5(2), 213-223.*

[9] *Kathuria, P. C. & Rai, M. (2021) Efficacy of Combined Omalizumab with Cat allergen Immunotherapy in Cat induced Allergic Rhino-conjunctivitis & intermittent Asthma-Case Report. Arch Surg Clin Case Rep, 4, 159.*