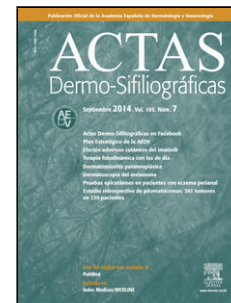# Journal Pre-proof

Nuevas fronteras en el tratamiento de la dermatitis de contacto alérgica: el rol de las terapias emergentes

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Revisión

Nuevas fronteras en el tratamiento de la dermatitis de contacto alérgica: el rol de las terapias emergentes

[[Translated article]]Exploring New Horizons In Allergic Contact Dermatitis Treatment: The Role of Emerging Therapies

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Resumen

La naturaleza resistente y recalcitrante de la dermatitis de contacto alérgica (DCA) grave hace que su tratamiento sea desafiante. Con los avances en la comprensión de la patogénesis celular y molecular de esta dermatosis, están surgiendo nuevas opciones terapéuticas. En particular, el uso de fármacos biológicos como dupilumab e inhibidores de moléculas pequeñas (como los inhibidores de JAK) han cobrado impulso, dada la inhibición transversal de las acciones de múltiples citoquinas. Este artículo tiene como objetivo revisar los datos disponibles actuales sobre el uso de fármacos biológicos y fármacos inhibidores de moléculas pequeñas en la DCA. Los resultados sugieren que los iJAK, como abrocitinib, tofacitinib, upadacitinib y baricitinib; y los fármacos biológicos, como dupilumab, muestran promesas significativas en la DCA refractaria, aunque se necesitan más ensayos clínicos a largo plazo para confirmar su eficacia y seguridad.

Palabras clave: dermatitis de contacto alérgica, nuevas terapias, inhibidores de JAK, fármacos biológicos

Abstract

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The resistant and recalcitrant nature of severe allergic contact dermatitis (ACD) makes treatment challenging. With advances in the understanding of the cellular and molecular pathogenesis of this dermatosis, new therapeutic options are emerging. In particular, the use of biologic drugs such as dupilumab and small molecule inhibitors, such as JAK inhibitors have gained momentum given the cross-cutting inhibition of multiple cytokine actions. This article aims to review the current available data on the use of biologic drugs and small molecule inhibitor drugs in the management of ACD. Results suggest that iJAKs, such as abrocitinib, tofacitinib, upadacitinib, and baricitinib; although biologic drugs, such as dupilumab show significant promise in refractory ACD, more long-term clinical trials are needed to confirm their safety and efficacy profile.

Keywords: allergic contact dermatitis, new therapies, JAK inhibitors, biologic drugs

Introduction

Contact dermatitis accounts for an estimated 4 to 7% of dermatological consultations[1]. The prevalence of allergic contact dermatitis (ACD) is unknown, although some studies have estimated it to be between 1.7% and 9.8%[2], with occupational ACD being particularly significant[3]. ACD presents with different clinical patterns depending on the affected area. Recognizing these patterns can not only aid physicians in diagnosis but also suggest potential allergens and forms of contact[4]. The gold standard for investigating these patients remains patch testing, with a relevant positivity rate between 15% and 20.1% of patched patients[5]. All patients should be tested with the national standard series[6], their own products[7], and, depending on the case characteristics and exposure sources, additional commercially available specific series. Identifying the responsible allergens and avoiding them is not always sufficient to resolve the problem, requiring the prescription of topical and/or systemic immunosuppressive treatment in refractory cases. The lack of response to allergen avoidance and the limitations of traditional treatments highlight the need for new therapies[8]. Recent research into small molecule inhibitors and biological drugs offers new hope, especially for those who do not respond to conventional approaches.

In the routine clinical practice, it may not be possible to perform patch testing after suspending immunosuppressive medication, which increases the risk of false negatives[9]. Patients with polysensitization (3 or more allergens) on patch tests are a difficult-to-manage group, with an increased risk of refractoriness after attempting avoidance[10].

In recent years, there has been progress in understanding the pathophysiology of ACD and the different groups of allergens[11]. This information provides an opportunity to consider advanced targeted treatments, off-label, for the control of ACD refractory to the avoidance of identified allergens. During the initial phase of the type IV hypersensitivity process, the innate immune system actively participates after the formation of the antigenic complex, inducing the release of cytokines such as IL-1α, IL-1β, TNF-α, IL-8, IL-18, and granulocyte-macrophage colony-stimulating factor[12]. Prior to the sensitization phase, the antigen-

presenting cell captures the hapten to present it to naive T lymphocytes in the regional lymph node, which can recognize it and activate the Th1 pathway if IL-12 is released, Th2 if IL-4 is released, Th17 if IL-17 or IL-23 is released, or Th22 if IL-22 is released[13],[14]. Activation of regulatory T lymphocytes is also possible. In the last decade, the inflammatory specificity of some allergens has been more precisely defined, such as nickel sulfate with predominantly Th1 and Th17 cytokines, fragrances with predominantly Th2 inflammation, and rubber (latex) related to Th2 and Th22 type inflammation[14]. Table 1 illustrates the main allergens studied from a molecular point of view and the inflammatory pathways they activate.

Understanding that assigning specific immunogenic profiles to each allergen (or group of them) can be complex, and that we are likely talking about inflammatory predominances, the use of drugs with specific therapeutic targets in these patients remains interesting. Currently, and broadly speaking, we can classify therapeutic options into two groups: small molecule inhibitors such as Janus kinase inhibitors (JAKi), and biological therapies (monoclonal antibodies directed against IL-4, 13, 17, 12, 23, immunoglobulin E [IgE], and TNF-α). None of these commercially available treatments are approved for the treatment of ACD; therefore, their request will be off-label[8].

This review excluded the study of classic immunosuppressants, such as corticosteroids, cyclosporine, methotrexate, mycophenolate, or azathioprine, in the treatment of ACD[15]. This decision was made because these do not represent novel treatments.

Material and Methods

We conducted a narrative literature review on PubMed up to July 28th, 2024, using specific terms related to ACD and new therapies: "allergic contact dermatitis," "allergens," "delayed-type hypersensitivity reaction," "patch test," "Jak inhibitors," "iJak," "biologics," "biological therapy," "monoclonal antibodies," "abrocitinib," "tofacitinib," "upadacitinib," "baricitinib," "ruxolitinib," "delgocitinib," "apremilast," "roflumilast," "crisaborol," "difamilast," "dupilumab," "tralokinumab," "nemolizumab," "lebrikizumab," "secukinumab," "ustekinumab," "omalizumab," "anti-TNF," "infliximab," "adalimumab," "etanercept," "certolizumab," and "certolizumab pegol." Studies in English and Spanish evaluating the safety and efficacy profile of small molecule inhibitors and biological drugs in ACD were included. Studies focused on traditional treatments, such as corticosteroids and classic immunosuppressants, were excluded given their non-novel nature. Articles were selected based on the relevance of their abstracts and were evaluated in detail after full-text reading.

Small Molecule Inhibitors

JAK Inhibitors (JAKi): abrocitinib, tofacitinib, upadacitinib, baricitinib, ruxolitinib, and delgocitinib

The intracellular signaling pathway Janus kinase/signal transducer and activator of transcription (JAK/STAT) is initiated when an extracellular ligand binds to transmembrane receptors, leading to the phosphorylation of intracellular molecules. This triggers an intracellular signaling cascade and regulates the transcription of numerous genes. JAKs are part of this family of tyrosine kinases that function as intracellular signal transducers and include JAK1, JAK2, JAK3, and TYK2. JAKs form dimers in the intracellular cytoplasmic portion of cytokine receptors, allowing them to associate with multiple receptors and be activated by different cytokines. In turn, they activate various STAT proteins, such as STAT1, STAT2, STAT3, STAT4, STAT5a, STAT5b, and STAT6, thus participating in specific biological functions. When these

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STAT proteins are activated, they associate forming dimers and can translocate to the cell nucleus. There, they act as transcription factors, upregulating the expression of genes responsible for the production of pro-inflammatory cytokines and growth factors, and regulating the behavior of other intracellular proteins[16]. JAKi have emerged as a therapeutic class with multiple applications in dermatology (vitiligo, alopecia areata, psoriasis, and atopic dermatitis)[17],[18]. It is postulated that JAKi could be a promising therapeutic option in cases resistant to conventional therapies for ACD[19]. These drugs have been shown to influence multiple inflammatory pathways, including the TH1, TH2, and TH17 pathways that are involved in the pathophysiology of ACD[20]. The efficacy of JAKi may vary depending on the specific allergen involved, highlighting the importance of an individualized evaluation. Although clinical research in this field is still limited, cases have been documented where treatment with JAKi showed encouraging results. For example, the use of abrocitinib at a dose of 100 mg every 24 hours in a 37-year-old man with airborne ACD caused by plant particles of the *Compositae* (Asteraceae) family, with occupational exposure in a work environment where allergen avoidance was unfeasible, resulted in complete resolution of symptoms 8 months into therapy without adverse effects[21]. This patient had previously shown a lack of response to treatment with dupilumab 300 mg every 2 weeks for 11 months, suggesting that the allergen in question activates other inflammatory pathways not related to the Th2 pathway.

Another case reported the therapeutic success of tofacitinib 5 mg every 12 hours after a 4-week regimen without side effects in a 57-year-old Indian woman with airborne ACD to *Parthenium*, a genus of plants in the *Compositae*(Asteraceae) family[22]. This patient had previously been on topical and oral corticosteroids, topical tacrolimus 0.1%, and azathioprine without response. These findings support the viability of JAKi as a therapeutic option in selected cases of ACD.

Recently, 2 cases of patients with psoriasis and ACD to fragrance mix I and balsam of Peru, with good response to upadacitinib 15 mg daily, have been published[23]. The use of upadacitinib 30 mg also silenced the allergic reaction to multiple allergens (corticosteroids, lanolin, thiuram mix, 4-tert-butylphenol formaldehyde resin) when repeating patch tests in the same patient after 4 months of into upadacitinib 30 mg[24]. This is important not only because it may be an interesting therapeutic tool but also to avoid performing patch tests in patients on this type of drug due to the high risk of false negatives. We have experience treating ACD with rubber accelerators (thiuram mix, carba mix, and mercaptobenzothiazole) in a patient refractory to cyclosporine, who responded completely within 4 weeks into baricitinib 2 mg/24 hours (Fig. 1). We have not found any published cases of ACD on topical ruxolitinib or delgocitinib, but we suspect that after their commercialization, new cases of ACD treated with these topical drugs will be published. Table 2 illustrates the findings regarding JAKi in the treatment of ACD.

Phosphodiesterase 4 Inhibitors (PDE4i): apremilast, roflumilast, crisaborol, and difamilast

Phosphodiesterase 4 (PDE4) is an enzyme responsible for the degradation of cyclic adenosine monophosphate (cAMP), which promotes the production of inflammatory mediators (cytokines: TNF-α, IL-1β, and IL-6) and the activation of immune cells (T lymphocytes, macrophages, and mast cells) systemically and epidermally. The use of PDE4i in ACD would help limit the inflammatory response and preserve the skin barrier function against allergens and irritants. There are few publications on their use in ACD. Apremilast was used in an open-label phase 2 trial for recalcitrant ACD and/or AD, in which 10 patients participated at a dose of 20 mg twice daily for a period of 12 weeks, 4 of whom had ACD and 1, coexisting ACD and AD[25]. The primary endpoint was set at a 2-point improvement in the IGA (Investigator Global Assessment), which was achieved in 20% of the subjects. Only 10% achieved EASI-75 (Eczema Area and Severity Index-75), leading to the conclusion of its limited effect for these patients vs the results obtained

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in psoriasis[25]. However, an interesting finding was observed in this trial: subjects diagnosed with ACD responded better to apremilast vs patients with AD. ACD patients showed an average improvement of 40% in the EASI score, while AD patients experienced a 20% worsening (p = 0.026). Furthermore, ACD subjects presented a 30% reduction in pruritus, in contrast to a 10% reduction in AD patients. However, this difference in pruritus was not statistically significant, likely due to the small sample size. This finding suggests that apremilast might be more effective in the treatment of ACD than AD, although it should be noted that ACD patients had lower baseline EASI scores, with a mean of 12.5, compared to AD patients, who had a mean of 34.1; therefore, a larger number of patients is needed to confirm these results[25].

Roflumilast is a drug indicated for chronic obstructive pulmonary disease (COPD) that has shown promising results in the treatment of recurrent oral aphthosis, lichen planus, psoriasis, and AD, among others[26]. A phase IIa clinical trial (NCT04773587) with roflumilast cream at 0.15% and 0.015% VS placebo demonstrated a good safety profile with a decrease in EASI of 6.4 points in the roflumilast 0.15% group, 6 points in the roflumilast 0.05% group, and 4.8 points in the control group, without being statistically significant, in adults and children older than 6 years with mild-to-moderate AD[27]. However, another phase IIa clinical trial (NCT01856764) on topical roflumilast 0.5% vs placebo for the management of AD did not achieve results superior to placebo in the roflumilast group[28]. Despite the lack of evidence of roflumilast efficacy in ACD, its safety profile and anti-inflammatory potential may motivate its use in selected cases.

Regarding other topical drugs, crisaborol is the first topical PDE4i approved for AD since 2020 for individuals older than 3 months as a corticosteroid-sparing treatment. No publications on its use in ACD have been found; in fact, there are 2 recent articles that postulate it as a potential allergen[29],[30]. Difamilast is another topical PDE4i currently in phase 3 study for the treatment of AD, approved in Japan since 2021 for individuals older than 2 years. It has demonstrated rapid-acting anti-inflammatory and antipruritic effects from the first week of treatment[31]. We have also found no data on its use in ACD.

Biological Therapy

Dupilumab

Dupilumab, an inhibitor of the interleukin-4 receptor alpha (IL-4Rα), has been approved for treating moderate-to-severe AD. Possibly, of all the molecules reviewed, dupilumab has the most published scientific evidence. As discussed in several articles, some allergens are immunomediated by Th2-type inflammation, which is why the use of dupilumab in ACD is being considered[32]. A clinical trial is currently recruiting to evaluate the treatment of ACD (NCT03935971)[33]. On the other hand, in the clinical trial evaluating the and safety and efficacy profile of dupilumab vs placebo in patients with severe chronic hand eczema with inadequate response or intolerance to alitretinoin, 90% of patients on dupilumab showed allergic hypersensitivity to, at least, 1 substance with a 75% improvement in the Hand Eczema Severity Index (HECSI-75) on week 16 in 95% of patients on dupilumab vs 33% of patients on placebo[34]. The published therapeutic success of dupilumab in ACD increased interest in the use of this therapy in patients with relevant positive patch tests refractory to allergen avoidance[35]–[37]. Isolated cases and case series of ACD patients patched with positive tests have been analyzed before and after dupilumab[38]. Allergens such as rubber[39], sesquiterpene lactone mix[40],[41], potassium dichromate[42], isobornyl acrylate (IBOA)[43], and even systemic contact dermatitis syndrome due to nickel sulfate and balsam of Peru were successfully treated with dupilumab[44]. A national multicenter study showed that more than half of the patients patched before and after being on dupilumab showed false negatives[45]. In this regard, discontinuation of dupilumab treatment 2 weeks before patch testing should be considered, especially in those with frequent eczema

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flares and/or persistent localized dermatitis (such as the facial area). Due to the impact of occupational ACD and the sometimes difficult resolution of dermatitis, dupilumab has also been used successfully in 6 patients[46] or in cases of polysensitization in a hairdresser[47]. Although possibly controversial, dupilumab is an interesting option in patients sensitized to allergens whose immunogenic predisposition is of the Th2 type. Although they are likely valid treatments for ACD, there are no publications on tralokinumab, nemolizumab, or lebrikizumab to date. Table 3 illustrates the main studies on dupilumab and the treatment of ACD.

Secukinumab

Secukinumab is a fully human IgG1 kappa monoclonal antibody directed against IL-17[48]. IL-17 levels were elevated in mice and human subjects who showed a positive patch test reaction to nickel. These higher levels of IL-17 in these subjects indicate the involvement of IL-17 in the manifestation of ACD[14],[49]. Based on this finding, secukinumab was tested in ACD. However, in clinical practice, secukinumab therapy did not show any substantial clinical improvement[50].

Ustekinumab

Ustekinumab is a human IgG1k monoclonal antibody that blocks the biological activity of IL-12 and IL-23 by inhibiting the receptors for these cytokines on T cells, NK cells, and antigen-presenting cells, cytokines relevant for Th1 differentiation[51]. The probable role of IL-23 in ACD has recently been highlighted[52]. When ustekinumab was administered to 5 patients with recalcitrant ACD, only 1 patient showed clinical improvement[53]. In our opinion, the future commercialization of biosimilar ustekinumab may represent an interesting therapeutic option in patients sensitized to allergens whose predominant immunogenic pathway is Th1, where IL-12 plays a crucial role in the differentiation of naive T lymphocytes to Th1.

Omalizumab

Omalizumab is a monoclonal antibody directed against IgE, approved for the treatment of chronic urticaria and severe allergic asthma. Regarding its off-label use, cases of AD, bullous pemphigoid, Kimura's disease, and hyper-IgE syndrome with good response have been published[54]. Due to its mechanism of action, it does not interfere with the result of patch tests. In patients suffering from protein contact dermatitis mediated by IgE (type I hypersensitivity), omalizumab could be an interesting therapeutic option, especially in occupational cases. There is a publication of a case of recalcitrant occupational dermatitis associated with allergic asthma due to wheat exposure. Omalizumab 225 mg every 2 weeks was effective in controlling ACD without allergen avoidance[55]. The favorable response to treatment may be due to the combined type I and IV hypersensitivity mechanism, which opens a therapeutic window of opportunity for ACD due to proteins. We have experience in treating patients with innate intolerance to fragrances in general, without showing positive sensitization during patch tests, with significant improvement of symptoms and improved these patients' quality of life.

Tumor Necrosis Factor-α Inhibitors (anti-TNFα): infliximab, adalimumab, etanercept, and certolizumab-pegol

TNF-α contributes to the development of ACD through various mechanisms. During sensitization, it promotes the activation and migration of antigen-presenting cells, facilitating allergen presentation to T cells. In the elicitation phase, it stimulates the release of pro-inflammatory cytokines and chemokines, resulting in increased infiltration of inflammatory cells and amplification of the inflammatory response[15].

However, the use of anti-TNFα has proven insufficient in blocking ACD, suggesting that other pathways are involved that would act in compensation. Most studies in patients on biological therapy with these drugs do not show negativization of patch tests[56],[57]. On the other hand, subcutaneous injection of the drug can induce histopathological changes similar to a contact hypersensitivity reaction, such as local proliferation of fibroblasts and capillaries in the dermis, hyperplastic reaction of keratinocytes, or massive necrosis in the epidermis[58].

Only 1 case is available of a 30-year-old man with a personal history of atopy and sensitization to nickel sulfate and potassium dichromate with a good response to infliximab[59], demonstrating efficacy in reducing the extent of lesions and associated pruritus with good tolerance to treatment; however, this article was published in 2006, prior to the commercialization of new therapies in AD[59].

Discussion

ACD is a complex disease whose pathophysiology involves the activation of the immune system mediated by T cells in response to specific allergens[12]. Allergen avoidance, which is often not possible, and traditional treatments, such as topical corticosteroids and calcineurin inhibitors or classic immunosuppressants, have shown efficacy in many cases but have limitations in terms of side effects and incomplete response in some patients[15].

JAKi is a promising emerging therapy due to their ability to modulate multiple inflammatory pathways simultaneously. This mechanism is particularly relevant in patients polysensitized to multiple allergens, where TH1, TH2, and TH17 pathways may be involved. The reviewed cases show a significant reduction in ACD symptoms, with a favorable short-term safety profile[21–23]. Furthermore, the JAKi used in these patients have been administered at the lowest commercially available doses, including our experience with a patient on baricitinib 2 mg daily, which is interesting from a cost-effectiveness perspective[21],[22]. Despite this, the small number of patients and the short-term follow-up limit the generalization of these findings.

Apremilast could be a promising therapeutic option; however, there is only 1 clinical trial demonstrating efficacy in a limited number of patients[25].

Comparatively, biological therapies, such as IL-4/IL-13 inhibitors, also show encouraging results in the management of refractory ACD[39–44],[46],[47]. However, in real clinical practice, there are fewer reports of successful cases with anti-IL-17 and anti-IL-23 biological drugs, despite their potential utility in ACD[50],[53]. Knowledge of the molecular signatures of allergens is essential for the choice of treatment according to the inflammatory pathway they activate[13],[14]; for this reason, the response of ACD patients to these treatments varies.

The mechanism of inhibition of the OX40/OX40L pathway could be particularly interesting in preventing the development of ACD due to its crucial role in the regulation of the adaptive immune response, specifically in the activation and proliferation of T cells[60]. This therapeutic target is currently being investigated for the treatment of AD[61]. It will be interesting to know the preventive role of these molecules in the development of ACD in these patients.

Personalizing treatment based on the patient's immunological profile could optimize therapeutic outcomes. In patients with comorbidities such as atopy, alopecia areata, psoriasis, or hidradenitis, or in

those polysensitized where allergen avoidance is not possible, JAKi could offer a valuable therapeutic option[21]–[23].

Limitations

This article presents some limitations that must be acknowledged. The present review is limited by its narrative nature and is not a systematic review or meta-analysis. Most of the included studies are relatively recent case reports or case series and lack long-term safety and efficacy data; furthermore, in some patients, AD and ACD coexist.

In addition, the variability in patient response to treatments may complicate the generalization of the findings. The lack of direct comparative studies between the different emerging therapeutic options and conventional treatments is a significant limitation. Finally, more research is needed to identify biomarkers that can predict treatment response and guide the personalization of ACD management.

Conclusions

Emerging therapies for ACD, such as JAKi and biological therapies, show great potential to improve the management of this refractory condition. However, more data are needed to establish their place in routine clinical practice. JAKi, by acting more broadly by inhibiting multiple cytokines, would be the most promising drugs regarding efficacy; on the other hand, dupilumab would be a therapeutic option in those patients in whom atopic dermatitis and sensitization to allergens with predominantly Th2 polarization of the inflammatory response coexist. Personalizing treatment, based on the immunological profile and the identification of predictive biomarkers, is a promising area of research that could optimize clinical outcomes and improve the patients' quality of life.

Conflicts of interest

None declared.

References

<BIBL>

<BIB>

1

S Elmas F Ö.F.

S Akdeniz F N.

S Atasoy F M.

S Karadag F A.S.

AT Contact dermatitis: A great imitator

JT Clin Dermatol.

V 38

D 2020

P 176-L 192

<original_ref>[1] Elmas ÖF, Akdeniz N, Atasoy M, Karadag AS. Contact dermatitis: A great imitator. Clin Dermatol 2020; 38:176–92.</original_ref>

</BIB>

<BIB>

2

S Statescu F L.

S Branisteanu F D.

S Dobre F C.

S Solovastru F L.G.

S Vasilca F A.

S Petrescu F Z.<ET-AL>

AT Contact dermatitis - epidemiological study

JT Maedica (Bucur).

V 6

D 2011

P 277-L 281

<original_ref>[2] Statescu L, Branisteanu D, Dobre C, et al. Contact dermatitis - epidemiological study. Maedica (Bucur) 2011; 6:277–81.</original_ref>

</BIB>

<BIB>

3

S Hollins F L.C.

S Flamm F A.

AT Occupational Contact Dermatitis: Evaluation and Management Considerations

JT Dermatol Clin.

V 38

D 2020

P 329-L 338

<original_ref>[3] Hollins LC, Flamm A. Occupational Contact Dermatitis: Evaluation and Management Considerations. Dermatol Clin 2020; 38:329–38.</original_ref>

</BIB>

<BIB>

4

S Rozas-Muñoz F E.

S Gamé F D.

S Serra-Baldrich F E.

AT Dermatitis de contacto alérgica por regiones anatómicas. Claves diagnósticas

JT Actas Dermosifiliogr.

V 109

D 2018

P 485-L 507

<original_ref>[4] Rozas-Muñoz E, Gamé D, Serra-Baldrich E. Dermatitis de contacto alérgica por regiones anatómicas. Claves diagnósticas. Actas Dermosifiliogr 2018; 109:485–507.</original_ref>

</BIB>

<BIB>

5

S Alinaghi F F.

S Bennike F N.H.

S Egeberg F A.

S Thyssen F J.P.

S Johansen F J.D.

AT Prevalence of contact allergy in the general population: A systematic review and meta-analysis

JT Contact Dermatitis.

V 80

D 2019

P 77-L 85

DOI 10.1111/cod.13119

<original_ref>[5] Alinaghi F, Bennike NH, Egeberg A, et al. Prevalence of contact allergy in the general population: A systematic review and meta-analysis. Contact Dermatitis 2019; 80:77–85.</original_ref>

</BIB>

<BIB>

6

S Rubins F A.

S Romanova F A.

S Septe F M.

S Maddukuri F S.

S Schwartz F R.A.

S Rubins F S.

AT Contact dermatitis: Etiologies of the allergic and irritant type

JT Acta Dermatovenerol Alp Pannonica Adriat.

V 25

D 2020

P 181-L 184

<original_ref>[6] Rubins A, Romanova A, Septe M, et al. Contact dermatitis: Etiologies of the allergic and irritant type. Acta Dermatovenerol Alp Pannonica Adriat 2020; 25:181–4.</original_ref>

</BIB>

<BIB>

7

S Tous-Romero F F.

S Ortiz Romero F P.L.

S De Frutos F J.O.

AT Usefulness of Patch Testing With Patient's Own Products in the Diagnosis of Allergic Contact Dermatitis

JT Dermatitis.

V 32

D 2021

P 38-L 41

<original_ref>[7] Tous-Romero F, Ortiz Romero PL, De Frutos JO. Usefulness of Patch Testing With Patient's Own Products in the Diagnosis of Allergic Contact Dermatitis. Dermatitis 2021; 32:38–41.</original_ref>

</BIB>

<BIB>

8

S Bhatia F J.

S Sarin F A.

S Wollina F U.

S Lotti F T.

S Navarini F A.A.

S Mueller F S.M.<ET-AL>

AT Review of biologics in allergic contact dermatitis

JT Contact Dermatitis.

V 83

D 2020

P 179-L 181

DOI 10.1111/cod.13584

<original_ref>[8] Bhatia J, Sarin A, Wollina U, et al. Review of biologics in allergic contact dermatitis. Contact Dermatitis 2020; 83:179–81.</original_ref>

</BIB>

<BIB>

9

S Mufti F A.

S Lu F J.D.

S Sachdeva F M.

S Zaaroura F H.

S Kashetsky F N.

S Yeung F J.<ET-AL>

AT Patch Testing During Immunosuppressive Therapy: A Systematic Review

JT Dermatitis.

V 32

D 2021

P 365-L 374

DOI 10.1097/DER.0000000000000726

<original_ref>[9] Mufti A, Lu JD, Sachdeva M, et al. Patch Testing During Immunosuppressive Therapy: A Systematic Review. Dermatitis 2021; 32:365–74.</original_ref>

</BIB>

<BIB>

10

S Loman F L.

S Uter F W.

S Armario-Hita F J.C.

S Ayala F F.

S Balato F A.

S Ballmer-Weber F B.K.<ET-AL>

CB ESSCA Working Group

AT European Surveillance System on Contact Allergies (ESSCA): Characteristics of patients patch tested and diagnosed with irritant contact dermatitis

JT Contact Dermatitis.

V 85

D 2021

P 186-L 197

DOI 10.1111/cod.13833

<original_ref>[10] Loman L, Uter W, Armario-Hita JC, et al. European Surveillance System on Contact Allergies (ESSCA): Characteristics of patients patch tested and diagnosed with irritant contact dermatitis. Contact Dermatitis 2021; 85:186–97.</original_ref>

</BIB>

<BIB>

11

S Tramontana F M.

S Hansel F K.

S Bianchi F L.

S Sensini F C.

S Malatesta F N.

S Stingeni F L.

AT Advancing the understanding of allergic contact dermatitis: from pathophysiology to novel therapeutic approaches

JT Front Med (Lausanne).

D 2023

P 10

DOI 10.3389/FMED.2023.1184289

<original_ref>[11] Tramontana M, Hansel K, Bianchi L, et al. Advancing the understanding of allergic contact dermatitis: from pathophysiology to novel therapeutic approaches. Front Med (Lausanne) 2023; 10. <DOI>10.3389/FMED. 2023.1184289.</DOI></original_ref>

</BIB>

<BIB>

12

S Nassau F S.

S Fonacier F L.

AT Allergic Contact Dermatitis

JT Med Clin North Am.

V 104

D 2020

P 61-L 76

<original_ref>[12] Nassau S, Fonacier L. Allergic Contact Dermatitis. Med Clin North Am 2020; 104:61–76.</original_ref>

</BIB>

<BIB>

13

S Lefevre F M.A.

S Nosbaum F A.

S Rozieres F A.

S Lenief F V.

S Mosnier F A.

S Cortial F A.<ET-AL>

AT Unique molecular signatures typify skin inflammation induced by chemical allergens and irritants

JT Allergy.

V 76

D 2021

P 3697-L 3712

DOI 10.1111/all.14989

<original_ref>[13] Lefevre MA, Nosbaum A, Rozieres A, et al. Unique molecular signatures typify skin inflammation induced by chemical allergens and irritants. Allergy 2021; 76:3697–712.</original_ref>

</BIB>

<BIB>

14

S Dhingra F N.

S Shemer F A.

S Correa Da Rosa F J.

S Rozenblit F M.

S Fuentes-Duculan F J.

S Gittler F J.K.<ET-AL>

AT Molecular profiling of contact dermatitis skin identifies allergen-dependent differences in immune response

JT J Allergy Clin Immunol.

V 134

D 2014

P 362-L 372

DOI 10.1016/j.jaci.2014.03.009

<original_ref>[14] Dhingra N, Shemer A, Correa Da Rosa J, et al. Molecular profiling of contact dermatitis skin identifies allergen-dependent differences in immune response. J Allergy Clin Immunol 2014; 134:362–72.</original_ref>

</BIB>

<BIB>

15

S Sung F C.T.

S McGowan F M.A.

S Machler F B.C.

S Jacob F S.E.

AT Systemic Treatments for Allergic Contact Dermatitis

JT Dermatitis.

V 30

D 2019

P 46-L 53

<original_ref>[15] Sung CT, McGowan MA, Machler BC, Jacob SE. Systemic Treatments for Allergic Contact Dermatitis. Dermatitis 2019; 30:46–53.</original_ref>

</BIB>

<BIB>

16

S Virtanen F T.

S Haikarainen F A.

S Raivola F T.

S Silvennoinen F J.O.

AT Selective JAKinibs:;1. Prospects in Inflammatory and Autoimmune Diseases

JT BioDrugs.

V 33

D 2019

P 15-L 32

<original_ref>[16] T. Virtanen A, Haikarainen T, Raivola J, Silvennoinen O. Selective JAKinibs:;1. Prospects in Inflammatory and Autoimmune Diseases. BioDrugs 2019; 33:15–32.</original_ref>

</BIB>

<BIB>

17

S Garcia-Melendo F C.

S Cubiró F X.

S Puig F L.

AT Inhibidores de JAK: usos en dermatología Parte 1: generalidades, aplicaciones en vitíligo y en alopecia areata

JT Actas Dermosifiliogr.

V 112

D 2021

P 503-L 515

<original_ref>[17] Garcia-Melendo C, Cubiró X, Puig L. Inhibidores de JAK: usos en dermatología. Parte 1: generalidades, aplicaciones en vitíligo y en alopecia areata. Actas Dermosifiliogr 2021; 112:503–15.</original_ref>

</BIB>

<BIB>

18

S García-Melendo F C.

S Cubiró F X.

S Puig F L.

AT Inhibidores de JAK: usos en dermatología Parte 2: aplicaciones en psoriasis, dermatitis atópica y otras dermatosis

JT Actas Dermosifiliogr

V 112

D 2021

P 586-L 600

<original_ref>[18] García-Melendo C, Cubiró X, Puig L. Inhibidores de JAK: usos en dermatología. Parte 2: aplicaciones en psoriasis, dermatitis atópica y otras dermatosis. Actas Dermosifiliogr 2021; 112:586–600.</original_ref>

</BIB>

<BIB>

19

S Johnson F H.

S Guenther F J.

S Adler F B.L.

S Yu F J.De.

AT Janus Kinase Inhibitors: A Promising Therapeutic Option for Allergic Contact Dermatitis

JT Cutis.

D 2023

P 111

DOI 10.12788/CUTIS.0705

<original_ref>[19] Johnson H, Guenther J, Adler BL, Yu J De. Janus Kinase Inhibitors: A Promising Therapeutic Option for Allergic Contact Dermatitis. Cutis 2023; 111. <DOI>10.12788/CUTIS.0705.</DOI></original_ref>

</BIB>

<BIB>

20

S Amano F W.

S Nakajima F S.

S Yamamoto F Y.

S Tanimoto F A.

S Matsushita F M.

S Miyachi F Y.<ET-AL>

AT JAK inhibitor JTE-052 regulates contact hypersensitivity by downmodulating T cell activation and differentiation

JT J Dermatol Sci.

V 84

D 2016

P 258-L 265

DOI 10.1016/j.jdermsci.2016.09.007

<original_ref>[20] Amano W, Nakajima S, Yamamoto Y, et al. JAK inhibitor JTE-052 regulates contact hypersensitivity by downmodulating T cell activation and differentiation. J Dermatol Sci 2016; 84:258–65.</original_ref>

</BIB>

<BIB>

21

S Baltazar F D.

S Shinamoto F S.R.

S Hamann F C.P.

S Hamann F D.

S Hamann F C.R.

AT Occupational airborne allergic contact dermatitis to invasive Compositae species treated with abrocitinib: A case report

JT Contact Dermatitis.

V 87

D 2022

P 542-L 544

DOI 10.1111/cod.14204

<original_ref>[21] Baltazar D, Shinamoto SR, Hamann CP, et al. Occupational airborne allergic contact dermatitis to invasive Compositae species treated with abrocitinib: A case report. Contact Dermatitis 2022; 87:542–4.</original_ref>

</BIB>

<BIB>

22

S Muddebihal F A.

S Sardana F K.

S Sinha F S.

S Kumar F D.

AT Tofacitinib in refractory Parthenium-induced airborne allergic contact dermatitis

JT Contact Dermatitis.

V 88

D 2023

P 150-L 152

<original_ref>[22] Muddebihal A, Sardana K, Sinha S, Kumar D. Tofacitinib in refractory Parthenium-induced airborne allergic contact dermatitis. Contact Dermatitis 2023; 88:150–2.</original_ref>

</BIB>

<BIB>

23

S Ch'en F P.Y.

S Al-Saedy F M.

S Song F E.J.

AT Upadacitinib as a treatment for co-existent allergic contact dermatitis and psoriasis

JT JAAD Case Rep.

V 44

D 2023

P 20-L 22

<original_ref>[23] Ch'en PY, Al-Saedy M, Song EJ. Upadacitinib as a treatment for co-existent allergic contact dermatitis and psoriasis. JAAD Case Rep 2023; 44:20–2.</original_ref>

</BIB>

<BIB>

24

S Mainville F L.

S Veillette F H.

S Houle F M.C.

AT Sequential patch testing in a patient treated with dupilumab then with upadacitinib: Differences in patch test results as well as in disease control

JT Contact Dermatitis.

V 88

D 2023

P 402-L 404

<original_ref>[24] Mainville L, Veillette H, Houle MC. Sequential patch testing in a patient treated with dupilumab then with upadacitinib: Differences in patch test results as well as in disease control. Contact Dermatitis 2023; 88:402–4.</original_ref>

</BIB>

<BIB>

25

S Volf F E.M.

S Au F S.C.

S Dumont F N.

S Scheinman F P.

S Gottlieb F A.B.

AT A phase 2, open-label, investigator-initiated study to evaluate the safety and efficacy of apremilast in subjects with recalcitrant allergic contact or atopic dermatitis

JT J Drugs Dermatol.

V 11

D 2012

P 341-L 346

<original_ref>[25] Volf EM, Au SC, Dumont N, et al. A phase 2, open-label, investigator-initiated study to evaluate the safety and efficacy of apremilast in subjects with recalcitrant allergic contact or atopic dermatitis. J Drugs Dermatol 2012; 11:341–6.</original_ref>

</BIB>

<BIB>

26

S Mansilla-Polo F M.

S Gimeno F E.

S Morgado-Carrasco F D.

AT Roflumilast tópico y oral en dermatología Una revisión narrativa

JT Actas Dermosifiliogr.

V 115

D 2024

P 265-L 279

<original_ref>[26] Mansilla-Polo M, Gimeno E, Morgado-Carrasco D. Roflumilast tópico y oral en dermatología. Una revisión narrativa. Actas Dermosifiliogr 2024; 115:265–79.</original_ref>

</BIB>

<BIB>

27

S Gooderham F M.

S Kircik F L.

S Zirwas F M.

S Lee F M.

S Kempers F S.

S Draelos F Z.<ET-AL>

AT The Safety and Efficacy of Roflumilast Cream 0.15% and 0.05% in Patients With Atopic Dermatitis: Randomized, Double-Blind Phase 2 Proof of Concept Study

JT J Drugs Dermatol.

V 22

D 2023

P 139-L 147

DOI 10.36849/JDD.7295

<original_ref>[27] Gooderham M, Kircik L, Zirwas M, et al. The Safety and Efficacy of Roflumilast Cream 0.15% and 0.05% in Patients With Atopic Dermatitis: Randomized, Double-Blind, Phase 2 Proof of Concept Study. J Drugs Dermatol 2023; 22:139–47.</original_ref>

</BIB>

<BIB>

28

AstraZeneca. A Phase 2a, 15-Day, Randomized, Parallel Group, Double-Blind, Multi- Centre, Vehicle Controlled Trial to Assessthe Efficacy and Local Safety of a Cream Containing 0.5% Roflumilast - A Phosphodiesterase Type 4 Inhibitor (PDE4i) Dermal Formulation - on Atopic Dermatitis Patients With Skin Lesions of Moderate Severity. clinicaltrials.gov. 2016.

<original_ref>[28] AstraZeneca. A Phase 2a, 15-Day, Randomized, Parallel Group, Double-Blind, Multi- Centre, Vehicle Controlled Trial to Assessthe Efficacy and Local Safety of a Cream Containing 0.5% Roflumilast - A Phosphodiesterase Type 4 Inhibitor (PDE4i) Dermal Formulation - on Atopic Dermatitis Patients With Skin Lesions of Moderate Severity. clinicaltrials.gov. 2016.</original_ref>

</BIB>

<BIB>

29

S Kimyon F R.S.

S Schlarbaum F J.P.

S Liou F Y.L.

S Hylwa F S.A.

S Warshaw F E.M.

AT Allergic Contact Dermatitis to Crisaborole

JT Dermatitis.

V 30

D 2019

P 272-L 274

DOI 10.1097/DER.0000000000000488

<original_ref>[29] Kimyon RS, Schlarbaum JP, Liou YL, et al. Allergic Contact Dermatitis to Crisaborole. Dermatitis 2019; 30:272–4.</original_ref>

</BIB>

<BIB>

30

S Arora F P.

S Neeley F A.

AT Contact allergy to crisaborole in a paediatric patient with atopic dermatitis

JT Contact Dermatitis.

V 89

D 2023

P 309-L 310

<original_ref>[30] Arora P, Neeley A. Contact allergy to crisaborole in a paediatric patient with atopic dermatitis. Contact Dermatitis 2023; 89:309–10.</original_ref>

</BIB>

<BIB>

31

S Freitas F E.

S Torres F T.

AT Difamilast for the treatment of atopic dermatitis

JT J Int Med Res.

D 2023

P 51

DOI 10.1177/03000605231169445

<original_ref>[31] Freitas E, Torres T. Difamilast for the treatment of atopic dermatitis. J Int Med Res 2023; 51. <DOI>10.1177/03000605231169445.</DOI></original_ref>

</BIB>

<BIB>

32

S Ludwig F C.M.

S Krase F J.M.

S Shi F V.Y.

AT T Helper 2 Inhibitors in Allergic Contact Dermatitis

JT Dermatitis.

V 32

D 2021

P 15-L 18

<original_ref>[32] Ludwig CM, Krase JM, Shi VY. T Helper 2 Inhibitors in Allergic Contact Dermatitis. Dermatitis 2021; 32:15–8.</original_ref>

</BIB>

<BIB>

33

The Effects of Dupilumab on Allergic Contact Dermatitis. ClinicalTrials.gov ID NCT03935971.

<original_ref>[33] The Effects of Dupilumab on Allergic Contact Dermatitis. ClinicalTrials.gov ID NCT03935971.</original_ref>

</BIB>

<BIB>

34

S Voorberg F A.N.

S Kamphuis F E.

S Christoffers F W.A.

S Schuttelaar F M.L.A.

AT Efficacy and safety of dupilumab in patients with severe chronic hand eczema with inadequate response or intolerance to alitretinoin: a randomized, double-blind, placebo-controlled phase IIb proof-of-concept study

JT Br J Dermatol.

V 189

D 2023

P 400-L 409

<original_ref>[34] Voorberg AN, Kamphuis E, Christoffers WA, Schuttelaar MLA. Efficacy and safety of dupilumab in patients with severe chronic hand eczema with inadequate response or intolerance to alitretinoin: a randomized, double-blind, placebo-controlled phase IIb proof-of-concept study. Br J Dermatol 2023; 189:400–9.</original_ref>

</BIB>

<BIB>

35

S Jo F C.E.

S Mufti F A.

S Sachdeva F M.

S Pratt F M.

S Yeung F J.

AT Effect of dupilumab on allergic contact dermatitis and patch testing

JT J Am Acad Dermatol.

V 84

D 2021

P 1772-L 1776

DOI 10.1016/j.jaad.2021.02.044

<original_ref>[35] Jo CE, Mufti A, Sachdeva M, et al. Effect of dupilumab on allergic contact dermatitis and patch testing. J Am Acad Dermatol 2021; 84:1772–6.</original_ref>

</BIB>

<BIB>

36

S Kuzyk F A.

S Devani F A.R.

S Prajapati F V.H.

S Lio F P.A.

AT Patch Testing on Dupilumab: Reliable or Not?

JT Cutis.

V 109

D 2022

P 158-L 159

<original_ref>[36] Kuzyk A, Devani AR, Prajapati VH, Lio PA. Patch Testing on Dupilumab: Reliable or Not? Cutis 2022; 109:158–9.</original_ref>

</BIB>

<BIB>

37

S Johnson F H.

S Adler F B.L.

S Yu F J.De.

AT Dupilumab for Allergic Contact Dermatitis: An Overview of Its Use and Impact on Patch Testing

JT Cutis.

D 2022

V 109

P 265-L 267

DOI 10.12788/CUTIS.0519

<original_ref>[37] Johnson H, Adler BL, Yu J De. Dupilumab for Allergic Contact Dermatitis: An Overview of Its Use and Impact on Patch Testing. Cutis 2022; 109. <DOI>10.12788/CUTIS. 0519.</DOI></original_ref>

</BIB>

<BIB>

38

S Bocquel F S.

S Soria F A.

S Raison-Peyron F N.

S Badaoui F A.

S Marcant F P.

S Bara F C.<ET-AL>

AT Impact of dupilumab on patch test results and allergic contact dermatitis: A prospective multicenter study

JT J Am Acad Dermatol.

V 90

D 2024

P 512-L 520

DOI 10.1016/j.jaad.2023.10.029.

<original_ref>[38] Bocquel S, Soria A, Raison-Peyron N, et al. Impact of dupilumab on patch test results and allergic contact dermatitis: A prospective multicenter study. J Am Acad Dermatol 2024; 90:512–20.</original_ref>

</BIB>

<BIB>

39

S Koh F Y.G.

S Park F J.W.

S Shin F S.H.

S Kim F B.J.

S Yoo F K.H.

AT Dupilumab for the treatment of refractory allergic contact dermatitis from rubber/latex concomitant with atopic dermatitis

JT J Eur Acad Dermatol Venereol.

V 36

D 2022

P e640-L e643

DOI 10.1111/jdv.18099

<original_ref>[39] Koh YG, Park JW, Shin SH, et al. Dupilumab for the treatment of refractory allergic contact dermatitis from rubber/latex concomitant with atopic dermatitis. J Eur Acad Dermatol Venereol 2022; 36:e640–3.</original_ref>

</BIB>

<BIB>

40

S Ruge F I.F.

S Skov F L.

S Zachariae F C.

S Thyssen F J.P.

AT Dupilumab treatment in two patients with severe allergic contact dermatitis caused by sesquiterpene lactones

JT Contact Dermatitis.

V 83

D 2020

P 137-L 139

<original_ref>[40] Ruge IF, Skov L, Zachariae C, Thyssen JP. Dupilumab treatment in two patients with severe allergic contact dermatitis caused by sesquiterpene lactones. Contact Dermatitis 2020; 83:137–9.</original_ref>

</BIB>

<BIB>

41

S Gallo F R.

S Trave F I.

S Castelli F R.

S Gasparini F G.

S Parodi F A.

AT Follow-up of patch test reactivity to sesquiterpene lactone mix in a patient successfully treated with dupilumab for severe airborne allergic contact dermatitis

JT Contact Dermatitis.

V 89

D 2023

P 140-L 141

DOI 10.1111/cod.14367

<original_ref>[41] Gallo R, Trave I, Castelli R, et al. Follow-up of patch test reactivity to sesquiterpene lactone mix in a patient successfully treated with dupilumab for severe airborne allergic contact dermatitis. Contact Dermatitis 2023; 89:140–1.</original_ref>

</BIB>

<BIB>

42

S Wilson F B.N.

S Balogh F E.A.

S Rayhan F D.J.

S Shitabata F P.

S Yousefzadeh F D.

S Feldman F S.

AT Chromate-Induced Allergic Contact Dermatitis Treated With Dupilumab

JT J Drugs Dermatol.

V 20

D 2021

P 1340-L 1342

DOI 10.36849/jdd.6246

<original_ref>[42] Wilson BN, Balogh EA, Rayhan DJ, et al. Chromate-Induced Allergic Contact Dermatitis Treated With Dupilumab. J Drugs Dermatol 2021; 20:1340–2.</original_ref>

</BIB>

<BIB>

43

S Arasu F A.

S Ross F G.

AT Treatment of generalised isobornyl acrylate contact allergy from diabetes pump with Dupilumab

JT Australas J Dermatol.

V 63

D 2022

P e91-L e93

<original_ref>[43] Arasu A, Ross G. Treatment of generalised isobornyl acrylate contact allergy from diabetes pump with Dupilumab. Australas J Dermatol 2022; 63:e91–3.</original_ref>

</BIB>

<BIB>

44

S Jacob F S.E.

S Sung F C.T.

S Machler F B.C.

AT Dupilumab for Systemic Allergy Syndrome With Dermatitis

JT Dermatitis.

V 30

D 2019

P 164-L 167

<original_ref>[44] Jacob SE, Sung CT, Machler BC. Dupilumab for Systemic Allergy Syndrome With Dermatitis. Dermatitis 2019; 30:164–7.</original_ref>

</BIB>

<BIB>

45

S Docampo-Simón F A.

S Sánchez-Pujol F M.J.

S Pastor-Nieto F M.A.

S Giménez-Arnau F A.

S Rodríguez-Serna F M.

S Serra-Baldrich F E.<ET-AL>

AT Patch Testing in Patients With Severe Atopic Dermatitis Treated With Dupilumab: A Multicentric Approach in Spain

JT Dermatitis.

V 34

D 2023

P 315-L 322

DOI 10.1089/derm.2022.0023

<original_ref>[45] Docampo-Simón A, Sánchez-Pujol MJ, Pastor-Nieto MA, et al. Patch Testing in Patients With Severe Atopic Dermatitis Treated With Dupilumab: A Multicentric Approach in Spain. Dermatitis 2023; 34:315–22.</original_ref>

</BIB>

<BIB>

46

S Slodownik F D.

S Levi F A.

S Lapidoth F M.

S Moshe F S.

AT Occupational Chronic Contact Dermatitis Successfully Treated with Dupilumab: A Case Series

JT Dermatology.

V 238

D 2022

P 1073-L 1075

<original_ref>[46] Slodownik D, Levi A, Lapidoth M, Moshe S. Occupational Chronic Contact Dermatitis Successfully Treated with Dupilumab: A Case Series. Dermatology 2022; 238:1073–5.</original_ref>

</BIB>

<BIB>

47

S Koblinski F J.E.

S Hamann F D.

AT Mixed occupational and iatrogenic allergic contact dermatitis in a hairdresser

JT Occup Med (Lond).

V 70

D 2020

P 523-L 526

<original_ref>[47] Koblinski JE, Hamann D. Mixed occupational and iatrogenic allergic contact dermatitis in a hairdresser. Occup Med (Lond) 2020; 70:523–6.</original_ref>

</BIB>

<BIB>

48

S Patel F D.D.

S Lee F D.M.

S Kolbinger F F.

S Antoni F C.

AT Effect of IL-17A blockade with secukinumab in autoimmune diseases

JT Ann Rheum Dis.

V 72

I Suppl2

D 2013

DOI 10.1136/ANNRHEUMDIS-2012-202371

<original_ref>[48] Patel DD, Lee DM, Kolbinger F, Antoni C. Effect of IL-17A blockade with secukinumab in autoimmune diseases. Ann Rheum Dis 2013; 72 Suppl 2. <DOI>10.1136/ANNRHEUMDIS-2012-202371.</DOI></original_ref>

</BIB>

<BIB>

49

S Dyring-Andersen F B.

S Skov F L.

S Løvendorf F M.B.

S Bzorek F M.

S Søndergaard F K.

S Lauritsen F J.P.<ET-AL>

AT CD4(+) T cells producing interleukin (IL)-17 IL-22 and interferon-γ are major effector T cells in nickel allergy

JT Contact Dermatitis.

V 68

D 2013

P 339-L 347

DOI 10.1111/cod.12043

<original_ref>[49] Dyring-Andersen B, Skov L, Løvendorf MB, et al. CD4(+) T cells producing interleukin (IL)-17, IL-22 and interferon-γ are major effector T cells in nickel allergy. Contact Dermatitis 2013; 68:339–47.</original_ref>

</BIB>

<BIB>

50

S Todberg F T.

S Zachariae F C.

S Krustrup F D.

S Skov F L.

AT The effect of treatment with anti-interleukin-17 in patients with allergic contact dermatitis

JT Contact Dermatitis.

V 78

D 2018

P 431-L 432

<original_ref>[50] Todberg T, Zachariae C, Krustrup D, Skov L. The effect of treatment with anti-interleukin-17 in patients with allergic contact dermatitis. Contact Dermatitis 2018; 78:431–2.</original_ref>

</BIB>

<BIB>

51

S Benson F J.M.

S Peritt F D.

S Scallon F B.J.

S Heavner F G.A.

S Shealy F D.J.

S Giles-Komar F J.M.<ET-AL>

AT Discovery and mechanism of ustekinumab: a human monoclonal antibody targeting interleukin-12 and interleukin-23 for treatment of immune-mediated disorders

JT MAbs.

V 3

D 2011

P 535-L 545

DOI 10.4161/MABS.3.6.17815

<original_ref>[51] Benson JM, Peritt D, Scallon BJ, et al. Discovery and mechanism of ustekinumab: a human monoclonal antibody targeting interleukin-12 and interleukin-23 for treatment of immune-mediated disorders. MAbs 2011; 3. <DOI>10.4161/MABS.3.6.17815.</DOI></original_ref>

</BIB>

<BIB>

52

S Pennino F D.

S Eyerich F K.

S Scarponi F C.

S Carbone F T.

S Eyerich F S.

S Nasorri F F.<ET-AL>

AT IL-17 amplifies human contact hypersensitivity by licensing hapten nonspecific Th1 cells to kill autologous keratinocytes

JT J Immunol.

V 184

D 2010

P 4880-L 4888

DOI 10.4049/jimmunol.0901767

<original_ref>[52] Pennino D, Eyerich K, Scarponi C, et al. IL-17 amplifies human contact hypersensitivity by licensing hapten nonspecific Th1 cells to kill autologous keratinocytes. J Immunol 2010; 184:4880–8.</original_ref>

</BIB>

<BIB>

53

S Bangsgaard F N.

S Zachariae F C.

S Menné F T.

S Skov F L.

AT Lack of effect of ustekinumab in treatment of allergic contact dermatitis

JT Contact Dermatitis.

V 65

D 2011

P 227-L 230

<original_ref>[53] Bangsgaard N, Zachariae C, Menné T, Skov L. Lack of effect of ustekinumab in treatment of allergic contact dermatitis. Contact Dermatitis 2011; 65:227–30.</original_ref>

</BIB>

<BIB>

54

S El-Qutob F D.

AT Off-Label Uses of Omalizumab

JT Clin Rev Allergy Immunol.

V 50

D 2016

P 84-L 96

<original_ref>[54] El-Qutob D. Off-Label Uses of Omalizumab. Clin Rev Allergy Immunol 2016; 50:84–96.</original_ref>

</BIB>

<BIB>

55

S Mur Gimeno F P.

S Martín Iglesias F A.

S Lombardero Vega F M.

S Bautista Martínez F P.

S Ventura López F P.

AT Occupational wheat contact dermatitis and treatment with omalizumab

JT J Investig Allergol Clin Immunol.

V 23

D 2013

P 287-L 288

<original_ref>[55] Mur Gimeno P, Martín Iglesias A, Lombardero Vega M, et al. Occupational wheat contact dermatitis and treatment with omalizumab. J Investig Allergol Clin Immunol 2013; 23:287–8.</original_ref>

</BIB>

<BIB>

56

S Rosmarin F D.

S Bush F M.

S Scheinman F P.L.

AT Patch testing a patient with allergic contact hand dermatitis who is taking infliximab

JT J Am Acad Dermatol.

V 59

D 2008

P 145-L 147

<original_ref>[56] Rosmarin D, Bush M, Scheinman PL. Patch testing a patient with allergic contact hand dermatitis who is taking infliximab. J Am Acad Dermatol 2008; 59:145–7.</original_ref>

</BIB>

<BIB>

57

S Kim F N.

S Notik F S.

S Gottlieb F A.B.

S Scheinman F P.L.

AT Patch test results in psoriasis patients on biologics

JT Dermatitis.

V 25

D 2014

P 182-L 190

<original_ref>[57] Kim N, Notik S, Gottlieb AB, Scheinman PL. Patch test results in psoriasis patients on biologics. Dermatitis 2014; 25:182–90.</original_ref>

</BIB>

<BIB>

58

S Piguet F P.F.

S Grau F G.E.

S Vassalli F P.

AT Subcutaneous perfusion of tumor necrosis factor induces local proliferation of fibroblasts, capillaries, and epidermal cells, or massive tissue necrosis

JT Am J Pathol.

V 136

D 1990

P 103-L 110

<original_ref>[58] Piguet PF, Grau GE, Vassalli P. Subcutaneous perfusion of tumor necrosis factor induces local proliferation of fibroblasts, capillaries, and epidermal cells, or massive tissue necrosis. Am J Pathol 1990; 136:103–10.</original_ref>

59

S Cassano F N.

S Loconsole F F.

S Coviello F C.

S Vena F G.A.

AT Infliximab in recalcitrant severe atopic eczema associated with contact allergy

JT Int J Immunopathol Pharmacol.

V 19

D 2006

P 237-L 240

<original_ref>[59] Cassano N, Loconsole F, Coviello C, Vena GA. Infliximab in recalcitrant severe atopic eczema associated with contact allergy. Int J Immunopathol Pharmacol 2006; 19:237–40.</original_ref>

60

S Sato F T.

S Ishii F N.

S Murata F K.

S Kikuchi F K.

S Nakagawa F S.

S Ndhlovu F L.C.<ET-AL>

JT Consequences of OX40-OX40 ligand interactions in Langerhans cell function: enhanced contact hypersensitivity responses in OX40L-transgenic mice

D 2002

V 32

P 3326-L 3335

C 10.1002/1521-4141(200211)32:11<3326::AID-IMMU3326>3.0.CO;2-9.

<original_ref>[60] Sato T, Ishii N, Murata K, et al. Consequences of OX40-OX40 ligand interactions in Langerhans cell function: enhanced contact hypersensitivity responses in OX40L-transgenic mice. 2002. <DOI>10.1002/1521-4141.</DOI></original_ref>

</BIB>

<BIB>

61

S Croft F M.

S Esfandiari F E.

S Chong F C.

S Hsu F H.

S Kabashima F K.

S Kricorian F G.<ET-AL>

AT OX40 in the Pathogenesis of Atopic Dermatitis—A New Therapeutic Target

JT Am J Clin Dermatol.

V 25

D 2024

P 447-L 461

DOI 10.1007/s40257-023-00838-9

<original_ref>[61] Croft M, Esfandiari E, Chong C, et al. OX40 in the Pathogenesis of Atopic Dermatitis—A New Therapeutic Target. Am J Clin Dermatol 2024; 25:447–61.</original_ref>

Figure 1 Patient with ACD to thiuram mix, carba mix, and mercaptobenzothiazole (A and B) on baricitinib 2 mg every 24 hours with complete response at 4 weeks (C and D).

Table 1. Allergen, Molecular Profile, and Main Reference

Allergen	Molecular Profile	Main Reference
Nickel	Predominantly Th1 and Th17 polarization	[14]
Fragrances	Predominantly Th2 polarization	[14]
Rubber (latex)	Predominantly Th2 and Th22 polarization	[14, 39]

Table 2. JAK Inhibitors (iJAK): Drug, Mechanism of Action, ACD with Sensitization to Relevant Present Allergen Treatable or Capable of Silencing on Patch Tests, Study Type, Response, and Reference

Drug	Mechanism of Action	Allergen Treated	Study Type	Response	Reference
Abrocitinib (100 mg/24h)	iJAK 1	*Compositae* plant species (airborne)	Case report (N = 1)	CR	[21]
Tofacitinib (5 mg/24h)	Pan-JAK inhibitor	*Compositae* plant species (airborne)	Case report (N = 1)	CR	[22]
Upadacitinib (15 mg/24h)	iJAK 1	Fragrance mix I, Balsam of Peru	Case series (N = 2)	CR	[23]
Upadacitinib (30 mg/24h)	iJAK 1	Corticosteroids, Lanolin, Thiuram mix, 4-tert-butylphenol formaldehyde resin	Case report (N = 1)	CR	[24]
Baricitinib (2 mg/24h)	iJAK 1 and 2	Thiuram mix, Carba mix, Mercaptobenzothiazole	Real-world experience (N = 1)	CR	*Hospital Universitario Clínico San Cecilio*, Granada (Spain)

ACD: allergic contact dermatitis; CR: complete response.

No data on delgocitinib, ruxolitinib, roflumilast, or difamilast. Topical crisaborol can cause ACD[29],[30].

Table 3. Dupilumab. ACD with Sensitization to Relevant Present Allergen Treatable, Study Type, Response, and Reference

Allergen Treated	Study Type	Response	Reference
Rubber/latex	Case report (N = 1)	CR	[39]
Sesquiterpene lactone mix (*Compositae* plant species)	Case series (N = 2) [40] Case report (N = 1) [41]	CR	[40,41]
Sesquiterpene lactone mix (*Compositae* plant species)	Case report (N = 1)	CR	[41]
Potassium dichromate	Case report (N = 1)	CR	[42]
Isobornyl acrylate (IBOA)	Case report (N = 1)	CR	[43]

Nickel sulfate and Balsam of Peru (systemic contact dermatitis syndrome)	Case series (N = 5)	CR	[44]
Occupational: irritant contact dermatitis, unknown ingredient in iced coffee powder, paraphenylenediamine, acrylates (airborne)	Case series (N = 6)	CR	[46]
Multiple allergens in hairdresser: paraphenylenediamine, glyceryl monothioglycolate, ammonium persulfate, tixocortol-21-pivalate, quaternium-15, formaldehyde, fragrance mix	Case report (N = 1)	PR	[47]

ACD: allergic contact dermatitis; CR: complete response; PR: partial response.

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