


REVIEW ARTICLE

SARS-CoV-2 vaccination and practical points in psoriasis patients: A narrative review

Zeinab Aryanian^{1,2} | Kamran Balighi^{1,3} | Parvaneh Hatami¹  |
Azadeh Goodarzi^{4,5} | Nessa Aghazadeh Mohandesi⁶ | Zeinab Mohseni Afshar⁷

¹Autoimmune Bullous Diseases Research Center, Tehran University of Medical Sciences, Tehran, Iran

²Department of Dermatology, Babol University of Medical Sciences, Babol, Iran

³Department of Dermatology, School of Medicine Razi Hospital, Tehran University of Medical Sciences, Tehran, Iran

⁴Department of Dermatology, Rasoul-e-Akram Hospital, Iran University of Medical Sciences, Tehran, Iran

⁵Skin and Stem Cell Research Center, Tehran University of Medical Sciences, Tehran, Iran

⁶Department of Dermatology, Mayo Clinic, Rochester, Minnesota, USA

⁷Clinical Research Development Center, Imam Reza Hospital, Kermanshah University of Medical Sciences, Kermanshah, Iran

Correspondence

Zeinab Mohseni Afshar, Clinical Research Development Center, Imam Reza Hospital, Kermanshah University of Medical Sciences, Post Code: 9137913316, Kermanshah, Iran.
Email: zeinabafshar710@gmail.com

Parvaneh Hatami, Autoimmune Bullous Diseases Research Center, Razi Hospital, Tehran University of Medical Sciences, Post Code: 1199663911, Tehran, Iran.
Email: p_hatami2001@yahoo.com

Abstract

SARS-CoV2 vaccines were approved without long-term monitoring due to emergent situations. This has raised some issues about timing and protocol of receiving vaccines in specific situations including patients with chronic inflammatory disorders such as psoriasis. Here, we present different aspects of SARS-CoV-2 infection and vaccination in psoriasis patients and aim to provide solutions to overcome the potential challenges. In brief, the benefits of vaccination outweigh the potential risk; vaccine-triggered de novo or flares of psoriasis is uncommon. As such, all psoriasis patients, especially those receiving systemic treatments including anti tumor necrosis factor agents, are strongly recommended to get SARS-CoV-2 vaccines. It is recommended that new immunosuppressive/immunomodulatory therapies be initiated at least 1 week after the second SARS-CoV-2 vaccine dose, if possible. In addition, in severe and active forms of psoriasis, it is better to delay vaccination until stabilization of the disease.

KEYWORDS

biologic therapies, COVID-19 vaccine, immunosuppressive therapies, psoriasis

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) has led to a great rate of morbidity and mortality since its emergence. COVID-19 vaccination has proven to be highly safe and effective in clinical trials and real world, however, some unique challenges have risen especially in individuals with underlying diseases who are at higher risk of complications.¹ Vaccination against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been followed by several local and systemic cutaneous adverse events. Among them, local injection site reactions, urticarial eruptions and maculopapular rash have occurred

with the highest frequency, most of which have been self-limited.²⁻⁷ New-onset and exacerbation of some dermatological disorders, including lichen planus and psoriasis, have been reported following COVID-19 vaccination.⁸

Psoriasis is a common chronic inflammatory dermatosis which can affect the skin, nails, and the axial and peripheral joints.^{9,10} Psoriasis patients on immunosuppressive medications are at increased risks of infectious complication potentially including more severe forms of SARS-CoV-2 infection.^{11,12} Vaccination, along with social distancing and utilization of masks, can be an excellent strategy to decreased the risk of acquisition and complications associated with COVID-19 in

psoriasis patients, particularly those on immunomodulatory/immunosuppressive therapy.^{13,14} Immunosuppressive medications, however, are likely to affect the vaccine response and interfere with antibody production.¹⁵ Therefore, planned timing of vaccination, as much as possible may be crucial in some patients. Furthermore, studies suggest that individuals with inflammatory conditions such as psoriasis may have vaccine hesitancy due to concerns for disease exacerbation following vaccination.^{8,16}

Here, we present different aspects of SARS-CoV-2 infection and vaccination in psoriasis patients and aim to provide solutions to overcome the potential challenges.

1.1 | The impact of psoriasis and psoriasis treatments on COVID-19 infection

Psoriasis, per se, is not a state of immunosuppression, but it causes a milieu of systemic inflammation in the body.¹⁷ Tissue angiotensin converting enzyme (ACE) activity, which is the main component for SARS-CoV-2 spike protein binding, is higher in psoriasis patients, which, in theory, could lead to more severe COVID-19 infections.¹⁸ Moreover, immunosuppressant agents used for psoriasis precipitate the host to get an infection.¹⁹ Agents such as interleukin (IL)-17 inhibitors, which are the cornerstone of psoriasis treatment, can impair the mucosal immunity, thereby increase the risk of lower respiratory tract infections.²⁰ Anti-tumor necrosis factor (anti-TNF) agents as well as conventional immunosuppressive agents such as methotrexate and cyclosporine which are sometimes utilized for psoriasis management would also increase the risk of pulmonary infections, including SARS-CoV-2 ones.^{21–23} On the other hand, retinoids such as acitretin, due to their anti-inflammatory characteristics, may even have antiviral effects.²⁴ These problems had led the dermatologist to cease or reduce the dosage of certain medications in psoriasis patients.²⁵

1.2 | The impact of SARS-CoV-2 infection and medications used for its management on the course of psoriasis

Considering the hyper-inflammatory state and cytokine release along with ACE over-activity occurring in the settings of SARS-CoV-2 infection, psoriasis can be induced or exacerbated by COVID-19.^{26,27} Moreover, hydroxychloroquine (HCQ), which was widely utilized in the early days of COVID-19 pandemic, can be trigger psoriasis onset in predisposed individuals or its exacerbation.²⁸ The pathophysiologic mechanism might be blockade of epidermal transglutaminase activity by HCQ, which results in epidermal barrier break and subsequently psoriasis induction or flare-up. The increased production of IL-17 by HCQ can lead to keratinocyte overgrowth.^{29,30} Azithromycin, which was also commonly used in the beginning of the COVID-19 outbreak, may potentially improve psoriatic lesions by its immunomodulatory effect on keratinocytes and epidermal Langerhans cells.³¹

1.3 | Vaccination challenges in patients with psoriasis

Since some individuals with psoriasis are potentially at increased risk of severe COVID-19 due to immunosuppressant agent usage, vaccination against COVID-19 seems to be necessary for this population.³² However, there are several challenges for vaccinating these patients.

In general, several factors, such as genetic, stress, trauma, drugs and infections, are involved in the introduction or exacerbation of skin disorders, including psoriasis.³³ Reviewing the literature reveals, several cases of de novo psoriasis or disease flare up following SARS-CoV-2 infection.^{34–36} Vaccination has also been reported as a triggering factor for the evolution or exacerbation of psoriasis. The vaccine-induced psoriasis is so prevalent that the term “psoriasis vaccinialis” has been suggested for vaccine-induced new-onset psoriasis.³⁷ New-onset psoriasis or flare-up has been reported following several vaccines, including yellow fever, tetanus-diphtheria, BCG, pneumococcal polysaccharide, and influenza vaccines.^{38–44} A variety of clinical presentation of psoriasis have been reported in association with the latter vaccines such as plaque, guttate, erythrodermic, and pustular psoriasis.^{41,45,46} Accordingly, as the number of SARS-CoV-2 vaccinated psoriasis patients increases, the prevalence of vaccine-induced consequences increases proportionately.⁴⁷ Up to the present time, various forms of psoriasis flares, including Similarly, erythrodermic, guttate, plaque, and acute generalized pustular psoriasis have been reported following COVID-19 vaccines.^{32,48–53} A case of nail limited psoriasis was also observed.⁵² These complications have been observed irrespective of the vaccine platform and reported with various vaccine types such as Oxford-AstraZeneca, BNT162b2, Pfizer-BioNTech, and ChAdOx1 nCoV-19 Corona virus vaccines.^{32,51,54,55} Most cases have occurred within 1 month of the vaccine and following the second vaccine dose.⁸

The underlying mechanism could be the immunologic reaction to vaccine adjuvants and immune system dysregulation due to viral component, which may lead to epidermal changes and induction or exacerbation of certain cutaneous disorders such as psoriasis.^{38,56} It is believed that induction of neutralizing antibodies and T-cell responses by vaccines can lead to increased TNF- α and interferon (IFN)- γ production.⁵⁷ In addition, plasmacytoid and dermal myeloid dendritic cells might be activated with vaccination. All of these conditions can be a trigger for psoriasis cascade.^{57,58} Moreover, vaccines might induce IL-6 production, which is the trigger for T helper (Th) 17 cells to produce IL-22, which itself stimulates keratinocyte proliferation, lead to epidermal changes, and consequently psoriasis induction or exacerbation.^{56,59} However, it is believed that mRNA vaccines, due to their modifying effect on toll-like receptors, can potentially decrease the risk of exacerbation in autoimmune diseases like psoriasis.⁶⁰ Nonetheless, this hypothesis should be proved since several psoriasis flares have been reported following receiving SARS-CoV-2 mRNA vaccines.^{32,61} It is also important to know that psoriasis patients on Apremilast, which is a phosphodiesterase (PDE)-4 inhibitor, have not experienced disease flare-up after any of COVID-19 vaccines.⁶²

1.4 | The impact of psoriasis treatment regimens on vaccine immune response

Psoriasis is treated with several regimens which have various impacts on vaccine-induced immune response.⁶³ However, literature review reveals conflicting results about the interaction between vaccines and therapeutics used in psoriasis and other autoimmune disorders.⁶⁴ It has been demonstrated that psoriasis patients on systemic treatment, such as secukinumab and other biologics, are protected against vaccine-induced exacerbation, while those who are receiving merely topical treatment are more likely to develop flare-ups following vaccination.⁶⁵

1.5 | The decision to vaccinate psoriasis patients

Despite the small risk of new-onset or flares following vaccination, psoriasis patients are strongly encouraged to receive SARS-CoV-2 vaccines, because vaccine-induced psoriasis, is rare, short-lived, has a favorable prognosis and responds well to standard treatments.^{66,67} Moreover, psoriasis patients are at increased risk of severe SARS-CoV-2 infection due to the inflammatory nature of this dermatological disorder and also the immunosuppressive medications they use.²⁷ Therefore, authorities recommend COVID-19 vaccination in all psoriasis patients without confirmed history of allergy to vaccine or any of its components, particularly individuals on any kind of immunosuppressive treatment.⁶⁸ However, it should be kept in mind not to administer attenuated live vaccines in those individual on immunomodulatory/immunosuppressive therapy.⁶⁹ In these conditions, non-live vaccines should be considered. Fortunately, none of the currently used SARS-CoV-2 vaccine platforms are live vaccines. Therefore, all psoriasis patients without a history of vaccine allergy or any contraindications, should receive SARS-CoV-2 vaccines as soon as possible.⁷⁰

1.6 | Vaccine response in psoriasis patients on immunosuppressive therapy

The immunosuppressed states, such as those induced by medications, can affect the ability of an individual to mount an effective and long-standing humoral, cellular and innate immunity to vaccines.⁷¹

It seems that vaccination is well-tolerated in patients with autoimmune disorders like psoriasis, even though the vaccine-induced immunity might be diminished in those individuals on immunosuppressive agents, namely methotrexate or CD20-targeted agents.^{72,73} However, real world data suggest that even this sub-optimal reduced response can be effective enough to prevent severe forms of SARS-CoV-2 infection.

The most prevalent therapeutics used for psoriasis management include methotrexate, and biologics which target the cytokines such as TNF and ILs.⁷⁴

Methotrexate, which is an antimetabolite agent and used in several autoimmune dermatoses including psoriasis, had been showed to

impair antibody responses to certain vaccines such as influenza and pneumococcal vaccines.^{75,76} Studies on serologic response to COVID-19 vaccines showed lower seroconversion rates in vaccinated psoriasis patients who were on methotrexate, compared with healthy individuals. Patients on methotrexate achieve the lowest antibody response after vaccination.⁷⁵ It appears that methotrexate dampens the humoral immune response, however, the cellular immune response may be relatively intact. Thus, despite the diminished antibody levels, a relatively favorable vaccine response is expected.⁷⁷

Biologic agents are other therapeutic regimens approved and commonly utilized for psoriasis patients. This class include anti-TNF- α , and anti-ILs including etanercept, infliximab, and secukinumab.⁷⁸ The impact of biologic agents on vaccine immunogenicity are more controversial; some studies acknowledge that targeted biologics, especially anti TNF agents, do not impair antibody response to vaccines and psoriasis patients receiving these agents show normal immunogenicity against SARS-CoV-2 vaccination.⁷⁹ For example, secukinumab, which is an IL-17A inhibitor, was shown to have no negative effect on vaccine-induced immunity.⁸⁰

Despite all the aforementioned challenges in individuals on immunosuppressant agents, the degree of seroconversion alone does not represent vaccine immunogenicity, since vaccine-induced cellular immunity seems to have a more important role, compared with humoral immunity for achieving protection against respiratory viruses such as influenza and SARS-CoV-2.^{81,82} It has been demonstrated that despite the decreased vaccine-induced humoral immune responses in patients receiving B-cell depleting agents, T-cell responses are still intact and the mere cellular responses following vaccination may suffice for protection against SARS-CoV-2.⁸³ Moreover, supposed that COVID-19 vaccines responses are diminished in psoriasis patients on immunosuppressive agents, it is still unclear whether this leads to increased rate of breakthrough SARS-CoV-2 infections.⁸⁴ In addition, vaccine immunogenicity in those patients undergoing immunomodulatory agents varies for different SARS-CoV-2 variants. This highlights the need to receive vaccine booster doses.⁸⁵

1.7 | Timing of vaccination in psoriasis patients who are on immune modulators/ immune suppressants

Due to the potential for reduced vaccine immune response in patients receiving immunosuppressive therapy, vaccination status should be assessed prior to initiating these therapeutic regimens.⁸⁶

Guidelines recommend patients on immunosuppressive therapy to receive live vaccines either 2–4 weeks before starting therapy or 1–3 months after stopping or ending therapy. In contrast, non-live vaccines are allowed concomitantly to immunosuppressive therapy.¹⁴ However, different guidelines have various opinions. In general, SARS-CoV-2 vaccination should be ideally completed at least 2 weeks prior to starting immunosuppressive agents. As COVID-19 vaccines doses are administered at least 4 weeks apart, the decision to hold

psoriasis treatment until vaccination completion can have adverse effects on the course of psoriasis, leading to recurrences.⁸⁷ Therefore, the risk–benefit should be weighed.

Psoriasis patients are allowed to continue certain immunosuppressive medications, such as biologics during COVID-19 vaccination. These agents are considered safe and noninterfering with vaccine-induced responses and their dosage does not need to be modified before vaccination. Hence, they can safely be administered concomitant with inactive vaccines, unless used along with methotrexate.⁸⁸

Conversely, some authorities recommend psoriasis patients to discontinue treatment with methotrexate during vaccination, due to the diminished antibody response, while some believe it should be stopped 2 weeks before and 2–4 weeks after vaccination.⁸⁹ However, due to the risk of exacerbation, some authorities recommend that this agent should be suspended only for 1 week after each vaccine dose.⁹⁰ Cyclosporine, a calcineurin inhibitor, despite having similar modifying effect on vaccine response, does not need to be stopped around vaccination time, since it has a relatively short half-life.⁹¹ Mycophenolate mofetil (MMF), it has been shown that temporary holding MMF for at least 1 week helps immune response to COVID vaccination.⁹² Azathioprine has a more favorable profile than MMF and cyclosporine in affecting humoral vaccine response, therefore, its continuation seems to be harmless concomitantly with vaccination.^{93,94} Apremilast, which is a selective PDE-4 inhibitor and is widely used for psoriasis, seems to have little adverse effect on vaccine-induced immune response due to its immunomodulatory properties. Therefore, it can probably be used before, during and after the vaccination program.⁹⁵

The issue may be somewhat different for timing of treatment with monoclonal antibodies such as rituximab which have seldom been used to treat psoriasis, compared to other dermatoses.^{96–99} It is advised to give space between the last rituximab infusion and vaccination, in order for the immune system to reconstitute B cells and achieve higher seroconversion. If patients are not at risk of organ damage or disease relapse, it is better to delay rituximab administration until completion of COVID-19 vaccination.⁹⁹ Some guidelines even recommend to postpone vaccination to at least 6 months after the last rituximab infusion.¹⁰⁰ Nonetheless, every patient should be decided individually based on the risk–benefit ratio.

In brief, for achieving the optimal vaccine response, it is recommended that new immunosuppressive/immunomodulatory therapies be initiated at least 1 week after the second SARS-CoV-2 vaccine dose, if possible. In addition, in severe and active forms of psoriasis, it is better to delay vaccination until stabilization of the disease.

Another important point of view is the fact that although vaccine-induced immune responses are attenuated in psoriasis patients receiving immunosuppressive agents, repeating vaccine doses can further increase T-cell responses following vaccination. Therefore, booster doses seems to be beneficial in these patients.⁷³ However, booster doses might not be given priority in patients under treatment with anti TNF agents due to reaching to an acceptable level of post-vaccine immunity compared to those receiving other immunosuppressant agents.¹⁰¹

2 | CONCLUSION

Vaccine-triggered de novo or flares of psoriasis is uncommon and the benefits of vaccinations significantly outweighs the risks, psoriasis patients are strongly recommended to get SARS-CoV-2 vaccines. The majority of post-vaccination psoriasis flare have reported to be relatively mild in severity and responsive to topical treatments. Thus, psoriasis patients can be reassured about the slight risk of psoriasis flare up with COVID vaccination. Some medications, such as anti-TNFs, IL-17 inhibitors and apremilast may potentially have protective effect against COVID vaccine-induced flares.

CONFLICT OF INTERESTS

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

All authors contributed to the preparation of data and finalization of this article.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Parvaneh Hatami  <https://orcid.org/0000-0002-3531-2907>

REFERENCES

1. Afshar ZM, Babazadeh A, Janbakhsh A, Afsharian M, Ebrahimpour S. COVID-19 vaccines: challenges and solutions. *Minerva Dermatol.* 2021;60(4):136–141.
2. Babazadeh A, Miladi R, Barary M, Shirvani M, Ebrahimpour S, Afshar ZM. COVID-19 vaccine-related new-onset lichen planus. *Authorea Preprints.* 2021;10(2).
3. Hatami P, Nicknam Asl H, Aryanian Z. Cutaneous manifestations of COVID-19 in children: practical points for clinicians. *J Skin Stem Cell.* 2022;8(4):e122260. doi:10.5812/jssc.122260
4. Kalantari Y, Sadeghzadeh-Bazargan A, Aryanian Z, Hatami P, Goodarzi A. The first reported case of delayed-type hypersensitivity reaction to non-hyaluronic acid polycaprolactone dermal filler following COVID-19 vaccination: a case report and a review of the literature. *Clin Case Rep.* 2022;10(2):e05343. doi:10.1002/ccr3.5343
5. Hatami P, Aryanian Z, Nicknam Asl H, Goodarzi A. Mucocutaneous adverse effects following COVID-19 vaccination: a comprehensive review of the literature with a presentation of some cases from Iran. *Iran J Dermatol.* 2021;24(4):331–338. doi:10.22034/IJD.2021.3110.94.1451
6. Hatami P, Balighi K, Nicknam Asl H, Aryanian Z. Serious health threat of mucormycosis during the ongoing COVID-19 pandemic: what dermatologists need to know in this regards. *International Journal of Dermatology.* 2022. doi:10.1111/ijd.16101
7. Mohaghegh F, Hatami P, Aryanian Z. A case of atypical disseminated herpes zoster in a patient with COVID-19; a diagnostic challenge in COVID era. *J Clin Case Rep.* 2022;10(2):e05342. doi:10.1002/ccr3.5342
8. Wei N, Kresch M, Elbogen E, Leibold M. New onset and exacerbation of psoriasis after COVID-19 vaccination. *JAAD Case Rep.* 2022; 19:74–77.
9. Ghiasi M, Nouri M, Abbasi A, Hatami P, Abbasi MA, Nourijelyani K. Psoriasis and increased prevalence of hypertension and diabetes

- mellitus. *Indian J Dermatol.* 2011;56(5):533-536. doi:10.4103/0019-5154.87149
10. Aryanian Z, Jafaripour I, Kohneshin E, et al. Echocardiographic and electrocardiographic assessments in patients with psoriasis. *Caspian J Intern Med.* 2021;12(2):162.
 11. Mohseni Afshar Z, Babazadeh A, Hasanpour A, et al. Dermatological manifestations associated with COVID-19: a comprehensive review of the current knowledge. *J Med Virol.* 2021;93(10):5756-5767.
 12. Lima X, Cueva M, Lopes E, Alora M. Severe COVID-19 outcomes in patients with psoriasis. *J Eur Acad Dermatol Venereol.* 2020;34(12):776-778.
 13. Speeckaert R, Lambert J, Puig L, et al. Vaccinations in patients receiving systemic drugs for skin disorders: what can we learn for SARS-Cov-2 vaccination strategies? *Drugs R&D.* 2021;21(3):341-350.
 14. Chiricozzi A, Gisondi P, Bellinato F, Girolomoni G. Immune response to vaccination in patients with psoriasis treated with systemic therapies. *Vaccine.* 2020;8(4):769.
 15. Elmas ÖF, Demirbaş A, Kutlu Ö, et al. Psoriasis and COVID-19: a narrative review with treatment considerations. *Dermatol Ther.* 2020;33(6):e13858.
 16. Sotiriou E, Bakirtzi K, Papadimitriou I, et al. COVID-19 vaccination intention among patients with psoriasis compared with immunosuppressed patients with other skin diseases and factors influencing their decision. *Br J Dermatol.* 2021;185(1):209-210. doi:10.1111/bjd.19882
 17. Griffiths CE, Barker JN. Pathogenesis and clinical features of psoriasis. *The Lancet.* 2007;370(9583):263-271.
 18. Huskić J, Mulabegović N, Alendar F, et al. Serum and tissue angiotensin converting enzyme in patients with psoriasis. *Coll Antropol.* 2008;32(4):1215-1219.
 19. Syed M, Shah M, Shin D, Wan M, Winthrop K, Gelfand J. Effect of anti-tumor necrosis factor therapy on the risk of respiratory tract infections and related symptoms in psoriasis patients—a meta-estimate of pivotal phase 3 trials relevant to decision-making during the COVID-19 pandemic. *J Am Acad Dermatol.* 2020;84(1):161-163.
 20. Wan MT, Shin DB, Winthrop KL, Gelfand JM. The risk of respiratory tract infections and symptoms in psoriasis patients treated with interleukin 17 pathway-inhibiting biologics: a meta-estimate of pivotal trials relevant to decision making during the COVID-19 pandemic. *J Am Acad Dermatol.* 2020;83(2):677-679.
 21. Syed MN, Shah M, Shin DB, Wan MT, Winthrop KL, Gelfand JM. Effect of anti-tumor necrosis factor therapy on the risk of respiratory tract infections and related symptoms in patients with psoriasis—a meta-estimate of pivotal phase 3 trials relevant to decision making during the COVID-19 pandemic. *J Am Acad Dermatol.* 2021;84(1):161-163.
 22. Karadag AS, Aslan Kayıran M, Lotti T, Wollina U. Immunosuppressive and immunomodulator therapy for rare or uncommon skin disorders in pandemic days. *Dermatol Ther.* 2020;33(5):e13686.
 23. Fagni F, Simon D, Tascilar K, et al. COVID-19 and immune-mediated inflammatory diseases: effect of disease and treatment on COVID-19 outcomes and vaccine responses. *Lancet Rheumatol.* 2021;3(10):e724-e736.
 24. Caselli E, Galvan M, Santoni F, et al. Retinoic acid analogues inhibit human herpesvirus 8 replication. *Antivir Ther.* 2008;13(2):199.
 25. Torres T, Pereira M, Lopes MJP, et al. Dermatologists' attitude towards psoriasis treatment during the COVID-19 pandemic. *Drugs Context.* 2021;10(4):101-103.
 26. Ozaras R, Berk A, Ucar DH, Duman H, Kaya F, Mutlu H. Covid-19 and exacerbation of psoriasis. *Dermatol Ther.* 2020;33(4):e13632.
 27. Shahidi-Dadras M, Tabary M, Robati RM, Araghi F, Dadkhahfar S. Psoriasis and risk of the COVID-19: is there a role for angiotensin converting enzyme (ACE)? *J Dermatol Treat.* 2020;30(1):2.
 28. Wong YK, Yang J, He Y. Caution and clarity required in the use of chloroquine for COVID-19. *Lancet Rheumatol.* 2020;2(5):e255.
 29. Wolf R, Lo Schiavo A, Lombardi ML, De Angelis F, Ruocco V. The in vitro effect of hydroxychloroquine on skin morphology in psoriasis. *Int J Dermatol.* 1999;38(2):154-157.
 30. Said A, Bock S, Lajqi T, Müller G, Weindl G. Chloroquine promotes IL-17 production by CD4+ T cells via p38-dependent IL-23 release by monocyte-derived Langerhans-like cells. *J Immunol.* 2014;193(12):6135-6143.
 31. Saxena V, Dogra J. Long-term oral azithromycin in chronic plaque psoriasis: a controlled trial. *Eur J Dermatol.* 2010;20(3):329-333.
 32. Bostan E, Elmas L, Yel B, Yalici-Armagan B. Exacerbation of plaque psoriasis after inactivated and BNT162b2 mRNA COVID-19 vaccines: a report of two cases. *Dermatol Ther.* 2021;34(6):e15110.
 33. Lee EB, Wu KK, Lee MP, Bhutani T, Wu JJ. Psoriasis risk factors and triggers. *Cutis.* 2018;102(5S):18-20.
 34. Nasiri S, Araghi F, Tabary M, Gheisari M, Mahboubi-Fooladi Z, Dadkhahfar S. A challenging case of psoriasis flare-up after COVID-19 infection. *J Dermatol Treat.* 2020;31(5):448-449.
 35. Ganandan K, Sacks B, Ewing I. Guttate psoriasis secondary to COVID-19. *BMJ Case Rep CP.* 2020;13(8):e237367.
 36. Miladi R, Janbakhsh A, Babazadeh A, et al. Pustular psoriasis flare-up in a patient with COVID-19. *J Cosmet Dermatol.* 2021;20(11):3364-3368.
 37. Gao P-R, Huang Y-H, Ng CY. Psoriasis vaccinialis. *Dermatol Sin.* 2020;38(4):258.
 38. Shi CR, Nambudiri VE. Widespread psoriasis flare following influenza vaccination. *Vaccine.* 2017;35(36):4785-4786.
 39. Sbidian E, Eftekhari P, Viguier M, et al. National survey of psoriasis flares after 2009 monovalent H1N1/seasonal vaccines. *Dermatology.* 2014;229(2):130-135.
 40. Barros MHD, Avelleira JCR, Mendes KAP. Impact of yellow fever vaccine on patients with psoriasis: preliminary results. *An Bras Dermatol.* 2019;94(6):757-759.
 41. Koca R, Altinyazar HC, Numanoglu G, Ünalacak M. Guttate psoriasis-like lesions following BCG vaccination. *J Trop Pediatr.* 2004;50(3):178-179.
 42. Macias VC, Cunha D. Psoriasis triggered by tetanus-diphtheria vaccination. *Cutan Ocul Toxicol.* 2013;32(2):164-165.
 43. Blum A, Suleiman S, Shalabi R. Erythrodermic pustular psoriasis triggered by subcutaneous flu vaccine. *J Clin Case Rep.* 2013;3(255):2.
 44. Yoneyama S, Kamiya K, Kishimoto M, Komine M, Ohtsuki M. Generalized exacerbation of psoriasis vulgaris induced by pneumococcal polysaccharide vaccine. *J Dermatol.* 2019;46(11):e442-e443.
 45. Shin MS, Kim SJ, Kim SH, Kwak YG, Park H-J. New onset guttate psoriasis following pandemic H1N1 influenza vaccination. *Ann Dermatol.* 2013;25(4):489-492.
 46. Munguía-Calzada P, Drake-Monfort M, Armesto S, Reguero-del Cura L, López-Sundh AE, González-López MA. Psoriasis flare after influenza vaccination in Covid-19 era: a report of four cases from a single center. *Dermatol Ther.* 2021;34(1):e14684.
 47. Sotiriou E, Tsentemidou A, Bakirtzi K, Lallas A, Ioannides D, Vakirlis E. Psoriasis exacerbation after COVID-19 vaccination: a report of 14 cases from a single centre. *J Eur Acad Dermatol Venereol.* 2021;35(12):857-859.
 48. Perna D, Jones J, Schadt CR. Acute generalized pustular psoriasis exacerbated by the COVID-19 vaccine. *JAAD Case Rep.* 2021;17:1-3.
 49. Lehmann M, Schorno P, Hunger R, Heidemeyer K, Feldmeyer L, Yawalkar N. New onset of mainly guttate psoriasis after COVID-19 vaccination: a case report. *J Eur Acad Dermatol Venereol.* 2021;35(11):752-755.
 50. Teh N, Leow LJ. Psoriatic flare following Oxford-AstraZeneca ChAdOx1 COVID-19 and influenza vaccines. *Curr Opin Allergy Clin Immunol.* 2021;21(4):401-409.
 51. Onsun N, Kaya G, Işık BG, Güneş B. A generalized pustular psoriasis flare after CoronaVac COVID-19 vaccination: case report. *Health Promot Perspect.* 2021;11(2):261-262.

52. Ricardo JW, Lipner SR. Case of de novo nail psoriasis triggered by the second dose of Pfizer-BioNTech BNT162b2 COVID-19 messenger RNA vaccine. *JAAD Case Rep.* 2021;17:18-20.
53. Elamin S, Hinds F, Tolland J. De novo generalized pustular psoriasis following Oxford-AstraZeneca COVID-19 vaccine. *Clin Exp Dermatol.* 2022;47(1):153-155.
54. Fang WC, Chiu LW, Hu SCS. Psoriasis exacerbation after first dose of AstraZeneca coronavirus disease 2019 vaccine. *J Dermatol.* 2021; 48(11):e566.
55. Nagrani P, Jindal R, Goyal D. Onset/flare of psoriasis following the ChAdOx1 nCoV-19 Corona virus vaccine (Oxford-AstraZeneca/Covishield): report of two cases. *Dermatol Ther.* 2021; 34(5):e15085.
56. Gunes AT, Fetil E, Akarsu S, Ozbagcivan O, Babayeva L. Possible triggering effect of influenza vaccination on psoriasis. *J Immunol Res.* 2015;2015:1-4.
57. Ewer KJ, Barrett JR, Belij-Rammerstorfer S, et al. T cell and antibody responses induced by a single dose of ChAdOx1 nCoV-19 (AZD1222) vaccine in a phase 1/2 clinical trial. *Nat Med.* 2021;27(2): 270-278.
58. Farkas A, Tonel G, Nestle F. Interferon- α and viral triggers promote functional maturation of human monocyte-derived dendritic cells. *Brit J Dermatol.* 2008;158(5):921-929.
59. Takayama K, Satoh T, Hayashi M, Yokozeki H. Psoriatic skin lesions induced by BCG vaccination. *Acta Derm Venereol.* 2008;88(6): 621-622.
60. Stingeni L, Bianchi L, Peris K, et al. SARS-CoV-2 vaccines and biological treatments: dermatological perspectives. *Ital J Dermatol Venereol.* 2021;156(2):118-120.
61. Krajewski P, Matusiak Ł, Szepietowski J. Psoriasis flare up associated with second dose of Pfizer-BioNTech BNT16B2b2 COVID-19 mRNA vaccine. *J Eur Acad Dermatol Venereol.* 2021;65(10):632-634.
62. Pacifico A, d'Arino A, Pigatto P, Malagoli P, Network YDI, Damiani G. COVID-19 vaccine does not trigger psoriasis flares in psoriatic patients treated with apremilast. *Clin Exp Dermatol.* 2021; 46(7):1344-1346.
63. Gisondi P, Geat D, Naldi L, Piaserico S. Insights into Sars-CoV-2 vaccination in patients with chronic plaque psoriasis on systemic treatments. *J Eur Acad Dermatol Venereol.* 2021;35(6):361-362.
64. Papp KA, Haraoui B, Kumar D, et al. Vaccination guidelines for patients with immune-mediated disorders on immunosuppressive therapies. *J Cutan Med Surg.* 2019;23(1):50-74.
65. Damiani G, Allocco F, Network YDI, Malagoli P. COVID-19 vaccination and patients with psoriasis under biologics: real-life evidence on safety and effectiveness from Italian vaccinated healthcare workers. *Clin Exp Dermatol.* 2021;46(6):1106-1108. doi:10.1111/ced.14631
66. Diotallevi F, Campanati A, Radi G, et al. Vaccination against SARS-CoV-2 and psoriasis: the three things every dermatologist should know. *J Eur Acad Dermatol Venereol.* 2021;35(7):e428.
67. Pesqué D, Lopez-Trujillo E, Marcantonio O, Giménez-Arnau AM, Pujol RM. New-onset and exacerbations of psoriasis after mRNA COVID-19 vaccines: two sides of the same coin? *J Eur Acad Dermatol Venereol.* 2021;36(2):80-81.
68. Diotallevi F, Campanati A, Radi G, et al. Vaccines against SARS-CoV-2 in psoriasis patients on immunosuppressive therapy: implications of vaccination nationwide campaign on clinical practice in Italy. *Dermatol Ther.* 2021;11(6):1889-1903.
69. Mihai MM, Ion A, Popa LG, et al. Coronavirus vaccination in patients with Psoriasis vulgaris under immunosuppressive therapy. *Proc Rom Acad Ser B, Chem Life Sci Geosci.* 2021;23(10000):108-114.
70. Skroza N, Bernardini N, Tolino E, et al. Safety and impact of anti-COVID-19 vaccines in psoriatic patients treated with biologics: a real life experience. *J Clin Med.* 2021;10(15):3355.
71. Jeyanathan M, Afkhami S, Smaill F, Miller MS, Lichty BD, Xing Z. Immunological considerations for COVID-19 vaccine strategies. *Nat Rev Immunol.* 2020;20(10):615-632.
72. Simon D, Tascilar K, Fagni F, et al. SARS-CoV-2 vaccination responses in untreated, conventionally treated and anticytokine-treated patients with immune-mediated inflammatory diseases. *Ann Rheum Dis.* 2021;80(10):1312-1316.
73. Kennedy NA, Lin S, Goodhand JR, et al. Infliximab is associated with attenuated immunogenicity to BNT162b2 and ChAdOx1 nCoV-19 SARS-CoV-2 vaccines in patients with IBD. *Gut.* 2021;70(10):1884-1893.
74. Kalb RE, Fiorentino DF, Lebwohl MG, et al. Risk of serious infection with biologic and systemic treatment of psoriasis: results from the psoriasis longitudinal assessment and registry (PSOLAR). *JAMA Dermatol.* 2015;151(9):961-969.
75. Kapetanovic MC, Roseman C, Jönsson G, Truedsson L, Saxne T, Geborek P. Antibody response is reduced following vaccination with 7-valent conjugate pneumococcal vaccine in adult methotrexate-treated patients with established arthritis, but not those treated with tumor necrosis factor inhibitors. *Arthritis Rheum.* 2011;63(12):3723-3732.
76. Kim JY, Dao H Jr. Influenza vaccination recommendations during use of select immunosuppressants for psoriasis. *Cutis.* 2020;106(4): 194-195.
77. Mahil SK, Bechman K, Raharja A, et al. Humoral and cellular immunogenicity to a second dose of COVID-19 vaccine BNT162b2 in people receiving methotrexate or targeted immunosuppression: a longitudinal cohort study. *Lancet Rheumatol.* 2021;4(1):42-52.
78. Kamata M, Tada Y. Safety of biologics in psoriasis. *J Dermatol.* 2018; 45(3):279-286.
79. Haberman RH, Herati R, Simon D, et al. Methotrexate hampers immunogenicity to BNT162b2 mRNA COVID-19 vaccine in immune-mediated inflammatory disease. *Ann Rheum Dis.* 2021; 80(10):1339-1344.
80. Furer V, Zisman D, Kaufman I, et al. Immunogenicity and safety of vaccination against seasonal influenza vaccine in patients with psoriatic arthritis treated with secukinumab. *Vaccine.* 2020;38(4): 847-851.
81. Peng Y, Mentzer AJ, Liu G, et al. Broad and strong memory CD4+ and CD8+ T cells induced by SARS-CoV-2 in UK convalescent individuals following COVID-19. *Nat Immunol.* 2020;21(11):1336-1345.
82. McElhane JE, Ewen C, Zhou X, et al. Granzyme B: correlates with protection and enhanced CTL response to influenza vaccination in older adults. *Vaccine.* 2009;27(18):2418-2425.
83. Bonelli MM, Mrak D, Perkmann T, Haslacher H, Aletaha D. SARS-CoV-2 vaccination in rituximab-treated patients: evidence for impaired humoral but inducible cellular immune response. *Ann Rheum Dis.* 2021;80(10):1355-1356.
84. Mahil SK, Bechman K, Raharja A, et al. The effect of methotrexate and targeted immunosuppression on humoral and cellular immune responses to the COVID-19 vaccine BNT162b2: a cohort study. *Lancet Rheumatol.* 2021;3(9):e627-e637.
85. Emary KR, Golubchik T, Aley PK, et al. Efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine against SARS-CoV-2 variant of concern 202012/01 (B. 1.1. 7): an exploratory analysis of a randomised controlled trial. *The Lancet.* 2021;397(10282):1351-1362.
86. Papp KA, Haraoui B, Kumar D, et al. Vaccination guidelines for patients with immune-mediated disorders on immunosuppressive therapies—executive summary. *J Can Assoc Gastroenterol.* 2019;2(4): 149-152.
87. Anderson EJ, Rouphael NG, Widge AT, et al. Safety and immunogenicity of SARS-CoV-2 mRNA-1273 vaccine in older adults. *N Engl J Med.* 2020;383(25):2427-2438.
88. Visvanathan S, Keenan GF, Baker DG, Levinson AI, Wagner CL. Response to pneumococcal vaccine in patients with early rheumatoid arthritis receiving infliximab plus methotrexate or methotrexate alone. *J Rheumatol.* 2007;34(5):952-957.
89. Park JK, Lee YJ, Shin K, et al. Impact of temporary methotrexate discontinuation for 2 weeks on immunogenicity of seasonal influenza

- vaccination in patients with rheumatoid arthritis: a randomised clinical trial. *Ann Rheum Dis*. 2018;77(6):898-904.
90. Curtis JR, Johnson SR, Anthony DD, et al. American college of rheumatology guidance for COVID-19 vaccination in patients with rheumatic and musculoskeletal diseases: version 2. *Arthritis Rheumatol*. 2021;73(8):e30-e45.
91. Karbasi-Afshar R, Izadi M, Fazel M, Khedmat H. Response of transplant recipients to influenza vaccination based on type of immunosuppression: a meta-analysis. *Saudi J Kidney Dis Transpl*. 2015;26(5):877-883.
92. Connolly CM, Chiang TP, Boyarsky BJ, et al. Temporary hold of mycophenolate augments humoral response to SARS-CoV-2 vaccination in patients with rheumatic and musculoskeletal diseases: a case series. *Ann Rheumat Dis*. 2022;81:293-295.
93. Oesterreich S, Lindemann M, Goldblatt D, Horn PA, Wilde B, Witzke O. Humoral response to a 13-valent pneumococcal conjugate vaccine in kidney transplant recipients. *Vaccine*. 2020;38(17):3339-3350.
94. Keshtkar-Jahromi M, Argani H, Rahnavardi M, et al. Antibody response to influenza immunization in kidney transplant recipients receiving either azathioprine or mycophenolate: a controlled trial. *Am J Nephrol*. 2008;28(4):654-660.
95. Schafer P, Parton A, Capone L, et al. Apremilast is a selective PDE4 inhibitor with regulatory effects on innate immunity. *Cell Signal*. 2014;26(9):2016-2029.
96. Aryanian Z, Balighi K, Daneshpazhooh M, et al. Rituximab exhibits a better safety profile when used as a first line of treatment for pemphigus vulgaris: a retrospective study. *Int Immunopharmacol*. 2021;96:107755. doi:10.1016/j.intimp.2021.107755
97. Balighi K, Hatami P, Sheikh Aboli MJ, et al. Multiple cycles of rituximab therapy for pemphigus: a group of patients with difficult-to-treat disease or a consequence of late rituximab initiation? *Dermatol Ther*. 2021;8:e15249. doi:10.1111/dth.15249
98. Tavakolpour S, Aryanian Z, Seirafianpour F, et al. A systematic review on efficacy, safety, and treatment-durability of low-dose rituximab for the treatment of pemphigus: special focus on COVID-19 pandemic concerns. *Immunopharmacol Immunotoxicol*. 2021;43(5):507-518. doi:10.1080/08923973.2021.1953063
99. Hatami P, Balighi K, Nicknam Asl H, Aryanian Z. COVID vaccination in patients under treatment with rituximab: a presentation of two cases from Iran and a review of the current knowledge with a specific focus on pemphigus. *Dermatol Ther*. 2021;35(1):e15216.
100. Gabay C, Bel M, Combescure C, et al. Impact of synthetic and biologic disease-modifying antirheumatic drugs on antibody responses to the AS03-adjuvanted pandemic influenza vaccine: a prospective, open-label, parallel-cohort, single-center study. *Arthritis Rheum*. 2011;63(6):1486-1496.
101. Waldman RA, Grant-Kels JM. Dermatology patients on biologics and certain other systemic therapies should receive a "booster" messenger RNA COVID-19 vaccine dose: a critical appraisal of recent Food and Drug Administration and advisory committee on immunization practices recommendations. *J Am Acad Dermatol*. 2021;85(5):1113-1116. doi:10.1016/j.jaad.2021.08.031

How to cite this article: Aryanian Z, Balighi K, Hatami P, Goodarzi A, Mohandesi NA, Afshar ZM. SARS-CoV-2 vaccination and practical points in psoriasis patients: A narrative review. *Dermatologic Therapy*. 2022;35(5):e15430. doi:10.1111/dth.15430