COVID-19 vaccines: What dermatologists should know?

Azin Ayatollahi | Hamed Hosseini | Rojin Firooz | Alireza Firooz

Abstract
As COVID-19 vaccination has started worldwide to control this pandemic, dermatologists may face various challenges with these new vaccines. In this manuscript, we review different types of available COVID-19 vaccines and their various production platforms. Vaccination considerations in patients with skin diseases, especially those using immunomodulatory drugs will be presented. Finally, adverse cutaneous reactions of COVID-19 vaccines will be reviewed.

KEYWORDS
COVID-19, dermatologist, immunomodulatory drugs, vaccine

INTRODUCTION

SARS-CoV-2 is a novel coronavirus causing COVID-19 infection with high infectivity and severe morbidity and mortality. The COVID-19 pandemic urged the world of medicine to conduct multifaceted research leading, among other things, to development of novel vaccine platforms (i.e., mRNA, DNA, non-replicating viral vectors, and so on.).

Since the onset of the pandemic in early 2020, dermatologists have observed that various cutaneous manifestations such as diffuse erythematous eruptions, widespread urticaria, and chickenpox-like vesicles are related to COVID-19.

Now, with the COVID-19 vaccination effort being ramped up around the world, dermatologists also need to become aware of its considerations in patients with skin diseases, as well as possible vaccine-related cutaneous reactions.

This narrative review was performed by searching PubMed up to June 10, 2021, for the COVID-19 vaccine and dermatology practice-related manuscripts.

COVID-19 VACCINES

Various approaches to the development of a viral vaccine exist killed whole or split virus vaccines, subunits or single proteins, live-attenuated vaccines, vectored or chimeric virus approaches, naked DNA, and so on.

A year into the pandemic, the global efforts to develop and distribute an effective vaccine have produced several favorable options. Based on the WHO report, until May 15, 2021, there were 100 vaccines in clinical development and 164 vaccines in pre-clinical development. In different countries, eight vaccines have been licensed for emergency use.

The following are the examples of available COVID-19 vaccines:
- Viral vector DNA vaccines: Sputnik V (Russia), Oxford-AstraZeneca (Sweden), Johnson & Johnson (USA).
- mRNA vaccines: Pfizer (BNT162b2, USA), MODERNA (mRNA-1273, USA).
- Whole virus vaccines (inactivated and attenuated vaccines): SINOVAC (China), SINOPHARM (China), BHARAT Covaxin (India).
- Protein subunit recombinant vaccines: NOVAVAX (USA), SOBERANA (Cuba).

COVID-19 VACCINATION IN DERMATOLOGICAL DISEASES

The published studies of COVID-19 vaccines have revealed excessive reactogenicity, with fever, headache, and fatigue being more common than in other vaccines. This higher than usual observed side effects may relate to the characteristic inflammatory nature of these vaccines.

Older generation vaccines with lower reactogenicity are still deemed to be triggering flares of dermatological diseases like psoriasis. These observations hint that COVID-19 vaccines might cause flares in patients with dermatological diseases.

These vaccines have been shown to reinforce the cellular immune system and produce a predominantly Th1 type response with high
levels of TNFα, IFNγ, and IL2. Therefore, theoretically, they may have a role in the flare of dermatological diseases such as psoriasis, lichen planus, vitiligo, and other diseases that have a proven Th1 role in their pathogenesis.6

4 | ATOPIC DERMATITIS AND OTHER SKIN ALLERGIC DISEASES

There are rare reports of severe allergic reactions to different particles of vaccines in those with a history of allergies. However, it is recommended that all atopic dermatitis (AD) patients and others with allergic skin diseases follow the routine vaccination program. The risk/benefit of vaccination is considered promising for the overall AD population.

Currently, there is no evidence to suggest that AD is an independent risk factor for acquiring SARS-CoV-2, or of having a more severe course of COVID-19. Based on European Task Force for Atopic Dermatitis (ETFAD) recommendation, Atopic dermatitis is not a contraindication to vaccination.

Systemic drugs used to treat AD, except for dupilumab, may attenuate the vaccination response. It is preferable to pausing or lowering the dosage of immunosuppressant agents, typically from the vaccination day until 1 week after for Janus kinase (JAK)-inhibitors and cyclosporine, or until 2 weeks after for methotrexate and azathioprine, to possibly improve chances of appropriate vaccination response.7

In selected cases, the use of anti-allergic medication before vaccination, such as antihistamines and oral glucocorticoids, may be helpful. These patients should be observed for 30 min after the vaccine injection. The only contraindication is related to patients with documented severe allergic reactions to ingredients of the vaccine.8

5 | PSORIASIS

According to National Psoriasis Foundation there is not any contraindication for COVID vaccination in psoriasis patients. The effect of psoriasis treatment on the efficacy of COVID-19 vaccines is not known completely. Based on currently available evidence, it is recommended that patients continue their therapies during the vaccination period.9

An observational study of 941 patients (713 psoriasis patients and 228 other patients with bullous disorders, atopic dermatitis, and hidradenitis suppurativa) in Greece, who used immunosuppressive medication, revealed that patients with psoriasis were 32% more willing to receive the vaccine compared with others. Among patients with psoriasis, individuals with concomitant psoriasis arteritis were nearly 20% more likely to undergo COVID-19 vaccination.

Factors such as comorbidities with diabetes, malignancies, and COPD, receiving the biological treatment, younger age, female gender, and higher education are related to the degree of willingness showed by an individual in receiving vaccines.10

6 | PEMPHIGUS

The ideal timing of vaccination for patients treated by Rituximab, due to the immunosuppressive effect of this drug, is unknown. However, it is recommended that individuals who have not initiated rituximab therapy get vaccinated at least 4 weeks before rituximab infusion. Those who are actively receiving rituximab often receive the influenza vaccine, 12 to 20 weeks after completion of a treatment cycle, so that the patients have at least 4 weeks before their next cycle (assuming a six-month treatment cycle).11

7 | VACCINATION AND IMMUNOSUPPRESSIVE AGENTS

Three principal vaccine platforms have been used to develop already approved vaccines that are considered safe for patients on immunosuppressive agents: inactivated vaccines, protein subunit vaccines, and virus-like particle vaccines.

At the present time, there is a lack of data of COVID-19 vaccines. Despite this limited knowledge, it appears that COVID19 vaccines would be safe and effective. Some suggest checking the antibody titers after vaccination and using the additional vaccinations, if needed, to boost the level of protective antibodies. Gresham et al. is a comprehensive review that is currently available.1

Australian Medical Dermatology Group recommended vaccination against COVID-19 based on the available standard protocols for all patients on immunomodulatory drugs and/or biologic agents. No specific additional risk in this group of patients has so far been identified. Presently, there is inadequate data to recommend one COVID-19 vaccine or vaccine type over another.

If initiation of an immunosuppressive agent is planned, patients should be vaccinated beforehand. Current effective immunomodulatory therapy should not be stopped before vaccination. In patients who are on a biologic agent and have not been vaccinated, it is suggested that vaccination should be administered at least 1 week apart from the biologic dosing and at a different anatomical location.12
| First author, reference number | Vaccine type | Adverse reaction | Number of patients with reaction | Onset of reaction after vaccine (d = day, h = hour) | Outcome |
|--------------------------------|--------------|-----------------|----------------------------------|---------------------------------------------------|---------|
| McMahon,17                     | Moderna      | Local injection site reaction | 143/267 first dose (fd) 71/102 second dose (sd) | 0-1d | All reactions were mild and recovered by antihistamines and topical corticosteroids |
| Pfizer                         | Pfizer       |                   | 8/34 first dose 10/40 second dose |                   |         |
| Pfizer                         | Moderna      | Delayed large local reaction | 175/267 f.d 31/102 s.d | 1-3d |         |
| Pfizer                         | Pfizer       |                   | 5/34 f.d 7/40 s.d |                   |         |
| Moderna                        | Moderna      | Urticaria | 13/267 f.d 5/102 s.d | 0-2d |         |
| Pfizer                         | Pfizer       |                   | 9/34 f.d 7/40 s.d |                   |         |
| Moderna                        | Pfizer       |                 | 3/34 f.d 1/40 s.d |                   |         |
| Moderna                        | Moderna      | Morbilliform | 11/267 f.d 7/102 s.d |              |         |
| Pfizer                         | Pfizer       |                   | 6/34 f.d 3/40 s.d |                   |         |
| Moderna                        | Pfizer       | Erythromelalgia | 5/267 f.d 6/102 s.d |              |         |
| Moderna                        | Pfizer       |                   | 1/34 f.d 2/40 s.d |                   |         |
| Moderna                        | Pfizer       | Vesicular | 4/267 f.d 1/102 s.d |              |         |
| Pfizer                         | Moderna      |                   | 3/34 f.d 2/40 s.d |                   |         |
| Moderna                        | Moderna      | Pernio/chilblains | 3/267 f.d 0 |              |         |
| Pfizer                         | Pfizer       |                   | 3/34 f.d 2/40 s.d |                   |         |
| Moderna                        | Pfizer       | Zoster | 5/267 f.d 0 |              |         |
| Moderna                        | Pfizer       |                   | 1/34 f.d 4/40 s.d |                   |         |
| Moderna                        | Pfizer       | Angioedema | 5/267 f.d 0 |              |         |
| Moderna                        | Pfizer       |                   | 0 1/40 s.d |                   |         |
| Moderna                        | Pfizer       | Pityriasis rosea | 1/267 f.d 0 |              |         |
| Moderna                        | Pfizer       |                   | 2/34 f.d 1/40 s.d |                   |         |
| Moderna                        | Pfizer       | Erythema multiforme | 3/267 f.d 0 |              |         |
| Moderna                        | Pfizer       |                   | 0 0 |                   |         |
| Moderna                        | Pfizer       | Filler reaction | 3/267 f.d 5/102 s.d |              |         |
| Moderna                        | Pfizer       |                   | 0 1/40 s.d |                   |         |
| Moderna                        | Pfizer       | Vasculitis | 2/267 f.d 0 |              |         |
| First author, reference number | Vaccine type | Adverse reaction                                                                 | Number of patients with reaction | Onset of reaction after vaccine (d = day, h = hour) | Outcome                                                                 |
|--------------------------------|--------------|----------------------------------------------------------------------------------|---------------------------------|---------------------------------------------------|-------------------------------------------------------------------------|
| Pfizer                         |              |                                                                                  | 1/34 f.d                        | 0                                                 |                                                                         |
| Moderna                        |              | Contact dermatitis                                                               | 3/267 f.d                       | 1/102 s.d                                         |                                                                         |
| Pfizer                         |              |                                                                                  | 0                               | 2/40 s.d                                          |                                                                         |
| Moderna                        |              | Petechiae                                                                        | 1/267 f.d                       | 2/102 s.d                                         |                                                                         |
| Pfizer                         |              |                                                                                  | 1/34 f.d                        | 0                                                 |                                                                         |
| Corbeddu,18                    | Pfizer       | Itchy erythematooedematous plaque at injection site                              | 1/11 f.d                        | 1d                                                | Mild and very mild                                                      |
|                                |              | Erythema & swelling of left foot dorsum                                          | 1/11 s.d                        | 2d                                                |                                                                         |
|                                |              | Erythema and itch of face                                                         | 1/11 f.d                        | 8d                                                |                                                                         |
|                                |              | Diffuse erythematous rash                                                         | 1/11 s.d                        | 3d                                                |                                                                         |
|                                |              | Itchy erythematooedematous plaque at injection site                              | 1/11 f.d                        | 1 h                                               |                                                                         |
|                                |              | Erythema of both legs                                                             | 1/11 f.d                        | 1 h                                               |                                                                         |
|                                |              | Urticaria at injection site                                                       | 1/11 f.d                        | 1 h                                               |                                                                         |
|                                |              | Diffuse erythematous rash of trunk                                                | 1/11 s.d                        | 5 h                                               |                                                                         |
|                                |              | Erythema and swelling of left chest                                               | 1/11 f.d                        | 7d                                                |                                                                         |
|                                |              | Diffuse erythematous rash of trunk                                                | 1/11 s.d                        | 2d                                                |                                                                         |
|                                |              | Urticarial rash, flare-up of atopic dermatitis                                    | 1/11 f.d                        | 2d                                                |                                                                         |
| Pileri,19                      | Pfizer       | Chilblain lesions                                                                 | 1, f.d                          | —                                                 | Not worsening by second dose                                            |
| Temiz,20                       | CoronaVac (inactivated virus)                                                     | Acral chilblain like lesions    | 2, f.d                                          | 7d                                                | Complete improvement after 3 weeks                                      |
| Piccolo,21                     | Pfizer       | Chilblain like lesion                                                             | 1, s.d                          | 1d                                                | The lesions were extremely painful, the outcome not mentioned          |
| Davido,22                      | Pfizer       | Chilblain like lesion                                                             | 1, f.d                          | 4d                                                | 4 weeks after vaccination she remained totally asymptomatic, except for one remaining chilblain-like lesion until 150 days |
| Nawimana,23                    | Pfizer       | Flare of preexisting erythema multiforme                                         | 1, f.d & s.d                    | 12 h (fd), 24 h (sd)                              | Topical corticosteroid treatment                                        |
| Busto Leis,24                  | Pfizer       | Pityriasis rosea                                                                  | 2, s.d                          | 1, 7d                                            | Mild, self limited                                                     |
| Akdas,25                       | CoronaVac    | Pityriasis rosea                                                                  | 1, f.d                          | 4d                                                | Mild, self limited                                                     |
| Carballido Vazquez,26          | Pfizer       | Pityriasis rosea                                                                  | 1, f.d & s.d                    | —                                                 | Improvement after 2 weeks.                                             |
Literature shows that in patients on nonbiologic immunotherapy most of the available vaccines are safe for administration. Specifically, there is convincing evidence on the safety of nonviral vaccines in dermatologic patients being treated with standard dermatologic doses of immunosuppressives.

Studies reported few vaccine-related adverse reactions in patients receiving biological therapies, although no causal relationship was established between the reported reactions and vaccination.

| First author, reference number | Vaccine type | Adverse reaction | Number of patients with reaction | Onset of reaction after vaccine (d = day, h = hour) | Outcome |
|-------------------------------|-------------|-----------------|---------------------------------|-----------------------------------------------|----------|
| Cyrenne,27                    | Pfizer      | Pityriasis rosea| 1/2, f.d                        | 2, 21d                                         | Improvement after 2-3 weeks                        |
| Cohen,28                      | Pfizer      | Leukocytoclastic vasculitis flare | 1, f.d & s.d                  | 2d                                             | Topical corticosteroids                             |
| Kharkar,29                    | COVAXIN (inactivated vaccine) | Cutaneous small vessel vasculitis | 1, f.d                        | 4d                                             | Rest, leg elevation, antihistamine                   |
| Hiltun,30                     | Pfizer      | Lichen planus flare | 1, s.d                         | 2d                                             | Topical corticosteroids                             |
| Ackerman,31                   | Pfizer      | Persistent maculopapular rash | 1, f.d                        | 3 h                                            | The rash persisted over a month with a gradual improvement over the days with demecorticoid treatment |
| Bostan,32                     | CoronaVac   | Herpes zoster    | 1, f.d                         | 5d                                            | oral valacyclovir thrice a day for 1 week           |
| Lee,33                        | Pfizer      | Herpes zoster    | 3/20, f.d                      | 4-38d                                          | oral valacyclovir                                   |
| Moderna                       |             |                 | 12/20, f.d                     |                                                |                                                    |
| Arora,34                      | COVAXIN     | Herpes zoster    | 1, not mentioned               | 4d                                            | valacyclovir three times a day for 7 days          |
| Tessas,35                     | Pfizer      | Herpes zoster    | 1, f.d                         | —                                             | oral valacyclovir                                   |
| Nanova,36                     | Pfizer      | Recurrent varicella | 1, f.d                        | 7d                                            |                                                    |
| Fernandez Nieto,37           | Pfizer      | Delayed injection site reaction | 49/103, f.d, s.d               | Less than 8 hours to more than 3 days         |                                                    |
| Gyldenløve,38                 | Pfizer      | Recurrent injection-site reactions | 1, f.d (incorrect s.c administration) & s.d | 12d (fd), few hours (sd) | The rash disappeared without treatment |
| Tammaro,39                    | Pfizer      | Local reaction on the site of injection | 2/3, s.d, 1/3 not mentioned | 1d (2/3) 7d (1/3) | topical corticosteroid cream                      |
| Mintoff,3                     | Pfizer      | Fixed drug eruption | 1.f.d & s.d                     | 15d(fd), 14d (sd)                             | Self-limited                                       |
| Mazzantenta,40                | Pfizer      | Purpuric lesions on eyelids | 1/3 f.d, 2/3 s.d             | 10-21d                                         | Self-limited                                       |
| Afacan,41                     | CoronaVac   | Radiation recall dermatitis | 1, f.d                        | 5d                                            | —                                                 |
| Soyer,42                      | Pfizer      | Radiation recall dermatitis | 2, s.d                        | 5-6d                                           | resolved within a few days                         |
| Dash,43                       | Not mentioned | Steven-Johnson syndrome | 1, f.d                        | 3d                                            | oral cyclosporine 300 mg improved completely after 7 days |
| Onsun,44                      | CoronaVac   | Generalized pustular psoriasis flare | 1, f.d                        | 4d                                            | Intravenous infliximab afforded a complete response |

Despite the potential effect of systemic immune-targeting therapies on reducing the vaccine efficacy in these patients, additional vaccination and/or temporary drug withdrawal are recommended for providing the patients with sufficient protection.

Studies report that systemic corticosteroids cause dose-dependent variable effects on immunity. Many dermatology patients do not receive more than 20 mg/day of prednisone. Since this corticosteroid dose seems to have very little to no effect on patient's
immune response, vaccination, regardless of its type, is also recommended for these patients.\textsuperscript{1}

8  |  COVID-19 VACCINES ANAPHYLAXIS AND SKIN REACTIONS

Vaccination-related risk of anaphylaxis is known to be rare, with approximately 1.31 events per million doses administered.\textsuperscript{15} Active ingredients of a vaccine or its excipients are the potential culprits causing allergic and anaphylactic reactions to vaccines.\textsuperscript{16}

The cutaneous adverse reactions after COVID-19 vaccines are uncommon. Since the first approved and widely used vaccines are the mRNA vaccines (Pfizer/BioNTech (BNT162b2) and Moderna (mRNA-1273)), most side-effects reported after vaccination are from this type.

The American Academy of Dermatology’s cutaneous vaccine reactions registry has registered 414 patients with a median age of 44 (90% female) with one or more cutaneous reactions. The Moderna vaccine is responsible for 83% of these reactions.

21\% reported reactions after the first dose only, 63\% reported a reaction after the second dose only, and 16\% reported reactions to both doses.

The skin adverse reactions to different COVID-19 vaccines are summarized in table 1.

9  |  INFLAMMATORY REACTIONS TO DERMAL FILLERS AFTER COVID-19 VACCINATION

Some cases of temporary swelling at the site of previous filler injection were reported after mRNA vaccine injection. These reactions can be immunologically triggered. Because these reactions are rare and temporary, the American Society for Dermatologic Surgery recommended that patients already treated with dermal fillers could receive vaccines of any kind without worry and that those who have injected vaccines should not be disallowed from receiving dermal fillers.\textsuperscript{45}

In conclusion, dermatologists should be aware of the different types of COVID-19 vaccines and keep in mind their effects on skin diseases and their cutaneous side effects.

CONFLICT OF INTEREST
The authors declare no potential conflict of interest.

DATA AVAILABILITY STATEMENT
Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID
Alireza Firooz \(\text{https://orcid.org/0000-0001-7274-4840}\)

REFERENCES
1. Gresham LM, Marzario B, Dutz J, Kirchhof MG. An evidence-based guide to SARS-CoV-2 vaccination of patients on immunotherapies in dermatology. J Am Acad Dermatol. 2021;84(6):1652-1666.
2. Galván Casas C, Catalá A, Carretero Hernández G, et al. Classification of the cutaneous manifestations of COVID-19: a rapid prospective nationwide consensus study in Spain with 375 cases. Br J Dermatol. 2020;183(1):71-77. https://doi.org/10.1111/bjd.19163
3. Mintoff D, Pisani D, Betts A, Scerri L. SARS-CoV-2 mRNA vaccine-associated fixed drug eruption. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17390
4. Kusters I, Almond JW. Vaccine Strategies. Encycl Viral (Third Edition). 2008;235-243. https://doi.org/10.1016/B978-012374410-4.00597-5
5. draft-landscape-of-covid-19-candidate-vaccines
6. Sinha A, Kumar R, Raj SA. Implication of mass COVID-19 vaccination on dermatology practice in 2021. Dermatol Ther. 2021;34(2):e14765.
7. Thysen JP, Vestergaard C, Barbarot S, et al. European task force on atopic dermatitis: position on vaccination of adult patients with atopic dermatitis against COVID-19 (SARS-CoV-2) being treated with systemic medication and biologics. J Eur Acad Dermatol Venereol. 2021;35(5):e308-e311.
8. Ring J, Worm M, Wollenberg A, et al. Risk of severe allergic reactions to COVID-19 vaccines among patients with allergic skin diseases—practical recommendations. A position statement of ETFAD with external experts. J Eur Acad Dermatol Venereol. 2021;35(6):e362-e365.
9. Gelfand JM, Armstrong AW, Bel S, et al. National Psoriasis Foundation COVID-19 task force guidance for management of psoriatic disease during the pandemic: version 2 advances in psoriatic disease management, COVID-19 vaccines, and COVID-19 treatments. J Am Acad Dermatol. 2021;84(5):1254-1268.
10. Sotiriou E, 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. https://doi.org/10.1111/bjd.19882
11. Pacifico A, d’Arino A, Pigatto PDM, et al. COVID-19 vaccines do not trigger psoriasis flares in patients with psoriasis treated with apremilast. Clin Exp Dermatol. 2021. https://doi.org/10.1111/ced.14723
12. Gisondi P, Geat D, Naldi L, Piaserico S. Insights into SARS-COV-2 vaccine ingredients of a vaccine or its excipients are the potential culprits causing allergic and anaphylactic reactions to vaccines.\textsuperscript{16}
13. Waldman RA, Creed M, Sharp K, et al. Toward a COVID-19 vaccine strategy for patients with pemphigus on rituximab. J Am Acad Dermatol. 2021;84(4):e197-e198.
14. Wang C, Rademaker M, Tate B, et al. SARS-CoV-2 (COVID-19) vaccination in patients with chronic plaque psoriasis on systemic treatments. Br J Dermatol. 2021;185(1):209-210. https://doi.org/10.1111/bjd.19882
15. McNeil MM, Weintrab ES, Duffy J, et al. Risk of anaphylaxis after vaccination in children and adults. J Allergy Clin Immunol. 2016;137(3):868-878.
16. Ring J, Beyer K, Biedermann T, et al. Guidelines (S2) to acute therapy and management of anaphylaxis—update 2021. Allergo J Int. 2021;28(1):1-25. https://doi.org/10.1007/s40629-020-00158-y
17. McMahon DE, Amerson E, Rosenbach M, et al. Cutaneous reactions reported after Moderna and Pfizer COVID-19 vaccination: a registry-based study of 414 cases. J Am Acad Dermatol. 2021;85(1):46-55. https://doi.org/10.1016/j.jaad.2021.03.092
18. Corbeddu M, Diociaiu A, Vinci MR, et al. Transient cutaneous manifestations after administration of Pfizer-BioNTech COVID-19 vaccine: an Italian single-Centre case series. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17268
19. Pileri A, Guglielmo A, Raone B, et al. Chilblain lesions after COVID-19 mRNA vaccine. Br J Dermatol. 2021. https://doi.org/10.1111/bjd.20060

20. Temiz SA, Abdelmaksoud A, Dursun R, et al. Acral chilblain-like lesions following inactivated SARS-CoV-2 vaccination. Int J Dermatol. 2021. https://doi.org/10.1111/ijd.15619

21. Piccolo V, Bassi A, Argenziano G, et al. BNT162b2 mRNA Covid-19 vaccine-induced chilblain-like lesions reinforces the hypothesis of their relationship with SARS-CoV-2. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17320

22. Davido B, Mascitti H, Fortier-Beaulieu M, et al. ‘Blue toes’ following vaccination with the BNT162b2 mRNA COVID-19 vaccine. J Travel Med. 2021;28(4). https://doi.org/10.1093/taab/024

23. Nawimana S, Lavery MJ, Parslew R, et al. A flare of pre-existing erythema multiforme post BNT162b2 (Pfizer-BioNTech) COVID-19 vaccine. Clin Exp Dermatol. 2021. https://doi.org/10.1111/ced.14714

24. Busto Leis JM, Servera Negre G, Mayor Ibarguren A, et al. Pityriasis rosea, COVID-19 and vaccination: new keys to understand an old acquaintance. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17301

25. Akdas E, Ilter N, Oğut B, Erdem O. Pityriasis rosea following CorronaVax COVID-19 vaccination: a case report. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/ijd.17316

26. Carballido Vazquez AM, Morgado B. Pityriasis rosea-like eruption after Pfizer-BioNTech COVID-19 vaccination. Br J Dermatol. 2021. https://doi.org/10.1111/jdv.20143

27. Cryenne BM, Al-Mohammedi F, De Koven JG, Alhusayen R. Pityriasis rosea-like eruptions following vaccination with BNT162b2 mRNA COVID-19 vaccine. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17342

28. Cohen SR, Prussick L, Kahn JS, et al. Leukocytoclastic vasculitis flare following the COVID-19 vaccine. Int J Dermatol. 2021. https://doi.org/10.1111/ijd.15623

29. Kharkar V, Vishwanath T, Mahajan S, Joshi R, Gole P. Asymmetric cutaneous vasculitis following COVID-19 vaccination with unusual eosinophil preponderance. Clin Exp Dermatol. 2021. https://doi.org/10.1111/ced.14797

30. Hiltun I, Sarrigarte J, Martínez-de-Espronceda I, et al. Lichen planus arising after COVID-19 vaccination. J Eur Acad Dermatol Venereol. 2021;35(7):e414-e415. https://doi.org/10.1111/jdv.17221

31. Ackerman M, Henry D, Finon A, et al. Persistent maculopapular rash after the first dose of Pfizer-BioNTech COVID-19 vaccine. J Eur Acad Dermatol Venereol. 2021;35(7):e423-e425. https://doi.org/10.1111/jdv.17248

32. Bostan E, Yalıcı-Armagan B. Herpes zoster following inactivated COVID-19 vaccine: a coexistence or coincidence? J Cosmet Dermatol. 2021;20(6):1566-1567.

33. Lee C, Cotter D, Basa J, Greenberg HL. 20 post COVID-19 vaccine related shingles cases seen at the Las Vegas dermatology clinic and sent to us via social media. J Cosmet Dermatol. 2021;20(7):1960-1964. https://doi.org/10.1111/jocd.14210

34. Arora P, Sardana K, Mathachan SR, Malhotra P. Herpes zoster after inactivated COVID-19 vaccine: a cutaneous adverse effect of the vaccine. J Cosmet Dermatol. 2021. https://doi.org/10.1111/jocd.14268

35. Tessas I, Kluger N. Ipsilateral herpes zoster after the first dose of BNT162b2 mRNA COVID-19 vaccine. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17422

36. Nanova K, Zlotogorski A, Ramot Y. Recurrent varicella following SARS-CoV-2 vaccination with BNT162b2. Int J Dermatol. 2021. https://doi.org/10.1111/ijd.15660

37. Fernandez Nieto D, Hammerle J, Fernandez Escribano M, et al. Skin manifestations of the BNT162b2 mRNA COVID-19 vaccine in healthcare workers. ‘COVID-arm’: a clinical and histological characterization. J Eur Acad Dermatol Venereol. 2021;35(7):e425-e427. https://doi.org/10.1111/jdv.17250

38. Gyldenløve M, Skov L, Hansen CB, Garred P. Recurrent injection-site reactions after incorrect subcutaneous administration of a COVID-19 vaccine. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17341

39. Tammaro A, Adebanjo GAR, Parisella FR. Local reactions to the second dose of the BNT162 COVID-19 vaccine. Dermatol Ther. 2021; e15000.

40. Mazzatenta C, Piccolo V, Pace G, et al. Purpuric lesions on the eyelids developed after BNT162b2 mRNA COVID-19 vaccine: another piece of SARS-CoV-2 skin puzzle? J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17340

41. Afacan E, Oğut B, Ustun P, et al. Radiation recall dermatitis triggered by inactivated COVID-19 vaccine. Clin Exp Dermatol. 2021. https://doi.org/10.1111/ced.14786

42. Soyfer V, Guthold O, Shamai S, et al. COVID-19 vaccine-induced radiation recall phenomenon. Int J Radiat Oncol Biol Phys. 2021;110:957-961.

43. Dash S, Sirka C.S, Mishra S, Viswan P. Covid-19 vaccine induced Steven-Johnson syndrome: a case report. Clin Exp Dermatol 2021 3: doi: https://doi.org/10.1111/ced.14784.

44. Onsun N, Kaya G, Isik BG, Gunes B. A generalized pustular psoriasis flare after inactivated COVID-19 vaccine. J Eur Acad Dermatol Venereol. 2021. https://doi.org/10.1111/jdv.17422

45. Avram M, Bertucci C, Cox SE. American Society for Dermatologic Surgery guidance regarding SARS-CoV-2 mRNA vaccine side effects in dermal filler patients. Available from https://www.asds.net/Portals/0/PDF/secure/ASDS-SARS-CoV-2-Vaccine-Guidance.pdf (accessed 1 March 2021).