

## Case Series

# Interesting Mucocutaneous Manifestations in COVID-19 Infection or Vaccination Confirmed by Histopathology: A Case Series

Arash Pour Mohammad<sup>a</sup> Elahe Noroozi<sup>b</sup> Milad Gholizadeh Mesgarha<sup>a</sup>  
Nasrin Shayanfar<sup>c</sup> Azadeh Goodarzi<sup>d,e</sup>

<sup>a</sup>Faculty of Medicine, Iran University of Medical Sciences (IUMS), Tehran, Iran;

<sup>b</sup>Oncopathology Research Center, Iran University of Medical Sciences, Tehran, Iran; <sup>c</sup>Department of Pathology, Rasool Akram Medical Complex, School of Medicine, Iran University of Medical Sciences, Tehran, Iran; <sup>d</sup>Department of Dermatology, Rasool Akram Medical Complex Clinical Research Development Center (RCRDC), School of Medicine, Iran University of Medical Sciences, Tehran, Iran; <sup>e</sup>Skin and Stem Cell Research Center, Tehran University of Medical Sciences, Tehran, Iran

## Keywords

COVID-19 · SARS-CoV-2 · Vaccine · Adverse events · Mucocutaneous manifestations · Dermatology · Histopathology · Dermatopathology · Complication · Lichen planus · Pityriasis rosea · Psoriasis · Sarcoidosis · Purpura fulminans

## Abstract

**Introduction:** Mucocutaneous complications or adverse events due to SARS-CoV-2 infection or vaccination have been well delineated in the literature, respectively. Most eruptions are considered mild and self-limiting; however, for the atypical cases with a tentative clinical diagnosis, performing a biopsy and histopathological assessment is pivotal to confirm the diagnosis and subsequently prescribe a more tailored treatment. Despite the diverse reporting of such incidents globally, most studies restrict the rate of biopsied cases to less than 15%. **Case Presentations:** This case series elucidates 20 patients referred to the tertiary dermatology clinic, including 14 COVID-19 infection-related eruptions such as lichen planus (LP), cutaneous vasculitis, pityriasis rosea (PR), discoid lupus erythematosus, guttate psoriasis, sarcoidosis, Raynaud's phenomenon, non-specific lesions resembling genital warts, Beau's line, and one severe case of purpura fulminans with a promising outcome. Moreover, we presented six vaccine-induced cases comprising LP, urticarial vasculitis, PR, parapsoriasis, and localized morphea. The diagnosis of all challenging cases has been proven by histopathological evaluation. We included pertaining anamnesis details of each patient and vivid classifying

images to pinpoint the morphologic features of each condition. **Discussion:** In line with our previous studies, the vaccine-induced eruptions were less severe compared to infection-related complications of COVID-19 and are mostly controllable by antihistamines and corticosteroid administration. Therefore, reporting such events should not impede COVID-19 vaccination in the general population.

© 2024 The Author(s).

Published by S. Karger AG, Basel

## Introduction

The COVID-19 pandemic has caused various medical challenges. Although the disease was initially characterized as primarily affecting the respiratory system, with the virus's rapid spread, medical literature soon revealed that the virus affects numerous organ systems [1–4]. The skin, often serving as an external reflection of internal health, was among the first non-respiratory organs to demonstrate atypical symptoms in the early stages of the disease [5].

COVID-19 infection has been associated with several cutaneous manifestations, although the frequency of these findings varies significantly between studies [6]. Erythematous maculopapular eruptions are the most common dermatological manifestation, followed by erythema pernio-like lesions. Urticarial, vesicular, and livedo reticularis eruptions and purpura and necrosis are less common [7]. Regardless of the type of skin lesions, 80% of COVID-19 patients with cutaneous manifestations experienced mild and moderate, and 20% had severe COVID-19 disease [8]. The number of skin lesions among those who tested positive for SARS-CoV-2 is significantly higher than those who tested negative, supporting skin involvement in the symptoms associated with COVID-19 [7].

Several studies have reported a rise in adverse skin reactions after COVID-19 vaccinations, indicating that SARS-CoV-2 and COVID-19 vaccinations can potentially provoke such symptoms [9, 10]. In a US registry-based study of mRNA vaccines, a broad spectrum of cutaneous reactions was reported, ranging from local reactions at the injection site to specific dermatoses. Some of these reactions mimicked the COVID-19 infection itself [11].

Dermatologists recognized mucocutaneous manifestations of COVID-19 immediately and suggested comprehensive classifications for these findings [3]. Given the highly contagious nature of the SARS-CoV-2 virus and the urgency of the pandemic, the manufacturing, approval, and distribution of COVID-19 vaccines were expedited to meet the pandemic needs – this deviation from established protocols led to adverse reactions, including mucocutaneous manifestations [12]. Several studies have discussed various vaccine-induced mucocutaneous side effects. However, the administration of new booster doses, the emergence of new virus variants, and recurrent infections may result in a different pattern of symptoms [13, 14].

Each case presented in this study is original and was seen at a tertiary referral dermatology clinic between December 2021 and September 2022. These cases were notable for their severity, location, or progression. Furthermore, alternative potential causes, aside from COVID-19 infection or vaccination, have been systematically excluded. Biopsies were performed on each patient, with diagnoses confirmed by histopathological assessment. No identifying information was disclosed while composing this article; however, we obtained written informed consent from the patients and legal guardians of minor patients for publication of the details of their medical case and any accompanying images. The completed CARE Checklist is provided as supplementary material (for all online suppl. material, see

**Table 1.** Description of cases with vaccine-related eruptions

Patient demographics	Mucocutaneous manifestations	Vaccine type and brand	Biopsy-proven diagnosis
38-year-old woman with rheumatoid arthritis	Purplish papular lesions on trunk/forearms; severe white reticular lesions in oral/genital mucosa (lacy pattern)	After the BIV1-CovIran Barekat vaccine	LP (Fig. 1a–d)
66-year-old woman	Reddish-brownish patches and plaques on her abdomen, perimammary, axillary, inguinal region, and extensor arm for 1 year	After the fourth dose of ChAdOx1 nCoV-19 vaccine (AstraZeneca)	LP (Fig. 1i)
51-year-old woman	Pruritic and burning urticarial lesions on the forehead, chest, and dorsum of her hands	Three days after the second dose of the BBIBP-CorV vaccine (Sinopharm)	Urticarial vasculitis (Fig. 2b)
46-year-old woman	Pruritic scaly erythematous plaques on face, neck, and chest region	One month after vaccination with intranasal RAZI-COV PARS vaccine	Atypical PR (Fig. 2c, d)
51-year-old female	Severely pruritic, scattered red-brown patches and plaques on her trunk and inguinal region with a burning sensation	One month after the first dose of the BBIBP-CorV vaccine (Sinopharm)	Parapsoriasis (Fig. 3a)
54-year-old female	Shiny sclerotic dermal plaques with violaceous borders and central hypopigmentation on her left shin	After the first dose of the BBIBP-CorV vaccine (Sinopharm)	Localized morphea (Fig. 3b)

<https://doi.org/10.1159/000535739>) in accordance with the guidelines for reporting case studies. Tables 1 and 2 provide detailed descriptions of cases with vaccine-related and infection-related eruptions, respectively.

## Case Series

### *Lichen Planus*

A 38-year-old female with a history of rheumatoid arthritis presented with multiple purplish papular lesions on her trunk and forearms and severe white reticular lesions on her oral mucosa (lacy pattern) and genitalia mucosa following immunization with inactivated virus COVID-19 (BIV1-CovIran Barekat) vaccine. Her brother had a history of lichen planus (LP). Pathologic examination confirmed the clinical diagnosis of LP. Intramuscular methylprednisolone was administered twice due to severe oral lesions. Genitalia and trunk lesions improved, but oral lesions partially alleviated with mildly impaired gustatory sensation (Fig. 1a–d; Table 1).

A 16-year-old girl with a history of atopic dermatitis presented with papular skin lesions gradually turning into annular, lichenoid, and atrophic plaques on both her breasts, peri umbilicus, which was pruritic, and left thigh 2 weeks after being infected by SARS-CoV-2. A diagnosis of LP was made clinically and histopathologically. She was prescribed topical treatment of tacrolimus, administered twice daily (day and night), and fluocinolone, administered 2 days per week (Thursdays and Fridays). However, she had poor adherence to therapy, and improvement of lesions was not achieved (Fig. 1e, f; Table 2).

A 57-year-old woman presented with abundant and severely pruritic violaceous papules and plaques on her trunk, flexor extremities, and axillary, inguinal, and perimammary regions

**Table 2.** Description of cases with infection-related eruptions

Patient demographics	Mucocutaneous manifestations	Time frame within COVID-19 infection	Biopsy-proven diagnosis
16-year-old girl with a history of atopic dermatitis	Pruritic papular skin lesions evolving into annular, lichenoid, and atrophic plaques on breasts, periumbilicus, and left thigh	Two weeks after COVID-19 infection	LP (Fig. 1e, f)
57-year-old woman	Abundant and severely pruritic violaceous papules and plaques on her trunk, flexor extremities, axillary, inguinal, and perimammary region for the past 6 months	Two weeks after COVID-19 infection	LP (Fig. 1g, h)
55-year-old woman	Generalized LP	2.5 months after COVID-19 infection	LP (Fig. 1j)
15-year-old girl	Ascending palpable petechial lesions in lower extremities with predominance in legs and some similar scarce lesions in forearm, left ankle arthralgia upon walking, mild occasional abdominal pain	Two weeks after COVID-19 infection	Low-grade vasculopathic reactions (Fig. 2a)
13-year-old girl	Annular erythematous rash with collarette scaling resembling a herald patch	Two weeks after COVID-19 infection	PR (Fig. 2e)
58-year-old woman	Severe pruritic maculopapular lesions initiated on abdomen and progressing to back, buttock, and foot	Few weeks after COVID-19 infection	PR (Fig. 2f)
50-year-old man	Multiple pruritic erythematous plaques with collarette scaling on abdomen, back, and legs	Two months after COVID-19 infection	Guttate psoriasis (Fig. 2g)
42-year-old female	Eight-month Raynaud phenomenon in her hands and concurrent arthralgia	Two weeks after the COVID-19 infection	Raynaud phenomenon (Fig. 3c)
30-year-old female	Pruritic erythematous papular lesions on forehead and a scaly patch with focal alopecia in the scalp that spread out to the neck and back	One month after the COVID-19 infection	DLE (Fig. 3d, e)
73-year-old woman	Multiple painful plaques and nodules on both legs	After COVID-19 infection	Sarcoidosis (Fig. 3f)
31-year-old male	Multiple erythematous papules on the inguinal area mimicking genital warts	After COVID-19 infection	Non-specific dermatosis mimicking genital wart (Fig. 3g)
51-year-old woman with impaired level of consciousness and abdominal pain	Progressive purpuric and ecchymotic lesions emerging from both legs, which spread to the trunk, face, and upper extremities for 2 weeks	After severe COVID-19 infection	Purpura fulminans (Fig. 4)

DLE, discoid lupus erythematosus.



1

(For legend see next page.)

for the past 6 months. She stated that these rashes developed 2 weeks after the COVID-19 infection. A skin biopsy proved the diagnosis of LP. She was first prescribed topical treatment, which was unsuccessful, but ultimately, her disease had a self-limiting course (Fig. 1g, h; Table 2).

A 66-year-old woman presented with reddish-brownish patches and plaques on her abdomen, perimammary, axillary, inguinal region, and extensor arm for 1 year. These skin lesions developed following the fourth dose of vaccination with the ChAdOx1 nCoV-19 vaccine. The biopsy result was in favor of LP. Lesions improved with topical corticosteroids; however, pruritus became predominant (Fig. 1i; Table 1). Another 55-year-old woman presented with generalized LP, 2.5 months following infection by COVID-19 (Fig. 1j; Table 2).

#### *Vasculitis*

A 15-year-old girl presented with ascending palpable petechial lesions in the lower extremities, with predominance in the legs and some similar scarce lesions in the forearm, within 2 weeks following COVID-19 infection. She complained of left ankle arthralgia upon walking and also occasional abdominal pain rated as mild. She had not received any COVID-19 vaccine by the time of infection. Our obtained biopsy from lesions revealed low-grade vasculopathic reactions compatible with vasculitis. However, the immunofluorescent study reported negative IgA, which was against our primary diagnosis of Henoch-Schoenlein purpura (IgA vasculitis). Her symptoms abated with a self-limiting course (Fig. 2a; Table 2).

#### *Urticarial Vasculitis*

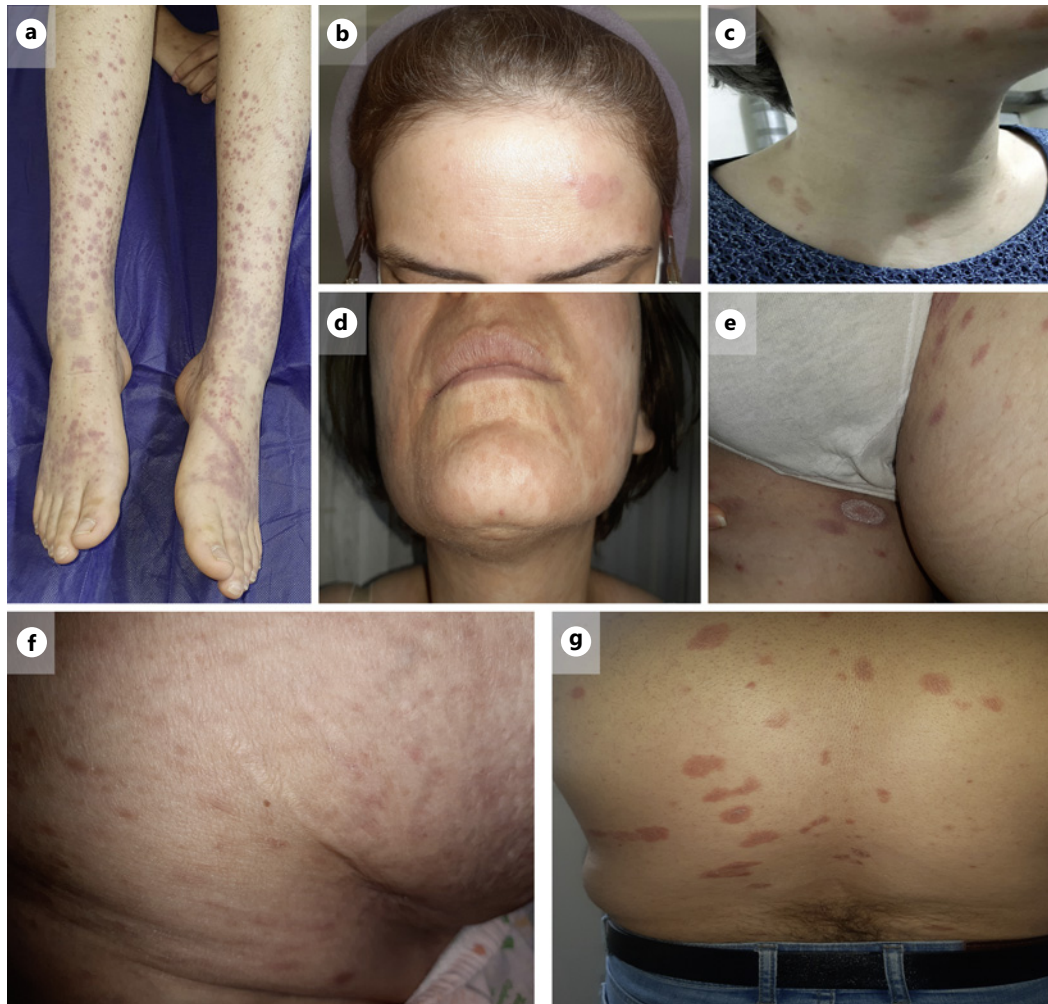
A 51-year-old woman presented with pruritic and burning urticarial lesions on the forehead, chest, and dorsum of her hands 3 days after inoculation with the second dose of the BBIBP-CorV vaccine. She also reported an episode of anaphylaxis following COVID-19 infection in the past. Biopsy from lesions revealed urticarial vasculitis. Accordingly, she was started on prednisolone and methotrexate but discontinued treatment due to exacerbating duodenal ulcer symptoms (Fig. 2b; Table 1).

#### *Pityriasis Rosea*

A 46-year-old woman presented with pruritic scaly erythematous plaques on the face, neck, and chest region 1 month following vaccination with intranasal RAZI-COV PARS. She was treated with local and systemic corticosteroid and tacrolimus ointment, which responded completely in the fifth-month follow-up. The histopathological assessment was compatible with atypical pityriasis rosea (PR) (Fig. 2d; Table 1).

Another 13-year-old girl was presented with an annular erythematous rash with collarette scaling resembling a herald patch 2 weeks following COVID-19 infection, which was consistent with PR (Fig. 2e; Table 2). A 58-year-old woman was referred to our clinic with severe pruritic maculopapular lesions initiated on the abdomen and progressing to the back, buttock, and foot for a few weeks, ensuing infection with COVID-19. Its biopsy findings and pathologic evaluation revealed the diagnosis of PR (Fig. 2f; Table 2).

**Fig. 1.** Lichen planus (LP). **a** 38 y/o female with typical papular lesions LP on the flexor surface of forearms. **b** Hypertrophic white plaques mimicking candidiasis consistent with LP. **c** White lacy pattern accompanied by some erosions on lateral edge of the tongue. **d** Genital mucosa involvement of the same patient with numerous white plaques on labia majora. **e** 16-year-old girl with annular lichenoid lesions with central atrophy on breast conforming to LP. **f** Pruritic periumbilical plaque in the same patient. Numerous abdominal (**g**) and trunk (**h**) plaques in 57 y/o woman. **i** Perimammary hyperpigmented lesions in 66 y/o woman post-COVID-19 vaccination. **j** Pretibial coalescing plaques in another 55 y/o woman, with generalized LP.



**Fig. 2.** **a** Widespread palpable purpuric lesions in a young patient's lower and upper extremities (right hand is shown) consistent with vasculitis. **b** Erythematous forehead lesions in 51 y/o woman with urticarial vasculitis. **c, d** 46 y/o female with PR post-vaccination. **e** Apparent collarette scaling in a groin lesion in a young child with PR. **f** Another 58 y/o woman diagnosed with PR with maculopapular lesions on the buttock. **g** Pruritic erythematous lesions on the back of a 50 y/o man, which was histopathologically compatible with guttate psoriasis.

#### *Guttate Psoriasis*

A 50-year-old man presented with multiple pruritic erythematous plaques with collarette scaling on the abdomen, back, and legs 2 months after infection with COVID-19. He reported similar mild eruptions with a much lesser extent, 5 months prior to contracting SARS-CoV-2, but was exacerbated significantly after this COVID-19 episode. The histopathological assessment was consistent with guttate psoriasis. His lesions exerted minimal response to corticosteroid therapy, which he decided to discontinue; however, he stated spontaneous improvement of lesions in later follow-ups (Fig. 2g; Table 2).

#### *Parapsoriasis*

A 51-year-old female developed scattered red-brown patches and plaques on her trunk and inguinal region after 1 month of receiving the first dose of the BBIBP-CorV vaccine. Rashes were severely pruritic, had a burning sensation, and persisted for 10 months. She also

reported a history of COVID-19 infection approximately 1 month before her COVID-19 vaccination. Pathologic investigation revealed parapsoriasis as the diagnosis. The skin rashes were treated successfully with topical corticosteroids, but pruritus did not abate (Fig. 3a; Table 1).

### *Localized Morphea*

A 54-year-old female presented with shiny sclerotic dermal plaques with violaceous borders and central hypopigmentation on her left shin. She reported that there was first swelling and pain in this region, which altered to this current condition after a while. This symptom occurred following immunization with the first dose of the BBIBP-CorV vaccine. She was reluctant to receive treatment for this lesion (Fig. 3b; Table 1).

### *Raynaud Phenomenon*

A 42-year-old female presented with an 8-month Raynaud phenomenon in her hands. She developed this symptom 2 weeks after the COVID-19 infection. She also reported concurrent arthralgia, whose onset was a bit sooner than her Raynaud. Based on high-titer positive antinuclear antibody (ANA) and anti-U1 ribonucleoprotein antibody (anti-U1 RNP), the patient received the diagnosis of mixed connective tissue disease. Treatment with prednisolone 7.5 mg twice daily (day and night) and hydroxychloroquine 200 mg once each night was started, and her Raynaud phenomenon improved with an escalating dose of amlodipine to 5 mg twice daily (Fig. 3c; Table 2).

### *Discoid Lupus Erythematosus*

A 30-year-old female presented with pruritic, erythematous papular lesions on her forehead and a scaly patch with focal alopecia in her scalp a month after COVID-19 infection. The lesions spread to her neck and back within 1 week of symptom initiation. The biopsy findings confirmed the diagnosis of discoid lupus erythematosus. The patient's symptoms exhibited a moderate response to topical corticosteroids. However, she reported a flare-up of lesions following COVID-19 vaccination with the third dose of BBIBP-CorV (Fig. 3d, e; Table 2).

### *Sarcoidosis*

A 73-year-old woman presented with multiple painful plaques and nodules on both legs following COVID-19 infection. Our biopsy findings demonstrated granulomatous tissue of sarcoidosis type concordant with panniculitis (Fig. 3f; Table 2).

### *Non-Specific Dermatitis Mimicking Genital Wart*

A 31-year-old male presented with multiple erythematous papules on the inguinal area following COVID-19 infection, which mimicked a genital wart. Our histopathology evaluation was consistent with non-specific COVID-19 dermatosis without evidence of viral cytopathic effects (Fig. 3g; Table 2).

### *Beau's Line*

Beau's lines are transverse depressions across all nails that form proximal to the nail bed and progress distally until they fall off the free edge. It has been detected in patients weeks following many febrile conditions due to transient interruption in nail formation. The recent medical literature has also noted the reports of its incidence in critical COVID-19 cases admitted to ICU wards. We have identified 2 cases with Beau's line in all fingers following severe infection with COVID-19 (Fig. 3h, i).





**Fig. 3.** **a** Dark abdominal patch and plaques in 51 y/o woman with parapsoriasis. **b** Shiny sclerotic patches medial to previous scar in left shin consistent with localized morphea in a 54 y/o woman. **c** White (pallor) stage of Raynaud phenomenon in 42 y/o woman with MCTD. **d** Cicatricial alopecia in the 31 y/o woman with DLE. **e** Same patient with DLE with dissemination of the lesions to the back. **f** Non-specific COVID-19 eruptions mimicking genital wart in a sexually active 31 y/o man. **h, i** Two cases of Beau's line following severe forms of COVID-19.

## *Purpura Fulminans*

A 51-year-old woman was admitted to the intensive care unit with an impaired level of consciousness and abdominal pain following a severe COVID-19 infection. Two weeks before admission, she had developed progressive purpuric and ecchymotic lesions emerging from both her legs, which spread to her trunk, face, and upper extremities. During the hospital stay, her lesions were exacerbated into focal necrotic ulcers, which were compatible with purpura fulminans. Fortunately, her symptoms were mitigated dramatically with vigilant management of COVID-19 infection and the subsequent disseminated intravascular coagulation. She was discharged with an acceptable overall condition, and her skin status improved steadily (Fig. 4; Table 2).

## Discussion

Numerous studies have pointed out the recurrent mucocutaneous manifestations associated with SARS-CoV-2 infection, including generalized morbilliform rash, urticaria, and pernio-like acral lesions [3, 6, 15]. Moreover, local injection site reactions and urticaria have also been reported frequently following COVID-19 vaccination [12]. Most of these conditions are mild, so they will completely subside without any medication within a couple of days; therefore, obtaining a biopsy is rarely necessary. Our experience, in line with numerous studies, demonstrated that unusual and severe dermatological cases often require histopathological confirmation for accurate diagnosis; however, biopsies are infrequently performed, leading to speculative diagnoses and treatments [13].

This case series describes 20 patients with 13 unique mucocutaneous patterns linked to COVID-19, with histopathology confirming all but two clinical diagnoses of Beau's lines and Raynaud's phenomenon. The series documents 14 infection-related skin conditions, including 3 LP cases and other dermatoses such as vasculitis, PR, and discoid lupus erythematosus. We also observed six vaccine-related cases with manifestations like LP, urticarial vasculitis, and localized morphea, predominantly following the BBIBP-CorV vaccine, the most widely used COVID-19 vaccine in Iran.

Flare-ups of LP have been described post-COVID-19 vaccination and infection; however, none of our patients reported previous episodes of skin eruptions attributable to LP and hence are considered naive LP cases [12]. The new LP onset is relatively infrequent in the COVID-19 context, which imparts peculiarity to our cases. Interestingly, our first introduced LP case (the 38-year-old woman) demonstrated a widespread manifestation of LP with mucosal involvement of genitalia and erosions on the tongue, which merits extra attention. We also reported a 16-year-old girl diagnosed with post-infection LP, which was found atypical given the rare incidence of LP in patients under 30 years of age [16].

We had only one reported case of severe mucocutaneous involvement due to COVID-19 infection with purpura fulminans. Many studies have investigated the spectrum of life-threatening dermatological considerations in the pandemic and have delineated an exhaustive classification of such events with their prognostic value for disease outcomes [17–21]. Despite the ominous prognosis of purpura fulminans, our patient miraculously recovered from the critical disseminated intravascular coagulation status, and her diffuse ecchymotic lesions progressively improved following discharge.

## *Limitations and Recommendations*

Our case series sheds light on some of the dermatological impacts of COVID-19, but it is subject to the inherent limitations of its retrospective design, notably recall bias. This may affect the accuracy of the temporal relationship between symptoms and exposure, which is



**Fig. 4.** 51 y/o woman admitted to ICU for critical COVID-19. The widespread ecchymotic lesions are evident in her face, trunk, and legs. Focal necrosis was discernible with predominance in lower extremities.

crucial for establishing causality. Furthermore, establishing a direct causal link between dermatological conditions and COVID-19 infection or vaccination is challenging, given the complex clinical presentations and the potential for other contributing factors. Nevertheless, the authors have made their best efforts to rule out other potential culprits for these manifestations.

It is recommended that future studies adopt a longitudinal perspective to examine the persistence of mucocutaneous manifestations following infection and vaccination. A comparative analysis between vaccine brands will provide a more comprehensive understanding of these eruptions.

## Conclusion

Although the scope of different mucocutaneous complications of COVID-19 infection or vaccine-induced adverse events has been outlined by many studies, the broad coverage of vaccines and new virus variants has led to alterations in patterns of these dermatological manifestations. This study introduced 20 patients with 13 diverse engrossing diagnoses confirmed with a biopsy, encompassing a comprehensive image collection of their eruptions to impart a better visual impact. Notably, the majority of vaccine-related adverse events are considered mild and self-limited, and the presentation of such cases should not hinder vaccine distribution or increase vaccine apprehension since its protective benefits far outweigh the rare complications [12].

## Capsule Summary

### *What Is Known in This Topic*

The majority of COVID-19 infections or vaccine-induced adverse events are reported to be mild and are identified in history and physical examination; yet in uncommon and elusive cases, a biopsy is vital to confirm the exact diagnosis.

### *What This Article Adds*

A unique collection of 20 interesting and unusual cases of dermatological eruption due to COVID-19 infection or vaccine has been presented, which were validated by microscopic evaluation.

## Acknowledgments

The authors would like to express their gratitude to the staff of the Rasool Akram Medical Complex Clinical Research Development Center (RCRDC) for their technical and editorial assistance.

## Statement of Ethics

The Ethics Committee of Iran University of Medical Sciences has waived the requirement for an ethical code. No identifying information was disclosed during the preparation of this article. Written informed consent was obtained from the patients and legal guardians of minor patients for publication of the details of their medical case and any accompanying images.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Funding Sources

This study was not supported by any sponsor or funder.

### Author Contributions

A.P.M.: conceptualization, data acquisition, writing initial draft, visualization, and project administration; E.N: data collection, writing initial draft, and draft revision; M.G.M: writing initial draft, draft revision, and visualization; N.S: data acquisition and initial draft; A.G: conceptualization, writing initial draft, and draft revision.

### Data Availability Statement

All data reported in this study are included in the article and its supplementary material files. Further inquiries can be directed to the corresponding author. This paper has been deposited in Authorea preprints (DOI: 10.22541/au.167468576.67323248/v2).

### References

- Gottlieb M, Long B. Dermatologic manifestations and complications of COVID-19. *Am J Emerg Med.* 2020; 38(9):1715–21.
- Hajsadeghi S, Gholizadeh Mesgarha M, Saberi Shahrbabaki E, Pishgahi M, Ebadi Fard Azar A, Pour Mohammad A. Constrictive pericarditis following inactivated virus COVID-19 vaccine: a case report with review of the literature. *Radiol Case Rep.* 2022;17(10):3774–8.
- Seirafianpour F, Sodagar S, Pour Mohammad A, Panahi P, Mozafarpour S, Almasi S, et al. Cutaneous manifestations and considerations in COVID-19 pandemic: a systematic review. *Dermatol Ther.* 2020;33(6):e13986.
- Bidari A, Zarei E, Hassanzadeh M, Gholizadeh Mesgarha M, Pour Mohammad A, Shafiei R, et al. Development of a scoring method based on a chest CT scan to determine the outcomes of COVID-19 patients. *Cureus.* 2023; 15(10):e47354.
- Pour Mohammad A, Mashayekhi F, Seirafianpour F, Gholizadeh Mesgarha M, Goodarzi A. COVID-19 and COVID-19 vaccine-related dermatological reactions: an interesting case series with a narrative review of the potential critical and non-critical mucocutaneous adverse effects related to virus, therapy, and the vaccination. *Clin Case Rep.* 2022;10(4):e05775.
- Hadeler E, Morrison BW, Tosti A. A review of nail findings associated with COVID-19 infection. *J Eur Acad Dermatol Venereol.* 2021;35(11):e699–709.
- Seque CA, Enokihara M, Porro AM, Tomimori J. Skin manifestations associated with COVID-19. *An Bras Dermatol.* 2022;97(1):75–88.
- Jamshidi P, Hajikhani B, Mirsaedi M, Vahidnezhad H, Dadashi M, Nasiri MJ. Skin manifestations in COVID-19 patients: are they indicators for disease severity? A systematic review. *Front Med.* 2021;8:634208.
- Gambichler T, Boms S, Susok L, Dickel H, Finis C, Abu Rached N, et al. Cutaneous findings following COVID-19 vaccination: review of world literature and own experience. *J Eur Acad Dermatol Venereol.* 2022;36(2): 172–80.
- McMahon DE, Kovarik CL, Damsky W, Rosenbach M, Lipoff JB, Tyagi A, et al. Clinical and pathologic correlation of cutaneous COVID-19 vaccine reactions including V-REPP: a registry-based study. *J Am Acad Dermatol.* 2022; 86(1):113–21.
- McMahon DE, Amerson E, Rosenbach M, Lipoff JB, Moustafa D, Tyagi A, 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.
- Seirafianpour F, Pourriyahi H, Gholizadeh Mesgarha M, Pour Mohammad A, Shaka Z, Goodarzi A. A systematic review on mucocutaneous presentations after COVID-19 vaccination and expert recommendations about vaccination of important immune-mediated dermatologic disorders. *Dermatol Ther.* 2022;35(6):e15461.
- Salehi S, Sadeghi S, Kalantari Y, Goodarzi A. A systematic review of histopathologic surveys on mucocutaneous biopsies in patients developed COVID-19 vaccine-related dermatologic manifestations. *Am J Dermatopathol.* 2023;45(1):1–27.

- 14 Sadeghi S, Amini Z, Goodarzi A. A comparative review on mucocutaneous reactions caused by Covid-19 infection versus Covid-19 vaccination. [Exp Dermatol](#). 2022;31(8):1122–7.
- 15 Recalcati S. Cutaneous manifestations in COVID-19: a first perspective. [J Eur Acad Dermatol Venereol](#). 2020; 34(5):e212–3.
- 16 Le Cleach L, Chosidow O. Clinical practice. Lichen planus. [N Engl J Med](#). 2012;366(8):723–32.
- 17 Mashayekhi F, Seirafianpour F, Pour Mohammad A, Goodarzi A. Severe and life-threatening COVID-19-related mucocutaneous eruptions: a systematic review. [Int J Clin Pract](#). 2021;75(12):e14720.
- 18 Bahadorizadeh L, Emamikhah M, Pour Mohammad A, Gholizadeh Mesgarha M. Simultaneous occurrence of cerebral venous sinus thrombosis and immune thrombocytopenic purpura in a patient with a history of COVID-19 infection. [Neurol Ther](#). 2022;11(1):491–7.
- 19 Bidari A, Asgarian S, Mohammad AP, Naderi D, Anaraki SR, Mesgarha MG, et al. Immune thrombocytopenic purpura secondary to COVID-19 vaccination: a systematic review. [Eur J Haematol](#). 2023;110(4):335–53.
- 20 Moradians V, Shateri Amiri B, Bahadorizadeh L, Gholizadeh Mesgarha M, Sadeghi S. Concurrent COVID-19 and pneumocystis carinii pneumonia in a patient subsequently found to have underlying hairy cell leukemia. [Radiol Case Rep](#). 2022;17(9):3238–42.
- 21 Bidari A, Hassanzadeh M, Naderkhani M, Gholizadeh Mesgarha M, Pour Mohammad A, Azadeh A, et al. Predictors of critical COVID-19 in an Iranian population: age and disabilities play a special role. [Med J Islam Repub Iran](#). 2021;35:94.