



# SARS-CoV-2 Infection and Vaccination Cutaneous Manifestations for the Inpatient Dermatologist

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Accepted: 25 September 2022

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## Abstract

**Purpose of Review** The overall purpose of this review was to characterize and summarize cutaneous eruptions associated with coronavirus disease 2019 (COVID-19) as well as COVID-19 vaccination.

**Recent Findings** Cutaneous eruptions associated with COVID-19 infection have a reported frequency of 1–20%. Increased COVID-19 disease severity has been associated with morbilliform exanthems, urticaria, retiform purpura, and livedo racemosa. Papulovesicular eruptions were associated with a milder COVID-19 disease course. A range of dermatoses have also been reported with COVID-19 vaccination but have rarely prevented subsequent vaccination.

**Summary** Dermatologists should be aware of the associations between COVID-19 disease severity and cutaneous eruptions. Livedo racemosa and retiform purpura are particularly associated with increased disease severity and death. In the setting of COVID-19 vaccination, cutaneous eruptions can largely be managed symptomatically and very rarely do these reactions prevent subsequent vaccination.

**Keywords** COVID-19 cutaneous eruptions · COVID-19 vaccinations · COVID-19 disease severity · COVID-19 vaccine reactions

## Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a virus which causes coronavirus disease 2019 (COVID-19), has resulted in over 450 million infections, and 6 million confirmed deaths globally at the time of this publication [1]. Although a respiratory virus, cutaneous manifestations have been widely reported, with a frequency varying among reports ranging between 1 and 20% [2, 3]. The most common morphology is a morbilliform eruption,

but retiform purpura, chilblain-like, and urticarial eruptions have also been reported (Tables 1 and 2) [4••]. Most cutaneous eruptions are reported to occur after or during COVID-19 symptoms; however, some cutaneous reactions may be an early indicator of infection similar to anosmia. Dermatologists must maintain awareness for cutaneous reactions in COVID-19 infections, as they may be utilized to help guide diagnosis, and, in some cases, influence disease severity and prognosis.

## Etiologies of Cutaneous Manifestations

The pathogenesis of COVID-19-associated cutaneous eruptions likely varies depending on clinical presentation. Mechanisms such as direct endothelial damage, complement activation, cytokine storm, ANCA and immune complex deposition, upregulation of IL-6, and direct cytotoxic NK T-cell activation have all been attributed to dermatologic manifestations of the disease. However, many presentations are idiopathic [5]. Some patients have been reported to develop anti-phospholipid antibodies [6], which may lead to a hypercoagulable state and microvascular occlusion. Viral particles have been detected

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This article is part of the Topical Collection on *Hospital-Based Dermatology*

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**Table 1** Summary of cutaneous eruptions associated with COVID-19 infection [4••, 9••, 10••, 22••]

Eruption	Association with COVID-19 severity	Prevalence among cutaneous eruptions associated with COVID-19 infection	Sex predominance	Age ranges (years)	Onset in relation to COVID-19 symptoms	Predominant location of eruptions	Histological patterns
Morbilloform	Increased disease severity	22–47%	Same (50%)	Median: 52	Resolution or after COVID-19 symptom onset	Trunk, extremities	Interface; spongiotic; perivascular lymphocytic infiltrate
Urticarial	Increased disease severity	16–19%	Female (78%)	Mean: 48.7	Prior or concurrent with symptom onset	Trunk	Urticarial vasculitis; neutrophilic perivascular inflammation and karyorrhexis Urticarial: vacuolar interface; occasional necrotic keratinocytes; spongiotic; perivascular lymphocytic infiltrate
Vesicular	Milder disease course	9–11%	Same	Mean: 60	After symptom onset	Trunk	Atrophic epidermis; basal layer vacuolar degeneration with dyskeratotic cells [19•]
Retiform purpura/livedo racemosa	Increased disease severity and fatal disease course	6%	Male	Median: 66	After symptom onset	Buttocks; extremities	Thrombotic vasculopathy
Erythema multiforme-like	N/A	9%	Women	Varied age ranges	Days to weeks after symptom onset/resolution	Palms and soles	Epidermal spongiosis, perivascular and interstitial lymphocytic infiltrate
Papulosquamous	N/A	9.9%	Male	Median: 28	After symptom onset	Trunk	Focal spongiosis, parakeratosis, lymphohistiocytic infiltrate

**Table 2** Summary of cutaneous eruptions associated with COVID-19 vaccination [54••, 58••, 85, 86]

Eruption	Prevalence among cutaneous eruptions associated with COVID-19 vaccination	Vaccine type	Sex predominance	Age ranges (years)	Predominant location of eruptions	Day to appear after vaccine dose 1	Histological patterns
<i>Local injection site reaction</i>	45%	Moderna (92%); Pfizer (8%)	94% Female	21–88	Vaccinated arm only	1	Perivascular infiltrates with mixed inflammation (including lymphocytes, neutrophils, and eosinophils)
<i>Delayed large local reactions</i>	50%	Moderna (94%); Pfizer (6%)	93% Female	27–88	Vaccinated arm only	7	Superficial perivascular and perifollicular lymphocytic infiltrate with rare eosinophils and scattered mast cells
<i>Urticarial eruptions</i>	6%;	Moderna (57%); Pfizer (43%)	89% Female	26–69	Arms, trunks, legs, face	3	Dermal edema with sparse perivascular lymphocytes, neutrophils, and eosinophils
<i>Morbilliform eruptions</i>	4%	Moderna (65%); Pfizer (35%)	88% Female	22–76	Arms, trunk, legs	3	Spongiform dermatitis with interspersed eosinophils
<i>Vascular reactions</i>	4%	Moderna (66%); Pfizer (34%)	52% Female	17–38	Foot; hand	N/A	Perivascular and interstitial neutrophilic infiltrate with leukocytoclasia and fibrin deposition within the vessel walls
<i>Erythromelalgia</i>	3%	Moderna (77%); Pfizer (23%)	92% Female	19–83	Arms, face, hands, feet	7	N/A
<i>Viral reactivation</i>	2%	Moderna (42%); Pfizer (58%)	N/A	29–79	Face, chest, back, abdomen	7	N/A

directly in the endothelium of some cutaneous lesions [7]. However, some cutaneous lesions did not contain any viral mRNA at all [8]. This variability in etiology may reflect the variability in morphology seen in cutaneous eruptions of COVID-19 disease.

## Cutaneous Eruptions Associated with COVID-19

### Morbilloform Eruptions

The most common cutaneous eruption associated with COVID-19 infection is the morbilliform exanthem, accounting for 22 to 47% of all cutaneous reactions, with a corresponding impact on prognosis being associated with increased disease severity [4••, 9••, 10••]. COVID-19-associated morbilliform exanthems were commonly reported on the trunk as well as the extremities and usually developed either at the time of development or resolution of COVID-19 symptoms [4••]. The median age at the time of development has been reported to be 52 years (36–66) [4••], and the rash was often associated with pruritus [11], pain, or a burning sensation [4••]. Histopathologic analysis of the COVID-19-associated morbilliform eruption has demonstrated a range of findings including interface dermatitis, spongiosis, or perivascular lymphocytic infiltrates [4••, 12]. Additional information is still needed in order to differentiate morbilliform eruptions associated with COVID-19 infection and drug induced or other viral exanthems, and, in practice, may be impossible to differentiate given the clinical context. This is often self-limited and can be treated symptomatically with topical steroids or antihistamines.

### Urticarial Eruptions

Urticarial eruptions are the second most common cutaneous eruption associated with COVID-19 infection and have also been associated with increased disease severity [10••, 13]. These lesions account for 16 to 19% of cutaneous reactions, with most cases reported in women [4••, 10••, 14]. The mean age of these patients was  $48.7 \pm 19.9$  years [10••]. Urticarial eruptions were largely generalized but almost always involved the trunk [10••]. In one systematic review, 45% of patients with COVID-19-associated urticaria developed urticarial lesions concurrently with the development of COVID-19 symptoms, while 10% of patients developed lesions prior to the development of other COVID-19 symptoms [14]. Subsequently, reports have described the presence of acute urticarial lesions associated with pyrexia as a presenting sign of COVID-19, potentially leading to a fatal or severe disease course [13, 15, 16]. Treatment of COVID-19-associated urticarial eruptions has largely been successful with oral antihistamines alone, oral corticosteroids, and

combinations of the two [14]. Urticarial eruptions frequently cleared within 5 days to a week of initial presentation [2, 11]. The etiology of COVID-19-associated urticaria is believed to be related with either complement activation and/or as a result of serum sickness illness associated with circulating viral particles leading to both IgE and viral antigen-immune complex mediated mast cell degranulation [17•]. Facial edema without urticaria has also been reported [14]. Lastly, urticarial vasculitis has been reported to occur as a result of COVID-19 infection in at least two patients, with biopsy results demonstrating neutrophilic perivascular inflammation and karyorrhexis consistent with small vessel vasculitis and damage [18].

### Vesicular Eruptions

Papulovesicular eruptions have been well documented as a dermatologic manifestation of COVID-19 and account for 9–11% of cutaneous reactions [4••, 10••]. These vesicular lesions have been described as “varicella-like,” typically occur after COVID-19 symptom onset and predominately affect middle-aged male patients [10••, 19•]. A study described 22 patients, with a mean age of 60, who developed papulovesicular lesions, of which the trunk was always involved [19•]. Most patients presented with a scattered or generalized distribution, with an average latency of 3 days after symptoms onset [19•]. Lesions typically resolve without scarring. These lesions are associated with a milder COVID-19 disease course, and there have been reports of vesicular eruptions preceding or as the only sign of COVID-19 infection [4••, 10••, 20].

### Retiform Purpura and Livedo Racemosa

Retiform purpura and livedo racemosa have been described in severe COVID-19 with patients requiring critical level care [4••, 10••, 21]. Among cutaneous lesions, retiform purpura accounts for 6% of eruptions and occurs predominately in elderly patients with a median age of 66 [4••]. These patients often present with other major systemic illnesses such as pulmonary emboli, acute respiratory distress syndrome (ARDS) and elevated D-dimer [22••]. Biopsies of these lesions often demonstrate thrombotic vasculopathy with C5b-C9 complement deposition [4••, 22••]. These lesions were often located on the buttocks and/or the extremities [4••], though they have occurred on the trunk [21]. In a study published of 4 patients with livedoid and purpuric skin eruptions, patients developed cutaneous thrombosis and pulmonary embolisms despite the use of prophylactic anticoagulation therapy [22••]. There have been case reports of retiform purpura as the presenting sign of severe COVID-19 infection in patients with hospital admissions initially unrelated to COVID-19 [23, 24]. Transient livedo reticularis has

also been described in patients with COVID-19; however, the severity of these COVID-19 cases has ranged from mild to severe [23, 25, 26].

### Erythema Multiforme-Like Eruptions

Erythema multiforme-like lesions (EM) are characterized as erythematous targetoid macules and papules that are generalized, often with oral and genital involvement. In a study of 176 patients who developed cutaneous reactions associated with COVID-19, 9% were described to develop EM-like lesions [27]. The EM-like eruptions had a latency ranging between a few days and several weeks after symptom onset [28]. All but two patients presenting with EM-like lesions were women [27]. In younger patients presenting with EM-like lesions, the COVID disease course was often mild and the lesions were primarily localized to the palms and soles [28]. EM-like eruptions have also been described among older patients, with one study of 17 patients reporting a mean age of 61.5 [27]. The lesions were generalized and often symptomatic with patient's noting increased pruritus and pain [27, 29]. Histology of adult patients with EM-like lesions demonstrated epidermal spongiosis as well as perivascular and interstitial lymphocytic infiltrate as opposed to the classical epidermal necrosis associated with true EM [30]. Treatment of these eruptions with systemic corticosteroids led to a mean resolution of lesions within approximately 10 days, though a case report of an elderly woman did illustrate a fatal disease course [29, 31].

### Papulosquamous Eruptions

Papulosquamous eruptions have been reported to occur during COVID-19 infection and have been described to resemble pityriasis rosea. They present with thin scaly erythematous papules and plaques, but often with the absence of the initial "herald patch" [2]. These eruptions account for approximately 9.9% of cutaneous reactions associated with COVID-19 [4••]. They are commonly localized on the trunk and extremities and have been associated with pruritus and pain [2, 4••]. Patients are described as predominately male (59%), having a median age of 28, and with 53% of patients developing lesions after COVID-19 symptoms began [4••]. Histopathology demonstrates focal spongiosis, parakeratosis, and a lymphohistiocytic infiltrate [32]. Case reports of erythrodermic psoriasis have also been reported, with one patient subsequently developing fatal COVID-19 pneumonia [33]. Psoriatic flares associated with COVID-19 infection most commonly occurred in patients with a pre-existing

history of psoriasis; however, new onset psoriatic eruptions have been reported [33].

### Mucocutaneous

Mucocutaneous involvement occurs in isolation as well as in conjunction with a wide variety of cutaneous eruptions associated with COVID-19. In a review of field hospital patients with mild to moderate infection, approximately 46% of patients presented with at least one mucosal lesion, usually oropharyngeal. The most common presentations included glossitis, lingual papillitis, aphthous stomatitis, and mucositis [34]. These patients had a mean age of 56 and were predominately female (58%). Erythema multiforme and EM-like eruptions with mucocutaneous involvement have been reported per the prior section, as well as reactive infectious mucocutaneous eruption (RIME) [28, 30, 35]. Among pediatric patients, multisystem inflammatory syndrome in children (MIS-C) has been described as a consequence of COVID-19 and has a similar clinical presentation as Kawasaki disease [36–38]. Clinical findings included strawberry tongue, conjunctival injection, and periorbital edema and may correspond to an elevated d-dimer [38]. EM has also been reported to occur concurrently with MIS-C [36]. MIS-C is a severe consequence of COVID-19 infection that needs to be readily recognized by physicians in the setting of prior infection and with coinciding gastrointestinal or cardiac involvement.

### Miscellaneous Reports

Additional rare cutaneous eruptions have been reported to occur with COVID-19. These cutaneous manifestations included dengue-like petechiae [39–42], erythema nodosum [43–46], and acute febrile neutrophilic dermatosis (sweet's syndrome) [47–49]. The latency of these cutaneous eruptions varied among patients, but largely occurred during or after the onset of COVID-19 symptoms. Hair loss has been reported with COVID-19, including alopecia areata, telogen effluvium (TE), as well as pressure-induced alopecia (PA) due to proning of an intubated patient with COVID-19 [50, 51]. While largely self-limited, it is estimated that up to 60% of patients infected with SARS-CoV-2 may experience TE [51]. As the COVID-19 pandemic progresses, the incidence of hair loss disorders, especially after surges of infection, may continue to rise. A controversial COVID-19-associated cutaneous reaction is chilblains, known colloquially as "COVID toes"; there is little to no evidence supporting a causal relationship between chilblains and COVID-19 infection or vaccine. Some authors believe the observed vascular cutaneous effects were more likely related to lifestyle changes during the pandemic [52].

## Conclusion

Cutaneous eruptions as a result of COVID-19 infection have been well described. In the inpatient setting, dermatologists must be aware of retiform purpura and livedo racemosa coinciding with COVID-19 infection and the associations with a critical or fatal disease course. Similarly, morbilliform and urticarial eruptions are also associated with increased disease severity, but not mortality, though drug etiologies must still be considered. For pediatricians, the development of mucocutaneous lesions alongside cardiac or gastrointestinal symptoms several weeks after COVID-19 infection should prompt an investigation into possible MIS-C.

## Cutaneous Eruptions Associated with COVID-19 Vaccination

### Introduction

In the setting of the global pandemic, the advent of mRNA and adenovirus-vectored SARS-CoV-2 vaccines have become important in the fight against COVID-19. Three vaccines are FDA-approved in the USA including BNT162b2 (Pfizer/BioNTech) and mRNA-1273 (Moderna) and adenovirus-vectored Ad26.CoV2.S (Johnson & Johnson/Janssen) [53]. Reviews of clinical trials, national registries, and case reports have demonstrated cutaneous reactions that may follow COVID-19 vaccination. The most common reported reactions to COVID-19 vaccination include local injection site reaction, delayed injection site reaction, urticaria, and morbilliform eruptions. Importantly, 43% of these patients experienced a recurrence of this cutaneous reaction when receiving a subsequent dose of the vaccine [54••]. These reactions likely have mixed etiology involving immune dysregulation and hypersensitivity. Molecular mimicry between the SARS-CoV-2 vaccine spike protein and human proteins is thought to account for the delayed type IV reactions. Vaccine excipients like polyethylene glycol (PEG) and polysorbate 80 are also thought to be major contributors to the type I reactions, but can also cause Type IV reactions, like systemic allergic contact dermatitis [55]. PEG-2000 is found in Pfizer/BioNTech and Moderna vaccines, while polysorbate 80 is found in adenovirus-vectored Oxford/AstraZeneca and Johnson & Johnson vaccines [55]. It is posited that this reaction could be an immunogenic host response rather than an allergy to the vaccine itself.

### Injection Site Reactions

Local injection site reactions and delayed extensive local reactions occur frequently with COVID-19 vaccination.

Both designations are likely the same pathology, differing by time relative to injection. Delayed reactions are defined as reactions occurring 8 days or more past the time of injection. Local injection reactions consist of erythema, edema, pain, and pruritus, similar to many other vaccines [53]. Local injection site reactions are seemingly more prevalent in patients younger than 60 [56] and with mRNA vaccines [57]. In a study analyzing 803 vaccine reactions, delayed large local reactions appeared morphologically as indurated erythematous plaques on the vaccinated arm. On histology, local injection site reactions demonstrated a superficial lymphocytic infiltrate with scattered eosinophils and mast cells.

### V-REPP

Vaccine-related eruption of papules and plaques (V-REPP) was the most common cutaneous reaction spectrum observed following all COVID-19 vaccine types in a registry-based study of 803 cases. V-REPP describes a spectrum of morphologies which exhibit papules and plaques with surface change; histopathology consistently revealed spongiotic dermatitis with interspersed eosinophils [58••]. V-REPP severity was defined by clinical morphology, with robust eruptions described as papulo-vesicular, moderate eruptions as pityriasis rosea-like, and mild eruptions as papulo-squamous. Histologically, the robust variant of V-REPP demonstrated increased spongiosis and decreased interface changes, while mild eruptions demonstrated increased interface changes with mild spongiosis. The proposed mechanism for V-REPP pathogenesis is either a delayed hypersensitivity response or a T-cell response to a viral epitope [58••].

### Dermal Hypersensitivity

Dermal hypersensitivity reactions are characterized as edematous, papular, and/or urticarial eruptions that can coalesce into plaques and last for greater than 24 h [58••, 59]. In a case series of 37 patients with dermal hypersensitivity, eruptions occurred after the second dose of vaccination, with an average latency of 7 days. Patients were most commonly between the ages of 21 and 30 years, and 78% of patients were asymptomatic, while 22% of cases demonstrated mild to moderate pruritus [59]. Histology demonstrated mixed perivascular inflammatory infiltrate, papillary dermal edema, and no epidermal changes [58••, 59]. Subsequently, these eruptions self-resolved within 2 weeks of onset without the presence of post-inflammatory hyperpigmentation. The pathogenesis of dermal hypersensitivity eruptions following COVID-19 vaccination is hypothesized to occur as a result of a type IV T-cell delayed hypersensitivity reaction [59].



## Urticaria

Acute urticaria is common following COVID-19 vaccination [54••]. Urticaria occurring within 4 hours of vaccine administration are considered part of an immediate hypersensitivity reaction. Acute urticaria and angioedema reports represented less than 1% of patient cohorts in multiple registries [60, 61]. In an analysis of 414 cutaneous reactions, only 22% of the 18 patients that developed urticaria experienced recurrence, with none of the reactions occurring on the day of injection and with no reports of anaphylaxis. Treatment with antihistamines and systemic steroids was effective in symptom control [54••]. In contrast, another study described 11 cases of anaphylaxis among 55 patients with documented urticaria (10 with Pfizer and 1 with Moderna) [56]. History of any immediate allergic reaction (< 4 h), even if non-severe, is a contraindication to receiving a vaccine of that same type in the future (CDC). In a statement by the British Society for Allergy & Clinical Immunology, individuals that only develop localized urticaria in the absence of systemic symptoms are advised to continue with the vaccine series in a facility equipped with full resuscitation measures [62, 63]; the CDC also endorses a 30-min observation period following vaccination [64]. Various countries have not reached a consensus on whether or not patients who had minor allergic reactions to the vaccine, such as urticaria, should receive the second dose [62]. Overall, skin testing can be considered, and shared-decision making with the patient is necessary as more information is needed to determine the safety of premedication, graded challenging, or exploring mixed vaccination [62].

## Morbilloform Eruptions

Morbilloform exanthems associated with the COVID-19 vaccination most commonly presented as confluent erythema or more classical confluent erythematous macules and papules [55]. This eruption commonly appeared a few days following injection and was self-limited [53]. In a prospective cohort of 50,000 health employees receiving COVID-19 vaccines, 1.5% of patients developed a morbilliform eruption (most common) from mRNA vaccines [55].

## Vascular Reactions

Several vascular reactions have been reported following SARS-CoV-2 vaccination including cutaneous small vessel vasculitis purpura/petechiae, urticarial vasculitis, erythromelalgia, and chilblain-like lesions. Vascular reactions were anticipated with the introduction of the vaccine due to the prevalence of these symptoms during COVID-19 infection [65]. In a cohort of 415 cutaneous reactions, 4% of these were purpura of the lower limbs [55]. New and worsening

cases of cutaneous small vessel vasculitis were observed with the Pfizer vaccine [66–68]. Chilblains and erythromelalgia were observed with both COVID-19 infection and vaccination. Erythromelalgia has also been observed following other vaccinations including influenza and hepatitis B vaccines [55]. Other more rare vascular reactions such as livedo racemosa [69] have been reported.

## Viral Reactivation

The COVID-19 vaccine has been reported to be associated with the reactivation of prior viral disease including herpes simplex virus (HSV), varicella-zoster virus (VZV), and pityriasis rosea (PR). Many of these latter reactions are termed “PR-like” as they are classically more pruritic exanthems without the presence of a herald patch [55]. Many cases may be categorized subsequently under the umbrella term of V-REPP. Interestingly, PR-like exanthems also presented with direct COVID-19 infection and are thought to be due to the host immune response rather than direct viral inoculation [70]. Subsequently, PR-like eruptions may be due to either human herpes virus-6/7 reactivation or host immune response [70], while herpes zoster may be activated following the release of VZV from the latent phase [71]. More than 1000 patients have documented herpes zoster following vaccination in the Vaccine Adverse Event Reporting System (VAERS), although a causal relationship has yet to be established [53].

## Flares of Existing Dermatoses

The COVID-19 vaccine has been reported to flare existing dermatologic conditions, a phenomenon most commonly described with psoriasis. In a case series of 14 patients who developed plaque psoriasis following vaccination, nine patients had pre-existing psoriasis. Another study showed a worsening of psoriatic arthritis [55]. Other inflammatory and autoimmune dermatoses were worsened following the vaccination, but these flares were self-limited [55]. Worsening atopic dermatitis, subacute cutaneous lupus erythematosus, and bullous pemphigoid have all been reported [55, 72, 73].

## Severe Cutaneous Adverse Reactions (SCARs)

Although rare, cases of severe cutaneous adverse reactions (SCARs) have been reported secondary to COVID-19 vaccination. One patient developed a drug rash with eosinophilia and systemic symptoms (DRESS) following the Johnson/Johanson vaccine [74]. A report of toxic epidermal necrolysis (TEN) was made following the Pfizer/BioNTech vaccine, and Steven-Johnson syndrome (SJS) was reported following the AstraZeneca/Oxford vaccine in a 60-year-old male [75]. Four cases of drug-induced erythema multiforme (EM)

developed following Moderna vaccination [54••], as well as a case of a bullous fixed drug eruption [76]. Lastly, bullous drug-induced reactions have been observed to occur within 3 weeks of receiving the COVID Pfizer mRNA vaccine; histology supported subepidermal or subcorneal blisters with eosinophils, with direct immunofluorescence staining positive for IgG and C3 [73]. Other vesicobullous reactions following Pfizer vaccination include acute generalized exanthematous pustulosis (AGEP) and dyshidrotic eczema [77]. AGEP was also reported following the AstraZeneca/Oxford vaccine [69].

### Miscellaneous Reactions

Other rare reactions included two cases of a local adjacent reaction near a previous Bacille Calmette-Guérin (BCG) inoculation site following mRNA vaccination, which presented as indurated plaques [55, 78]. Interestingly, multiple reports detailed a delayed inflammatory reaction to hyaluronic acid dermal fillers, which has also occurred with other viral illnesses and vaccines [79]. In a case series of four patients, one case occurred with SARS-CoV-2 infection, two cases following the Moderna vaccine, and one following the Pfizer vaccine. The etiology is thought to be related to the blockade of angiotensin-converting enzyme 2 (ACE-2) by the spike proteins on the COVID-19 mRNA vaccines. Hyaluronidase injections, systemic steroids, and more recently ACE inhibitors have been utilized to treat the filler reactions; ACE blockers are the preferred therapy, rather than systemic steroids [55]. Generalized petechia and purpura have been reported in the setting of immune thrombocytopenia associated with mRNA vaccination [53]. Lastly, multiple cases of radiation-recall dermatitis occurred in areas of prior irradiation sites [80, 81]. Other rarer reactive dermatoses reported alongside COVID-19 vaccination included Sweet's syndrome, lichen planus, fixed drug eruptions, rosacea, and new onset psoriasis of varying types [55, 82].

### Conclusion

In summary, local injection reactions, delayed large local reactions, morbilliform, and urticarial reactions were among the most common cutaneous effects of the SARS-CoV-2 vaccine. Exanthems, vascular lesions, and urticaria occurred following both SARS-CoV-2 infection and COVID-19 vaccination. Varying rates of recurrence of cutaneous reactions during the second dose of the COVID-19 vaccine were reported, yet few severe reactions serve as contraindications for additional doses of the SARS-CoV-2 vaccine. Only SCARs and immediate hypersensitivity reactions are complete contraindications for subsequent doses [62, 83, 84]. In summary, a wide variety of reactive dermatoses have manifested following both COVID-19 infection and vaccination,

most of which can be managed symptomatically. Very rarely do these reactions prevent further vaccination, and there is consensus they should not contribute to vaccine hesitancy.

### Compliance with Ethical Standards

**Conflict of Interest** The authors do not have existing conflicts of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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