



LITERATURE REVIEW

Skin manifestations in patients with covid-19: A literature review

Danny Gunawan^{1*}, Maureen Miracle Stella², Veronika Maria Sidharta³

¹ Department of Dermatology and Venereology, Faculty of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

² Medical Professional Education, Faculty of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

³ Department of Histology, Faculty of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

* Corresponding author, email: danny.gunawan@atmajaya.ac.id

ARTICLE INFO

ABSTRACT

Keywords:

Cutaneous
Skin
Manifestation
COVID-19

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. In December 2019, cases of pneumonia with unknown cause were first reported in Wuhan, Hubei Province, China. Confirmed cases and death rates due to COVID-19 in the world are still increasing. One part of the body that is affected and causes clinical symptoms in COVID-19 is the skin. This review aims to describe and analyze cutaneous manifestation in COVID-19. This study method is a review of the literature sourced from Google Scholar and PubMed. The literature was selected using English language criteria, using the clinical study method in the form of case reports. Meanwhile, literature review, systematic literature, and meta-analysis were excluded. Journal searches were carried out using the keywords "skin" OR "cutaneous" AND "manifestation" AND "COVID-19" OR "coronavirus". The skin manifestations of COVID-19 have been observed. The most common clinical symptoms of COVID-19 were fever (47%), dry or productive cough (25%), sore throat (16%), generalized sore throat (6%), and pain (5%). However, currently there has been a shift in the approach to diagnosing COVID-19 because it can cause symptoms in other organ systems, one of which is skin manifestations. There are early reports of skin involvement (erythematous rash, extensive urticaria, and chickenpox-like vesicles) occurring in 20% of patients in the course of the COVID-19 disease. In addition, several case reports provide descriptions of petechiae and chilblains. Based on the cases that have been reported, patients with COVID-19 who have manifestations on the skin can give a picture of maculopapular eruptions, vesicular eruptions, petechiae, and also chilblains.

1. Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by the 2019-nCoV virus, formerly known as SARS-CoV-2. COVID-19 was identified for the first time in December 2019 in Wuhan, Hubei Province, China, and rapidly spread to Thailand and South Korea in less than one month. The pandemic status of the disease was declared on March 11, 2020. According to a report by the World Health Organization (WHO) dated

March 12, 2021, there were 117,799,584 confirmed cases of COVID-19 with 2,615,014 deaths worldwide (WHO, 2021).

In Indonesia, the number of confirmed COVID-19 cases and death rates continue to rise. According to a report from the Ministry of Health of the Republic of Indonesia, there were 1,403,722 confirmed cases on March 11, 2020, and the death rate was 38,049. Along with the continuing increase in confirmed cases of COVID-19, COVID-19 research is still ongoing at

<https://doi.org/10.30659/sainsmed.v13i1.15563>

this time (Kemenkes RI, 2021). There are numerous ongoing studies, and the progression of COVID-19 disease is becoming increasingly clear.

The skin is a part of the body that is affected by COVID-19 and causes clinical symptoms. There are two types of clinical skin symptoms: those caused by viruses and those not caused by viruses. To identify the precise symptoms of the virus, direct detection of virus particles in the skin lesion is necessary. This can impede the rapid determination of whether a skin lesion is caused by COVID-19 or not (Vesely and Perkins, 2020). Therefore, clinicians must be aware of the appearance of skin lesions in patients with COVID-19, as this appearance is frequently not associated with SARS-CoV-2 infection (Liu *et al.*, 2020).

This literature review aims to identify and investigate the clinical manifestations of COVID-19 on the skin. This research is anticipated to provide a clearer picture to aid in identifying and establishing a diagnosis of COVID-19 in patients with clinical manifestations on the skin, so that it can be used as a further reference when conducting clinical trials.

2. Method

The method of this article is a literature review of literature from *Google Scholar* and *PubMed*. The literature is selected using English-language criteria, using the method of clinical studies in the form of case reports. Meanwhile, literature review, systematic literature, and meta-analysis are excluded. The literature search was conducted using the keywords “*skin*” OR “*cutaneous*” AND “*manifestation*” AND “*COVID-19*” OR “*coronavirus*” from 2019 to 2021. From the search for the literature, 333 articles were obtained. Articles relevant to the topic of clinical manifestations on the skin in COVID-19 patients are included into this literature review.

3. Discussion

3.1. Definition

Coronavirus is a non-segmented sensory-positive RNA genome virus surrounded by an envelope that causes respiratory and digestive tract infections in humans and animals. This viral infection can cause symptoms such as sore throat, tremors, confusion, high fever, shortness of breath, dry cough, headache, nausea, vomiting, and diarrhea in patients (Chen, Liu and Guo, 2020). The incubation period of the COVID-19 virus ranges from 2 to 14 days. The virus also has a high degree of virulence. The similarity of the initial symptoms of the COVID-19 virus with the symptoms of the common cold often causes people to ignore these symptoms, resulting in a significant increase in cases (Guan *et al.*, 2020).

3.2. Epidemiology

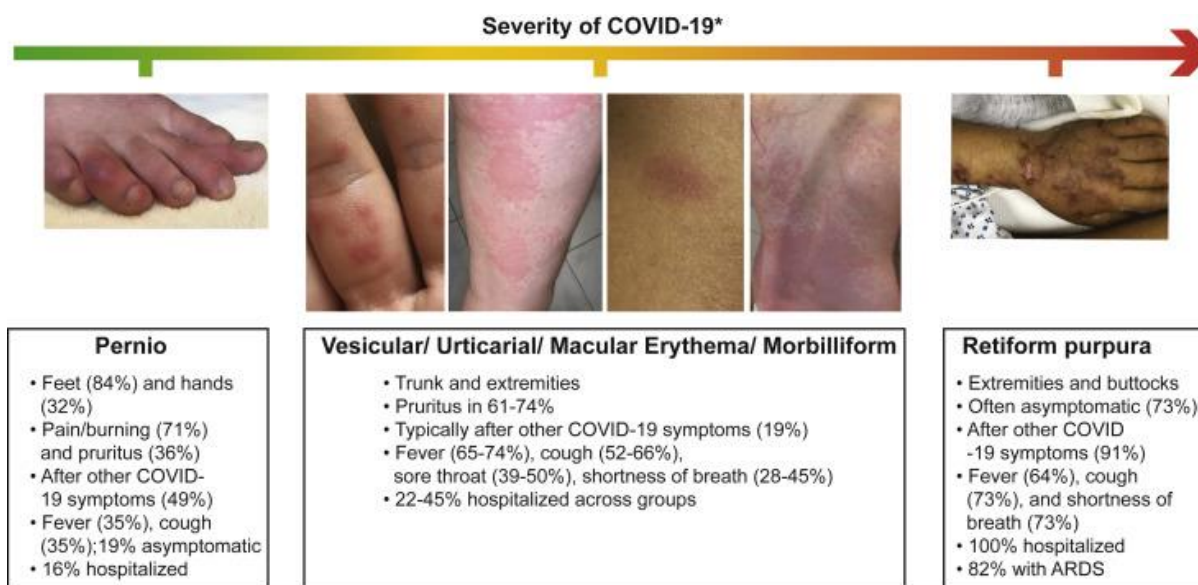
On March 11, 2020, WHO announced this disease as a pandemic, under the name *Coronavirus Disease* (COVID-19) caused by the SARS-CoV-2 virus. Based on the WHO report in 2021, on March 12, 2021, there were 117,799,584 confirmed cases of Covid-19 worldwide accompanied by 2,615,018 deaths. The American region has the most confirmed cases, at 52,202,902 cases. Furthermore, the European region with 40,438,291 cases, the Southeast Asian region with 13,789,730 cases, the Eastern Mediterranean region with 6,756,455 cases, the African region with 2,924,244 cases, and the Western Pacific region with 1,687,217 cases (WHO, 2021).

Confirmed cases of COVID-19 in Indonesia is still growing. Based on a report by the Ministry of Health of the Republic of Indonesia, on March 11, 2020, there were 1,403,722 confirmed cases with a death rate of 38,049 deaths. Based on a report from the Indonesian Ministry of Health on March 10, 2021, DKI Jakarta has the most cumulative confirmed cases, namely 353,075 cases with 5,894 deaths. The area with the fewest cumulative cases is Gorontalo with 4,866 cases with 138 deaths (Kemenkes RI, 2021).

3.3. Pathogenesis of COVID-19 on the Skin

The mechanism of clinical manifestations occurrence on the skin due to SARS-CoV-2 infection is still unclear today. However, there are already several hypotheses issued in this regard. SARS-CoV-2 is a single-stranded viral RNA consisting of 16 non-structural proteins (NSP 1-16) that play a role in the viral replication process. One of these proteins, namely NSP 3, has the property of blockading the immune response of host cells and inducing expression from cytokines. Meanwhile, NSP5 can inhibit interferon signals, and NSP16 can depress the host cell's immune system. There are 4 structural proteins essential for this viral infection: the S protein (spike on the surface of the virus), the M protein (in trans membranes), the E protein (involved in viral pathogenesis), and the N protein (binding to the RNA virus genome) (Chen, Liu and Guo, 2020). SARS-CoV-2 infects type 2 angiotensin-converting enzyme (ACE) cells such as type 2 alveolar cells (surfactants producing cells) (Prompetchara *et al.*, 2020).

Study by Criado *et al.* (2020) states dendritic cells, monocytes, and macrophages are the front lines of the body's immune system to fight viral infections. The immune protective response to viral infection is initiated by sensors that can detect the presence of foreign nuclear acids in the intracellular and extracellular space. Enzymes that metabolize endogenous nucleic acids can prevent activation of the immune system against viral infections. Inadequate regulation of immune system



*Severity calculated based on percentage of patients hospitalized for COVID-19

Figure 1. Spectrum of skin manifestations severity in COVID-19 (Freeman *et al.*, 2020)

receptors can stimulate the transcription of nucleic acids and proteins, which can occur as monogenic genetic disorders, or what is also called type 1 interferonopathy or auto-inflammatory diseases. Several studies have shown that direct T cell infection by SARS-CoV-2 can be detected by looking at SARS-like particles and SARS-CoV RNA in T lymphocytes from peripheral blood, spleen, and lymphoid tissue in various organs of the body. To date, it is not clear whether alveolar macrophages can transfer viral particles into lymphocytes (Criado *et al.*, 2020). Skin manifestation in COVID-19 can be caused through 2 different mechanism patterns (Suchonwanit, Leerunyakul and Kositkuljorn, 2020). First, clinical manifestations will appear similar to viral exotherms, as a form of immune response to viral nucleotides. Second, a secondary eruption of the skin is a complication of SARS-CoV-2 infection that has spread systemically. This eruption will appear as vasculitis and thrombotic vasculopathy (Nurulain T. Zaveri, 2016; Prompetchara, Ketloy and Palaga, 2020). The spectrum of skin manifestations in COVID-19 can be seen in Figure 1 (Freeman *et al.*, 2020).

3.4. Clinical Manifestations

Thanks to ongoing research, the course of the Covid-19 disease is becoming increasingly clear. The skin is a part of the body that is affected by COVID-19 and causes clinical symptoms. Clinical symptoms on the skin can be divided into two categories: those that are caused by viruses and those that are not. To determine whether a symptom is caused by a particular virus, the viral particles must be directly detected in the skin lesion. This can hinder the speed with which

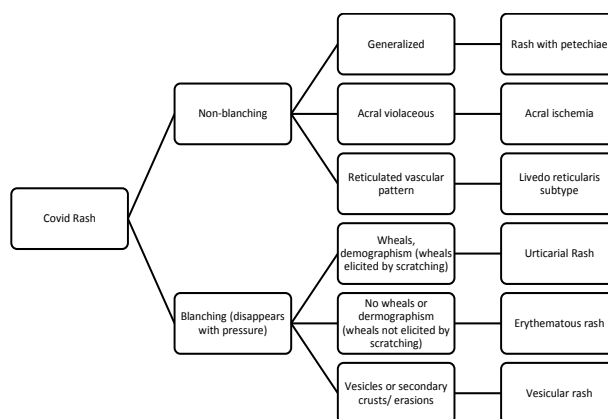


Figure 2. Algorithm of skin manifestations in patients with COVID-19 (Ortega-Quijano *et al.*, 2020)

a skin lesion caused by COVID-19 is identified. In the absence of methods for directly detecting the virus, the presence of an immune system reaction in patients with COVID-19 may result in skin manifestations without exception. Nonspecific skin lesions should be classified as either suggestive of COVID-19 or not suggestive of COVID-19 (Vesely and Perkins, 2020). A study gives an overview of the skin manifestation algorithm in patients with COVID-19 (Ortega-Quijano *et al.*, 2020) as illustrated in Figure 2.

Skin manifestations of COVID-19 have been observed in recent times. Although based on epidemiological data, SARS-CoV-2 infection is characterized by severe acute respiratory syndrome. The most common clinical symptoms of COVID-19 are fever (47%), dry or productive cough (25%), sore throat (16%), generalized sore throat (6%), and pain (5%). However, currently there has been a shift in the

approach to diagnosis COVID-19 because it can cause symptoms in other organ systems, one of which is skin manifestations. There were early reports of skin involvement (erythematous rashes, extensive urticaria, and chickenpox-like vesicles) that occurred in 20% of patients in the course of the COVID-19 disease (Gottlieb and Long, 2020; Torres and Puig, 2020).

1. Maculopapular eruption (morbilliform)

The case report study by shows that a 20-year-old man with COVID-19 has a diffuse morbilliform rash on the chest, back, and extremities ((Hunt and Koziatek, 2020) Figure 3). But this rash is not obtained on the mucosa nor on the face (Hunt and Koziatek, 2020). The results of a study reported that 15% (3 out of 20) of pediatric patients with COVID-19 showed manifestations on the skin (Bursal Duramaz *et al.*, 2020). Manifestations in the form of maculopapular rash in two patients, and erythema eruptions in one patient. The youngest patient, a woman with eight months of age, developed an erythema rash similar to the roseola picture. Rashes and fevers occur for 2 days and are reduced after administration of hydroxychloroquine for COVID-19. The second patient, an 11-year-old female, developed a maculopapular rash with itching upon arriving at the hospital. Such symptoms persist up to five days. The oldest patient, with the age of 17 years, developed a maculopapular rash with a mild itch on the 3rd day after administration of hydroxychloroquine. The picture in this patient is suspected to have occurred due to COVID-19 or the administration of hydroxychloroquine (Duramaz *et al.*, 2020).

According to previous studies, it was stated that out of 88 COVID-19 patients, 18 patients (20.4%) were found with manifestations on the skin, namely: exanthematous maculopapular (morbilliform / measles-like picture), rashes with papulovesicular forms such as chickenpox, urticaria (Avellana Moreno *et al.*, 2020). The results of other studies also stated that there were seven patterns of manifestation of maculopapular rash: morbilliform (45.5%), other maculopapular others (20.0%), purpuric (14.2%), *erythema multiforme-like* (9.7%), *pityriasis rosea-like* (5.7%), *erythema elevatum diutinum-like* (2.3%), and perifollicular (2.3%) (Català *et al.*, 2020). In most cases, a maculopapular eruption occurred simultaneously (61.9%) or was a continuation (34.1%) of other manifestations of COVID-19. Laboratory tests associated with maculopapular eruptions in these patients are high C-reactive protein (CRP), D-dimer, ferritin, interleukin-6 and the presence of lymphopenia (Català *et al.*, 2020). A study reported 2 COVID-19 patients with diffuse maculo papular eruptions on their bodies alone, according to the illustration caused by virus and similar to Grover's



Figure 3. Morbilliform rash in patients with COVID-19 (Hunt dan Koziatek, 2020)

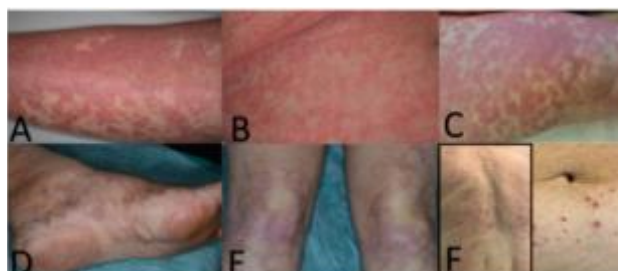


Figure 4. A) Maculo-papulo-vesicular rash. Areas with such an image as hemorrhagic points are due to extravasation of erythrocytes. B) Papular erythema exanthema on the body. C) Diffuse macular livedoid hemorrhagic lesions in patients with a histopathological picture similar to CID. D & E) Initial resolution in lesions after therapy. F) Papular erythema eruption with crustal lesions and Grover's disease-like erosive (Gianotti, Zerbi dan Dodiuk-Gad, 2020)

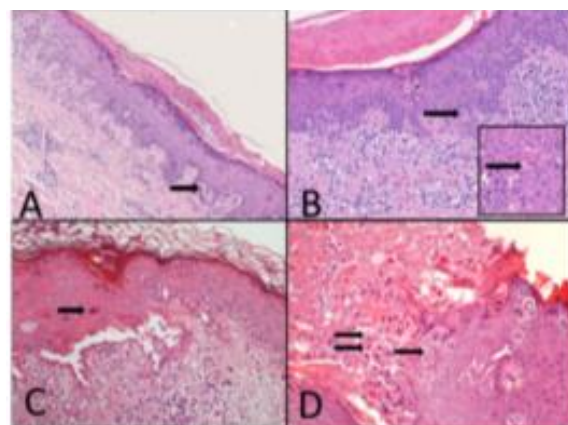


Figure 5. A) Parakeratosis, acanthosis, dyskeratotic keratinocytes, and small acantholytic fissures (arrows). B) Dyskeratotic keratinocytes of the upper epidermis. Necrotic keratinocytes (arrows). Inset, necrotic keratinocytes with lymphocyte satellitosis (arrows). C) Necrotic keratinocytes (arrows) and more pronounced acantholytic fissures. D) Necrotic keratinocytes (double arrows) and pseudo-herpetic images (arrows) (Gianotti, Zerbi dan Dodiuk-Gad, 2020)

disease (Figure 4F) (Gianotti, Zerbi and Dodiuk-Gad, 2020). Histopathological examination showed that in addition to classical dyskeratotic cells, there were also

enlarged multinuclear cells and necrotic keratinocytes with lymphocytic satellitosis (Figure 5 A-D).

a. Exanthema

A biopsy taken from a patient in the hospital at the beginning of the onset of exanthema on his body and legs showed diffuse telangiectasis without other strange symptoms (Figure 6A). The second biopsy shows a unique clue, namely a set of Langerhans cells within the epidermis (Figure 6B). When a maculopapule-vesicular rash begins to develop (Figure 4A), the histological picture shows perivascular spongiotic dermatitis with exocytosis along with a large set of Langerhans cells and an eosinophil-rich dense perivascular lymphocytic infiltration around the swollen blood vessels with erythrocyte extravasation (Figure 6C). A sample from a man treated at the hospital with papular erythemic exanthema on his body (Figure 4B) revealed the presence of a swollen dermis with many eosinophils. There is also a collection of lymphocytes around the blood vessels in a lymphocytic vasculitis (Figure 6D). A patient treated in the ICU experienced a severe macular hemorrhagic eruption (Figure 4C-E), which correlated with the presence of microthrombus inside the blood vessels of his skin (Figure 6E) (Gianotti, Zerbi dan Dodiuk-Gad, 2020).

1. Petechiae/purpuric rash

One study reported a picture of petechiae in a 41-year-old male patient who had COVID-19 with thrombocytopenia, cough, and runny nose (Murt *et al.*, 2021). The results of another study also showed that 1 in 48 patients with COVID-19 had a similar petechiae to the picture in dengue fever, where this rash would disappear within a few days and had no effect on the severity of COVID-19 (Joob and Wiwanitkit, 2020). Another study reported manifestations of skin disorders in the form of macular erythema, papule and petechiae distributed asymmetrically in peri flexural in a 48-year-old man from Spain with symptoms of COVID-19 (Figure 7). In the specimen biopsy, there was extravasation of red blood cells, papillary dermal edema, and dyskeratotic keratinocytes with *hematoxylin-eosin* staining and 100 times magnification (Figure 8) (Diaz-Guimaraens *et al.*, 2020).

1. Vesicular eruption

A study by Galvan Casas *et al* (2020)., indicates that vesicular eruptions of the chest and back can be seen early in COVID-19 (Català *et al.*, 2020). Another study reported there were four middle-aged male patients with COVID-19 who had vesicular eruptions (Lim and Tey, 2020). Another study also reported that vesicular eruptions occurred in 19 of the 24 patients

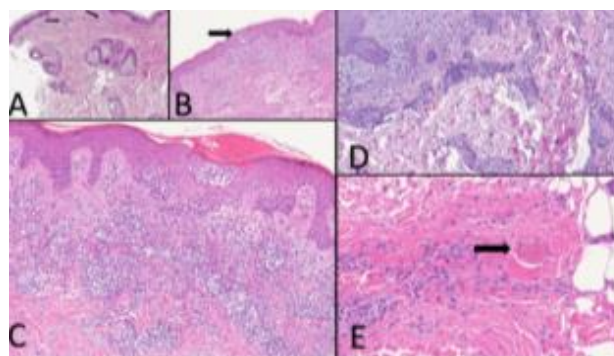


Figure 6. A) The initial phase of the exanthema rash. Blood vessels that undergo telangiectasis (arrows). Exanthema rash. B) Results of exanthema biopsy on day 3. A set of Langerhans cells on the epidermis (arrow). Mild perivascular lymphocytic infiltration of the dermis of the superficial part. C) Papulo-vesicular lesions. Spongiosis, intraepidermal collection of Langerhans cells. D) Maculo-papular exanthema. E) Diffuse hemorrhagic exanthema rash. There is a small thrombus in one of the capillary blood vessels (arrows)(Gianotti, Zerbi and Dodiuk-Gad, 2020)

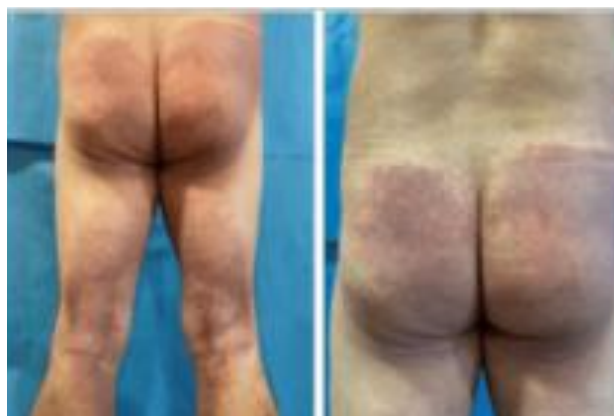


Figure 7. Petechiae in patients with COVID-19 (Diaz-Guimaraens *et al.*, 2020)

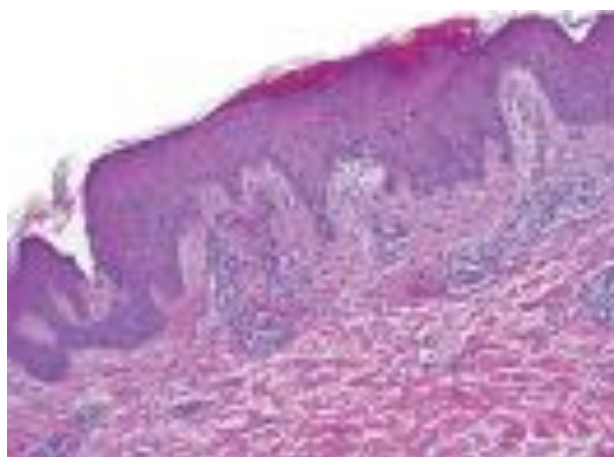


Figure 8. Biopsy specimen on petechiae (Diaz-Guimaraens *et al.*, 2020)



Figure 9. Vesicular eruption in COVID-19 patients (Fernandez-Nieto *et al.*, 2020)

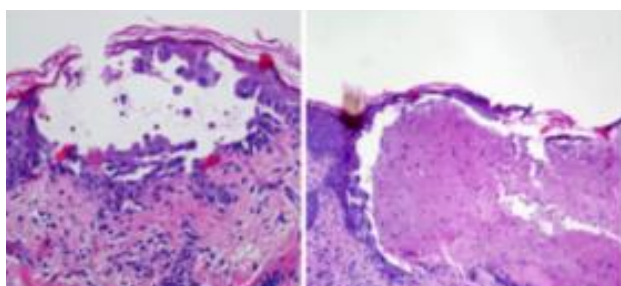


Figure 10. Histological picture of vesicular eruptions (Fernandez-Nieto *et al.*, 2020)



Figure 11. Chilblain lesions in patients with COVID-19 (Landa *et al.*, 2020)

who had been diagnosed with COVID-19 (Fernandez-Nieto *et al.*, 2020). These eruptions last an average of up to 14 days. Seven patients had received previous COVID-19 therapies in the form of lopinavir/ritonavir ($n = 5$), hydroxychloroquine ($n = 6$), and azithromycin ($n = 2$). A diffuse pattern was found in 18 patients, consisting of papules, vesicles and pustules varying in size from about 7 to 8 millimeters. Although some lesions form clusters, they tend to spread in the torso. Two patients also gave pictures of vesicular lesions on the palms of the hands and soles of the feet (Figure 9). On histological examination, it was found the presence of mild acantholysis, and keratinocytes that formed the balloon (Figure 10) (Fernandez-Nieto *et al.*, 2020).

b. COVID toes (chilblain-like)

The cohort study in six patients with COVID-19, had clinical manifestations in the form of multiple skin lesions on the toes, soles of the feet, and fingers similar to the *chilblain* images (Figure 11). Patients had few symptoms of cough and runny nose in the previous 3 to 4 weeks. Lesions are reddish in color and popular in shape, which depict *chilblain*. After 1 week, these lesions become increasingly flush with the skin and pruritic. The patient neither gave a picture of ischemia nor Raynaud's phenomenon. At the time the lesion is pressed, mild pain is felt (Landa *et al.*, 2020).

The year 2020 is a year that will always be remembered in history with the presence of the SARS-CoV-2 virus in human civilization. As we already know

SARS-CoV-2 is a virus that is a dangerous (deadly) "master imitator" in connection with its ability to cause disturbances in various body tissues which at the same time will also activate various immune responses excessively (cytokine storm) in the patient's body which becomes very dangerous. The existence of clinical manifestations in different parts of the body demands that we be more vigilant about any changes that occur in our body when we find symptoms that may lead to COVID-19.

4. Conclusion

Patients with COVID-19 can present an atypical symptom picture in the form of manifestations on the skin. Based on the cases that have been reported, patients with COVID-19 who give rise to manifestations on the skin can give an idea in the form of maculopapular eruptions, vesicular eruptions, *petechiae*, and *chilblain*. Therefore, further research is urgently needed so that clinicians can find out the characteristics in COVID-19 patients with skin manifestations to rule out differential diagnoses due to other viral etiologies.

References

- Bursal Duramaz, B., Yozgat, C.Y., Yozgat, Y. and Turel, O. (2020). Appearance of skin rash in pediatric patients with COVID-19: Three case presentations. *Dermatologic Therapy*, 33(4): 2–3. doi:10.1111/dth.13594.

- Català, A, Galván-Casas, C, Carretero-Hernández, G, et al. (2020). Maculopapular eruptions associated to COVID-19: A subanalysis of the COVID-Piel study. *Dermatologic Therapy*, 33(6): 1–10. doi:10.1111/dth.14170.
- Chen, Y., Liu, Q. and Guo, D. (2020). Emerging coronaviruses: Genome structure, replication, and pathogenesis. *Journal of Medical Virology*. 92(4): 418–423. doi:10.1002/jmv.25681.
- Covid19.who.int. 2021. *WHO Coronavirus (COVID-19) Dashboard*. [online] Available at: <https://covid19.who.int/> [Accessed 12 March 2021].
- Criado, P.R., Abdalla, B.M.Z., de Assis, I.C., van Blarcum de Graaff Mello C, Caputo GC, Vieira IC.. (2020). Are the cutaneous manifestations during or due to SARS-CoV-2 infection/COVID-19 frequent or not? Revision of possible pathophysiologic mechanisms. *Inflammation Research*. 69(8): 745–756. doi:10.1007/s00011-020-01370-w.
- Diaz-Guimaraens, B, Dominguez-Santas, M, Suarez-Valle, A, et al. (2020). Petechial Skin Rash Associated with Severe Acute Respiratory Syndrome Coronavirus 2 Infection. *JAMA Dermatology*, 156(7): 820–822. doi:10.1001/jamadermatol.2020.1741.
- Fernandez-Nieto, D., Ortega-Quijano, D., Jimenez-Cauhe, J., Burgos-Blasco, P., de Perosanz-Lobo, D., Suarez-Valle, A., Cortes-Cuevas, J.L., Carretero, I., Garcia-Del Real, C. and Fernandez-Guarino, M. (2020). Clinical and histological characterization of vesicular COVID-19 rashes: a prospective study in a tertiary care hospital. *Clinical and Experimental Dermatology*, 45(7), pp. 872–875. doi:10.1111/ced.14277.
- Fernandez-Nieto, D., Ortega-Quijano, D., Jimenez-Cauhe, J., Burgos-Blasco, P., de Perosanz-Lobo, D., Suarez-Valle, A., Cortes-Cuevas, J.L., Carretero, I., Garcia-Del Real, C. and Fernandez-Guarino, M. (2020). Clinical Characteristics of Coronavirus Disease 2019 in China. *New England Journal of Medicine*, 382(18): 1708–1720. doi:10.1056/nejmoa2002032.
- Freeman, E.E., McMahon, D.E., Lipoff, J.B., Rosenbach, M., Kovarik, C., Desai, S.R., Harp, J., Takeshita, J., French, L.E., Lim, H.W., Thiers, B.H., Hruza, G.J, Fox LP. (2020). The spectrum of COVID-19-associated dermatologic manifestations: An international registry of 716 patients from 31 countries. *Journal of the American Academy of Dermatology*, 83(4), pp. 1118–1129. doi:10.1016/j.jaad.2020.06.1016.
- Gianotti, R., Zerbi, P. and Dodiuk-Gad, R.P. (2020) “Clinical and histopathological study of skin dermatoses in patients affected by COVID-19 infection in the Northern part of Italy,” *Journal of Dermatological Science*, 98(2): 141–143. doi:10.1016/j.jdermsci.2020.04.007.
- Gottlieb, M. and Long, B. (2020). Dermatologic manifestations and complications of COVID-19. *American Journal of Emergency Medicine*, 38(9): 1715–1721. doi:10.1016/j.ajem.2020.06.011.
- Hunt, M. and Koziatek, C. (2020). A Case of COVID-19 Pneumonia in a Young Male with Full Body Rash as a Presenting Symptom. *Clinical Practice and Cases in Emergency Medicine*, 4(2):0–3. doi:10.5811/cpcem.2020.3.47349.
- Infeksiemerging.kemkes.go.id. 2021. *Infeksi Emerging Kementerian Kesehatan RI*. [online] Available at: <https://infeksiemerging.kemkes.go.id/dashboard/covid-19> [Accessed 12 March 2021].
- Joob, B. and Wiwanitkit, V. (2020). COVID-19 can present with a rash and be mistaken for dengue. *Journal of the American Academy of Dermatology*, 82(5): e177. doi:10.1016/j.jaad.2020.03.036.
- Landa, N., Mendieta-Eckert, M., Fonda-Pascual, P. and Aguirre, T.. (2020). Chilblain-like lesions on feet and hands during the COVID-19 Pandemic. *International Journal of Dermatology*, 59(6): 739–743. doi:10.1111/ijd.14937.
- Lim, S.Y.D. and Tey, H.L. (2020). Response to ‘Classification of the cutaneous manifestations of COVID-19: a rapid prospective nationwide consensus study in Spain with 375 cases’: vesicular eruption in COVID-19 – to exclude varicella, *British Journal of Dermatology*, 183(4): 790–791. doi:10.1111/bjd.19347.
- Liu, J, Zheng, X, Tong, Q. (2020). Overlapping and discrete aspects of the pathology and pathogenesis of the emerging human pathogenic coronaviruses SARS-CoV, MERS-CoV, and 2019-nCoV. *Journal of Medical Virology*, 92 : 491–494. doi:10.1002/jmv.25709.
- Moreno R.A, Estela Villa LM., Avellana Moreno V., Estela Villa C., Moreno Aparicio MA., Avellana Fontanella JA. (2020). Cutaneous manifestation of COVID-19 in images: a case report. *Journal of the European Academy of Dermatology and Venereology*. 34(7): e307–e309. doi:10.1111/jdv.16531.
- Murt, A., Eskazan, A.E., Yilmaz, U., Ozkan, T. and Ar, M.C. (2021). COVID-19 presenting with

- immune thrombocytopenia: A case report and review of the literature. *Journal of Medical Virology*, 93(1): 43–45. doi:10.1002/jmv.26138.
- Nurulain T. Zaveri (2016). 乳鼠心肌提取 HHS Public Access. *Physiology & behavior*, 176(10): 139–148. doi:10.1146/annurev-immunol-051116-052331. Intracellular.
- Ortega-Quijano, D, Jimenez-Cauhe, J, Selda-Enriquez, G, Fernandez-Guarino, M, Fernandez-Nieto D. et al. (2020) Algorithm for the classification of COVID-19 rashes. *Journal of the American Academy of Dermatology*, 83(2):
- Promptchara, E., Ketloy, C. and Palaga, T. (2020). Immune responses in COVID-19 and potential vaccines: Lessons learned from SARS and MERS epidemic. *Asian Pacific Journal of Allergy and Immunology*, 38(1):1–9. doi:10.12932/AP-200220-0772.
- Suchonwanit, P., Leerunyakul, K. and Kositkuljorn, C. (2020). Diagnostic and prognostic values of cutaneous manifestations in COVID-19. *Dermatologic Therapy*. doi:10.1111/dth.13650.
- Torres, T. and Puig, L. (2020). Managing Cutaneous Immune-Mediated Diseases During the COVID-19 Pandemic,” *American Journal of Clinical Dermatology*, 21(3), pp. 307–311. doi:10.1007/s40257-020-00514-2.
- Vesely, M.D. and Perkins, S.H. (2020). Caution in the time of rashes and COVID-19. *Journal of the American Academy of Dermatology*, 83(4): e321–e322. doi:10.1016/j.jaad.2020.07.026.