Risk of fungal infection in patients with psoriasis receiving biologics: A retrospective single-center cohort study

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Background: The risk of fungal infection in patients with psoriasis receiving biologics is not fully understood in clinical practice.

Objective: To assess the incidence and the risk of fungal infection onset in patients with psoriasis receiving biologics.

Methods: A retrospective cohort study of 592 psoriasis cases treated with biologics at a single center.

Results: Seventy-three (12.3%) of the 592 cases involved a fungal infection. Fungal infection occurrence was more frequently associated with the use of interleukin (IL) 17 inhibitors than of other biologics. The risk factors of fungal infection were the type of biologic agent ($P = .004$), age at the start of biologic therapy (odds ratio, 1.04; 95% CI, 1.02-1.06), and diabetes mellitus (odds ratio, 2.40; 95% CI, 1.20-4.79).

Limitations: The present, retrospective study did not include patients who did not receive biologic therapy. Moreover, the type of biologic agent used was changed in many cases.

Conclusions: Patients with psoriasis treated with IL-17 inhibitors were more likely to cause fungal infections, especially candidiasis, than other biologics. Moreover, the age at the start of biologic therapy and diabetes mellitus onset were also independent risk factors of fungal infection. (J Am Acad Dermatol 2025;92:108-15.)

Key words: age; biologics; candidiasis; diabetes mellitus; fungal infection; interleukin 17 inhibitor.

INTRODUCTION

Psoriasis is a chronic, inflammatory skin disease.[1] Previously, treatments for psoriasis chiefly consisted of topical corticosteroids and vitamin D analogs, phototherapy, retinoids, and cyclosporine.[2] Severe psoriasis was very difficult to treat with these medications. However, in recent years, treatment has advanced dramatically with the advent of biologics, including those that inhibit tumor necrosis factor (TNF)-α, such as infliximab (IFX), adalimumab, and certolizumab pegol; the p40 subunit of interleukin (IL) 12/23, such as ustekinumab; IL-17, such as secukinumab (SEC), ixekizumab (IXE), brodalumab, and bimekizumab (BKZ); and the p19 subunit of IL-23, such as guselkumab, risankizumab, and tildrakizumab.[2,3] Spesolimab, an IL-36 receptor antagonist, has been approved for the treatment of generalized pustular psoriasis in almost 40 countries, including Japan, the United States, and the European Union.[4] The therapeutic effect of these agents against psoriasis is very high.[5] On the contrary, their use is attended by the risk of infectious diseases caused by immunosuppression. IL-17 is particularly important for preventing superficial

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fungal infections.[6] Hiruma et al[7] reported that IL-17 inhibitors increased the susceptibility of patients with psoriasis to superficial fungal infections in clinical practice. Since the publication of this study, IL-23 p19 inhibitors have appeared, in addition to which various other biologic agents have become available. Through more detailed analysis than the previous report, this study clarified the differences in the complications related to fungal infections and the timing of their onset associated with the use of various types of biologic agents.

CAPSULE SUMMARY

- Interleukin 17 is important for preventing superficial fungal infections. However, the relationship between biologic therapy and fungal infections in patients with psoriasis in the clinical setting is unknown.
- Risk factors for fungal infections in patients with psoriasis treated with biologics include interleukin 17 inhibitors, elderly patients, and patients with diabetes.

PATIENTS AND METHODS

Study design

This, retrospective cohort study enrolled 297 patients with psoriasis aged ≥15 years receiving biologic therapy from January 1, 2010 to March 31, 2022, at Tokyo Medical University Hospital. The observation period ended on March 31, 2023. In cases where the biologic therapy had been completed by the end of the observation period, the final observation date was the first visit 6 months after the final administration of the biologic agent. The switching of the biologic agent to a different type was treated as a separate case. Any change in dosage was also treated as a separate case when assessing the risk of fungal infection due to dosage changes. Doubling the dosage and halving the dosing period were defined as a double dose. In total, 592 cases were finally analyzed. Because a fungal infection can recur, observation was continued past the time of onset. Ten types of biologics, such as IFX, adalimumab, certolizumab pegol, ustekinumab, SEC, IXE, brodalumab, guselkumab, risankizumab, and tildrakizumab, were investigated. BKZ was excluded because it was launched in April 2022. Fungal infections were diagnosed clinically and confirmed by direct microscopy (potassium hydroxide examination) or a fungal culture. This study was approved by the ethics committee of Tokyo Medical University (permission no. T2022-0232).

Statistical analysis

To examine differences in the patient characteristics by the presence or absence of a fungal infection or the rate of fungal infection depending on the dosage of the biologics, the patients were compared using Fisher's exact test for categorical variables and Mann-Whitney U test for continuous variables. Logistic regression analysis was used to investigate the risk of fungal infection in the patients with a history of biologic therapy. Missing data were imputed using the median values for continuous variables and the most frequent categories. The Kruskal-Wallis test was used to compare the duration from the start of biologic therapy to the onset of the first fungal infection. Steel-Dwass' multiple comparison test was also used to compare the groups. When estimating the cumulative incidence of fungal infections, competing risks were considered. The competing events for fungal infections were death and the first 6 months after the last administration of a biologic agent, after which a fungal infection with biologic was considered impossible. Gray's test was used to compare the cumulative incidence. Cases in which the period of biologic administration was unknown were excluded from the Kruskal-Wallis and Gray's tests. $P < .05$ was considered to indicate statistical significance. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University), a graphical user interface for R (the R Foundation for statistical Computing). It is a modified version of R commander designed to add statistical functions frequently used in biostatistics.[8]

RESULTS

Description of the study population

The 592 cases were divided into 4 groups: a TNF-α inhibitor group (n = 213 , 36.0%), an IL-12/23 p40 inhibitor group (n = 82, 13.9%), an IL-17 inhibitor group (n = 190 , 32.1%), and an IL-23 p19 inhibitor group (n = 107, 18.1%). Table I summarizes the clinical data on the characteristics of all the cases before imputation of the missing data. Supplementary Tables I and II (available via Mendeley at https://data.mendeley.com/datasets/46jtgzt4cb/2) show detailed data on each type of biologic agent and only the first biologic agent administered in all the patients.

Frequency of fungal infection by biologic agent type

There were 73 cases (12.3%) accompanied by a fungal infection, which occurred more frequently in those receiving an IL-17 inhibitor, especially SEC or IXE, than other biologics (Table II). In only 3 of the 592 cases was the therapy discontinued due to a

Abbreviations used:

BKZ: bimekizumab
DM: diabetes mellitus
IFX: infliximab
IL: interleukin
IXE: ixekizumab
NA: not available
OR: odds ratio
SEC: secukinumab
TNF: tumor necrosis factor

fungal infection. Pneumocystis pneumonia and cryptococcal pneumonia occurred in patients treated with IFX, whereas refractory dermatophytosis was associated with IXE use. Pneumocystis pneumonia is caused by *Pneumocystis jirovecii*, which was previously thought to be a protozoan but is now classified as a yeast-like fungus. The total number of fungal infections was 106 and consisted of dermatophytosis (n = 77; 72.6%), such as tinea pedis and onychomycosis; candidiasis (n = 22; 20.8%), such as mucocutaneous candidiasis; Malassezia infections (n = 5; 4.7 %), such as pityriasis versicolor and Malassezia folliculitis; and other fungal infections (n = 2; 1.9%). The last category comprised pneumocystis pneumonia and cryptococcal pneumonia. Aside from a single cryptococcal infection, neither infection due to traditional endemic fungi nor to pathogenic saprophytes was encountered in any of our biologic drug recipients. The incidence of candidiasis associated with IL-17 inhibitor use was extremely high (Supplementary Tables III and IV, available via Mendeley at https://data.mendeley.com/datasets/46jtgzt4cb/2).

Differences in patient characteristics by the presence or absence of a fungal infection

Univariate analysis was performed for each characteristic for infected and uninfected groups (Table III). The proportion of patients treated with IL-17 inhibitors was significantly higher in the infected group than in the uninfected group (P = .001). The median age at the start of biologic therapy was higher in the infected group than in the uninfected group (P < .001). Even when comparing patients aged ≥60 years with those aged <60 years, the proportion of the former in the infected group was significantly higher than in the uninfected group (P < .001). No difference was found in sex, the Psoriasis Area and Severity Index score, body weight, or body mass index. The duration from the onset of psoriasis to the start of biologic therapy did not differ significantly between the groups. In Japan, systemic agents are often used concomitantly when introducing a biologic for psoriasis. Japanese guidance states, for example, that the concomitant administration of cyclosporin with a biologic for 2 to 8 weeks is a useful method of accomplishing smooth switching.[9] In this study, 260 (43.9%) of the 592 cases were treated with systemic agents at least until immediately before the administration of a biologic agent (Table I). The systemic agents included cyclosporine (n = 112), retinoid (n = 88), apremilast (n = 51), methotrexate (n = 49), and systemic steroid (n = 14). In some cases, various combinations of these agents were used. However, the differences among these systemic agents between the groups were nonsignificant.

In terms of complications, the proportion of patients with diabetes mellitus (DM), hyperlipidemia, or hypertension was significantly larger in the infected group than the uninfected group (DM: P < .001; hyperlipidemia: P = .005; and hypertension: P = .001). On contrary, there was no difference in malignancies between the groups. Next, differences in the rate of fungal infection were examined in terms of the dosage of biologics. The dosage of TNF-α and IL-12/23 p40 inhibitors can be adjusted, but of the IL-17 inhibitors, the dosage only of IXE can be adjusted. The rate of fungal infection and candidiasis in terms of the dosage of any inhibitor did not differ significantly (Supplementary Table V, available via Mendeley at https://data.mendeley.com/datasets/46jtgzt4cb/2).

Risk of fungal infection in patients with psoriasis with biologic therapy

A previous study found no difference in the sex ratio or Psoriasis Area and Severity Index score between an infected and uninfected group.[7] The time to the start of biologic therapy was excluded as a confounding factor in the analysis of biologics and fungal infection because it had little effect on the selection of the drugs. Table IV shows the results of multivariable logistic regression analysis of fungal infection. The type of biologic agent had a statistically significant effect on the risk of fungal infection (P = .004). Compared with IL-12/23 p40 inhibitors, IL-17 inhibitors were associated with a significantly higher risk of fungal infection (OR, 3.30; 95% CI, 1.35-8.10). Moreover, the independent risk factors of fungal infection were age at the start of biologic therapy (OR, 1.04; 95% CI, 1.02-1.06) and DM (OR, 2.40; 95% CI, 1.20-4.79).

Cumulative incidence of fungal infection by biologic agent in the context of competing events

Fig 1 shows the cumulative incidence of fungal infections for each drug cohort. Cases treated with

Table I. Clinical features of the study population*

Clinical features	TNF-α	IL-12/23 p40	IL-17	IL-23 p19	Total	
Characteristics	*n* = 213	*n* = 82	*n* = 190	*n* = 107	*n* = 592	*P*
Sex (male), *n* (%)	148 (69.5)	62 (75.6)	119 (62.6)	77 (72.0)	406 (68.6)	.137
Age, median (IQR) (y)	46.0 (19.0)	51.0 (20.8)	49.0 (19.8)	53.0 (24.5)	49.0 (19.3)	<.001
Age ≥60 y, *n* (%)	21 (9.9)	26 (31.7)	46 (24.2)	42 (39.3)	135 (22.8)	<.001
Weight, median (IQR) (kg)	67.8 (19.6)	70.0 (18.5)	66.6 (21.7)	67.0 (24.5)	67.8 (21.0)	.866
BMI, median (IQR)	24.2 (5.2)	23.9 (4.9)	24.0 (5.9)	24.0 (7.9)	24.0 (5.9)	.963
PASI, median (IQR)	7.5 (10.9)	9.9 (12.3)	6.9 (9.4)	6.8 (9.3)	7.4 (10.4)	.083
Psoriasis type						NA
PsV, *n* (%)	95 (44.6)	54 (65.9)	77 (40.5)	70 (65.4)	296 (50.0)	
PsA, *n* (%)	82 (38.5)	14 (17.1)	84 (44.2)	20 (18.7)	200 (33.8)	
GPP, *n* (%)	30 (14.1)	10 (12.2)	25 (13.2)	14 (13.1)	79 (13.3)	
EP, *n* (%)	0 (0.0)	0 (0.0)	1 (0.5)	2 (1.9)	3 (0.5)	
PsA and GPP, *n* (%)	4 (1.9)	4 (4.9)	3 (1.6)	1 (0.9)	12 (2.0)	
PsA and EP, *n* (%)	2 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.3)	
Systemic agents, *n* (%)	88 (41.3)	39 (47.6)	92 (48.4)	41 (38.3)	260 (43.9)	.117
Diabetes mellitus, *n* (%)	22 (10.3)	15 (18.3)	21 (11.1)	15 (14.0)	73 (12.3)	.257
Hyperlipidemia, *n* (%)	39 (18.3)	20 (24.4)	46 (24.2)	33 (30.8)	138 (23.3)	.086
Hypertension, *n* (%)	59 (27.7)	37 (45.1)	52 (27.4)	42 (39.3)	190 (32.1)	.006
Malignancy, *n* (%)	4 (1.9)	8 (9.8)	12 (6.3)	8 (7.5)	32 (5.4)	.012
Observation period, median (IQR) (d)	378 (1066.5)	588 (1385.0)	670 (878.3)	707 (601.0)	596 (906.0)	.003
Time to introduction of biologics, median (IQR) (y)	12 (13.0)	13 (12.8)	12 (16.0)	14 (17.5)	12 (16.0)	.103

BMI, Body mass index; *EP*, erythrodermic psoriasis; *GPP*, generalized pustular psoriasis; *IL*, interleukin; *IQR*, Interquartile range; *NA*, not available; *PASI*, Psoriasis Area and Severity Index; *PsA*, psoriatic arthritis; *PsV*, psoriasis vulgaris; *TNF*, tumor necrosis factor.
*Data are expressed as a number and percentage or the mean and interquartile range. IQR : the difference between the third quartile and the first quartile.

Table II. Frequency of fungal infections by biologic agent type*

			TNF-α			IL-12/23 p40	IL-17				IL-23 p19			
	Total	Subtotal	IFX	ADA	CZP	UST	Subtotal	SEC	IXE	BRO	Subtotal	GUS	RIS	TID
n	73	20	6	13	1	7	36	18	13	5	10	4	5	1
%	12.3	9.4	8.6	10.2	6.3	8.5	18.9	20.7	20.0	13.2	9.3	9.8	9.6	7.1

ADA, Adalimumab; *BRO*, brodalumab; *CZP*, certolizumab pegol; *GUS*, guselkumab; *IFX*, infliximab; *IL*, interleukin; *IXE*, ixekizumab; *RIS*, risankizumab; *SEC*, secukinumab; *TID*, tildrakizumab; *TNF*, tumor necrosis factor; *UST*, ustekinumab.
*Fungal infections were more strongly associated with the use of IL-17 inhibitor than of other biologic agents.

IL-17 inhibitors were associated with a higher incidence of fungal infection than other biologic agents. Gray's test indicated that the cumulative incidence rate differed significantly by the type of biologic agent (P = .013). In cases where a fungal infection developed during the observation period, duration until infection onset differed significantly by the type of biologic agent, with IL-17 and IL-23 p19 inhibitors being associated with an earlier onset than TNF-α inhibitors (Supplementary Fig 1, available via Mendeley at https://data.mendeley.com/datasets/46jtgzt4cb/2). The median period of administration of IL-17, IL-23 p19, IL-12/23 p40, and TNF-α inhibitors was 22, 17, 31, and 55 weeks, respectively.

DISCUSSION

Clinical trials have reported that fungal infections, especially candidiasis, are more commonly associated with IL-17 inhibitor use.[10] However, studies based on actual, clinical practice are still few. This study found that fungal infections, especially candidiasis, were more commonly associated with IL-17 inhibitor use. Moreover, there are also reports that the frequency of candidiasis increases along with more frequent administration of high dose of IL-17 inhibitors.[11,12] However, the lack of any significant difference in this study was thought to be attributable to the relatively small number of cases of fungal infection, especially of candidiasis.

Table III. Differences in patient characteristics by the presence or absence of fungal infection*

Characteristics	Infected group (*n* = 73)	Uninfected group (*n* = 519)	*P*
Biologic agent			
TNF-α, *n* (%)	20 (27.4)	193 (37.2)	.118
IL-12/23 p40, *n* (%)	7 (9.6)	75 (14.5)	.364
IL-17, *n* (%)	36 (49.3)	154 (29.7)	.001
IL-23 p19, *n* (%)	10 (13.7)	97 (18.7)	.334
Sex (male), *n* (%)	52 (71.2)	354 (68.2)	.687
Age, median (Q1-Q3) (y)	56 (50-65)	48 (38-57)	<.001
Age ≥60 y, *n* (%)	30 (41.1)	105 (20.2)	<.001
Weight, median (Q1-Q3) (kg)	70.0 (60.0-80.0)	67.5 (58.3-78.0)	.326
BMI, median (Q1-Q3)	24.2 (22.6-28.0)	24.0 (21.9-26.8)	.375
PASI, median (Q1-Q3)	7.5 (3.6-11.4)	7.5 (3.8-12.4)	.864
Systemic agents, *n* (%)	34 (46.6)	226 (43.5)	.706
Diabetes mellitus, *n* (%)	19 (26.0)	54 (10.4)	<.001
Hyperlipidemia, *n* (%)	27 (37.0)	111 (21.4)	.005
Hypertension, *n* (%)	36 (49.3)	154 (29.7)	.001
Malignancy, *n* (%)	7 (9.6)	25 (4.8)	.099
Time to introduction of biologics, median (Q1-Q3) (y)	13 (7.0-23.0)	12 (6.0-21.5)	.574

BMI, Body mass index; *IL*, interleukin; *PASI*, Psoriasis Area and Severity Index; *TNF*, tumor necrosis factor.
*The proportion of patients receiving an IL-17 inhibitor and age at the start of biologic therapy were significantly higher in the infected group than in the uninfected group. The proportion of patients with diabetes mellitus, hyperlipidemia, and hypertension was also significantly higher in the former group.

Table IV. Risk of fungal infection in patients with psoriasis receiving biologic therapy*

	Odds ratio	95% CI	*P*
Biologics			.004†
IL-17	3.30	1.35-8.10	.009
IL-23 p19	1.05	0.37-2.99	.934
TNF-α	1.71	0.66-4.40	.267
IL-12/23 p40	(ref)		
Age	1.04	1.02-1.06	.001
BMI	1.01	0.96-1.08	.62
Systemic agents	1.02	0.60-1.74	.928
Diabetes mellitus	2.40	1.20-4.79	.013
Hyperlipidemia	1.03	0.54-1.96	.936
Hypertension	1.32	0.70-2.51	.392
Malignancy	1.18	0.44-3.15	.747

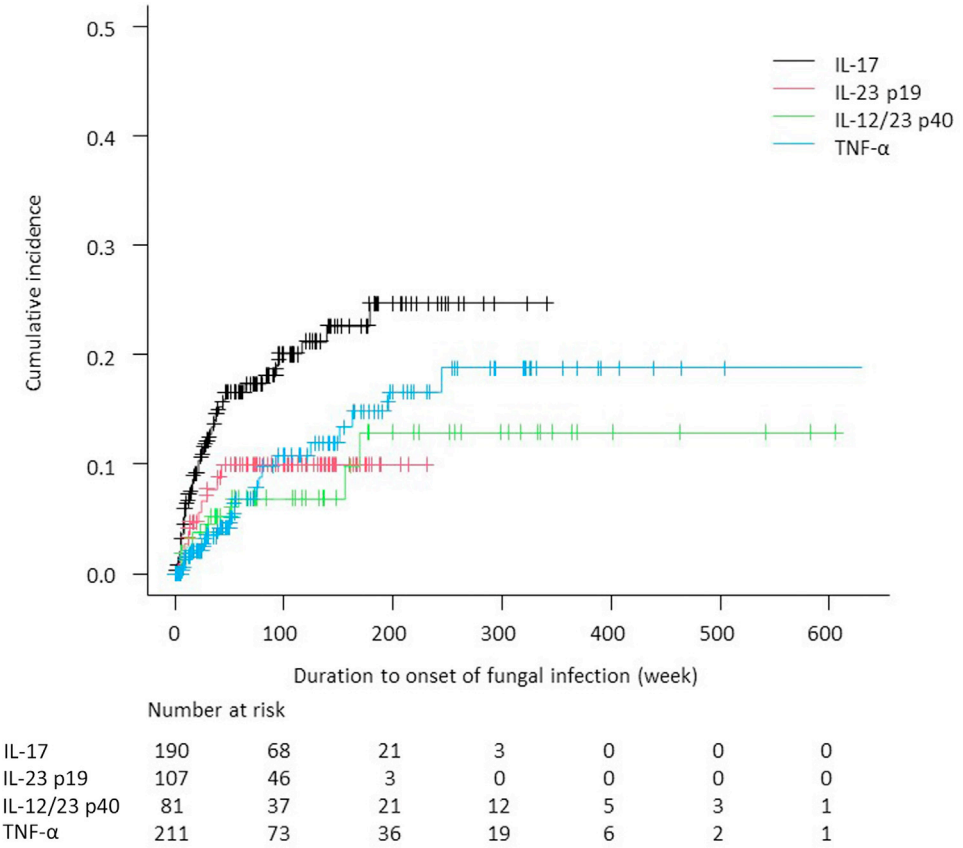
BMI, Body mass index; *CI*, confidence interval; *IL*, interleukin; *TNF*, tumor necrosis factor.
*IL-17 inhibitors, age at the start of biologic therapy, and diabetes mellitus were high risk factors of fungal infection.
†Wald test under the null hypothesis that all the biologics are associated with fungal infections to the same extent.

A past clinical trial found that candidiasis induced by IL-17 inhibitor administration was mostly mild to moderate in severity.[6] In this study, only superficial fungal infections were induced by IL-17 inhibitor administration. Furthermore, only one patient discontinued biologic therapy due to a fungal infection of IL-17 inhibitor.

Chronic mucocutaneous candidiasis is characterized by recurrent and persistent infections by *Candida spp.*, especially *Candida albicans* (*C. albicans*), and is mainly associated with the impairment of IL-17 immunity. This disease often affects the skin, nails, and oral and genital mucosa.[13] It is a superficial fungal infection and rarely becomes systemic. However, several types of systemic infection, such as pneumocystis pneumonia, are reportedly associated with TNF-α inhibitors.[7,14] In our study, IL-17 inhibitors induced only superficial fungal infections whereas only TNF-α inhibitors induced systemic fungal infections, pointing to the central role of IL-17 in protecting against superficial fungal infections.

Oral and esophageal candidiasis accounted for more than half of all candidiasis cases in the present study (Supplementary Table IV). *C albicans* is one of the most common candida infections in humans. However, the immune response to *C albicans* varies by the location in the body.

IL-17 plays an important role in the immune response to oral candidiasis. In addition to recruiting macrophages and neutrophils, oral epithelial cells, and neutrophils secrete IL-1β, which activates innate lymphoid cell type 3, $\gamma\delta$ T-cells, and T helper 17 cells. These then produce IL-17A and IL-17F, which potentiate the proinflammatory response of epithelial cells by inducing the secretion of



Number at risk

IL-17	190	68	21	3	0	0	0
IL-23 p19	107	46	3	0	0	0	0
IL-12/23 p40	81	37	21	12	5	3	1
TNF-α	211	73	36	19	6	2	1

Fig 1. Cumulative incidence of fungal infections by biologic agent in the context of competing events. IL-17 inhibitors were more likely to cause fungal infections than other biologics. *IL*, Interleukin; *TNF*, tumor necrosis factor.

proinflammatory cytokines and β-defensins by epithelial cells.[15] In contrast, the role of IL-17 in the immune response to vaginal candidiasis is limited; here, IL-1β and S100A8 alarmin derived from vaginal epithelial cells recruit neutrophils. In vaginal candidiasis, neutrophil phagocytosis is impaired, leading to a heightened nonprotective proinflammatory response.[15,16]

Oral candidiasis is particularly likely to occur during the first year of treatment with BKZ.[17] In this study, IL-17 inhibitors were likely to induce a fungal infection early after the start of biologic therapy. Further attention should be paid to fungal infections in the early period after the start of biologic therapy.

This study also demonstrated that older age and DM were risk factors of fungal infection. Tinea pedis and oral candidiasis were the most common forms of dermatophytosis and candidiasis, respectively (Supplementary Table IV). Tinea pedis is particularly common in patients with diabetes, who should be educated about the importance of washing their feet.[18] Patients of advanced age have a higher risk of xerostomia and hyposalivation.[19] Decreased saliva production causes oral candidiasis.[20] Therefore, these patients should avoid caffeinated, sweet, or acidic drinks and stimulate saliva production by chewing sugarless gum.[19] Dentures should be cleaned and disinfected daily and removed for 6 hours every day.[21]

Systemic fungal infections, including pneumocystis pneumonia, have been associated with the use of TNF-α inhibitors, which can cause invasive fungal infections by inhibiting interferon gamma, decreasing the expression of pattern-recognition receptors, and inducing leukocyte apoptosis.[22] Thus, close attention should be paid to the β-D glucan level in patients receiving a TNF-α inhibitor.[23]

This study has 3 limitations. First, it was retrospective; therefore, some of the patient data were missing. Nonetheless, IL-17 inhibitors (compared with IL-12/23 p40 inhibitors), age, and DM were found to be risk factors of fungal infection even when the analysis was restricted only to cases without missing values (Supplementary Table VI). Many patients had received various, systemic agents

before starting biologic therapy. This study did not examine differences in the incidence of fungal infection by the various types of systemic agent before biologic administration. Second, the study was performed at a university hospital, where biologic therapy is prescribed to most patients. Therefore, this study did not include patients who did not receive biologic agents. Finally, the type of biologic agent was switched in many of the cases, rendering it difficult to determine whether an infection was caused by the previous or current biologic agent. Therefore, Supplementary Table VII (available via Mendeley at https://data.mendeley.com/datasets/46jtgzt4cb/2) lists only the first biologic agent used in each of the patients in the cohort. As a result, age and DM were found to be risk factors of fungal infection, and it was also found that fungal infection should be kept in mind when administering IL-17 inhibitors.

Biologics are innovative drugs and are extremely useful in the treatment of psoriasis. On the contrary, due consideration must be taken for potential side effects and the risk factors and timing of fungal infection onset with the aim of early detection and prevention.

Conflicts of interest

Dr Minami has been a speaker for AbbVie*, Taiho Pharmaceutical*, Janssen Pharmaceuticals*, and Maruho*. Dr Mori has received honoraria from Kyowa Kirin*, Maruho*, and Taiho Pharmaceutical*. Dr Abe has received honoraria from Boehringer Ingelheim*, Maruho*, Kyowa Kirin*, Taiho Pharmaceutical*, GRAFA Laboratories, Sun Pharma*, UCB Pharma*, Janssen Pharmaceuticals*, Japan Tissue Engineering, Amgen, Bristol Myers Squibb, AbbVie*, and Syneos Health Commercial. Dr Kazutoshi Harada received research grants from Maruho*, Taiho Pharmaceutical*, Kaken Pharmaceutical, AbbVie*, Sun Pharma*, Eli Lilly*, and Pfizer and has been a speaker for Sato Pharmaceutical, Eisai*, Eli Lilly*, Pfizer, Sun Pharma*, and Kaken Pharmaceutical. Dr Okubo has received honoraria from AbbVie*, Amgen, Boehringer Ingelheim*, Bristol Myers Squibb, Eli Lilly*, Janssen Pharmaceuticals*, Kyowa Kirin*, Leo Pharma, Maruho*, Otsuka Pharmaceutical, Pfizer, Sanofi, Sun Pharma*, Taiho Pharmaceutical*, Tanabe-Mitsubishi*, and UCB Pharma*. Drs Hiruma, Kazuharu Harada, Fujimori, Suzuki, and Okura have no conflicts of interest to disclose. Asterisks indicate manufacturers of biologics used for psoriasis in Japan.

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JAAD Game changer

JAAD Game Changers: Cutaneous adverse events of anti–programmed cell death-1 therapy in patients with metastatic melanoma: A single-institution cohort

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How did this article change the practice of dermatology?

- Supportive oncodermatology is still a fledgling field, and given the rate at which new targeted therapies enter the market, characterizing and educating on anticipated or even newly identified cutaneous adverse events can be challenging.
- In fact, this area of dermatology has yet to receive the attention that it deserves in residency program curricula, adding to potential gaps in management.
- Therefore, studies such as the present one are needed for the purposes of field exposure, validation, and education.
- The utilization of checkpoint inhibitors will continue to expand for both melanoma and other malignancies, and therefore, knowing what to expect when assessing for cutaneous adverse events will have a tremendous impact on the patient's quality of life during therapy.

Conflicts of interest: None disclosed.

Note: A Game Changer is a short narrative stating how an article that originally appeared in *JAAD* changed the game of dermatology. The Game Changer author is not the author of the original article.

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