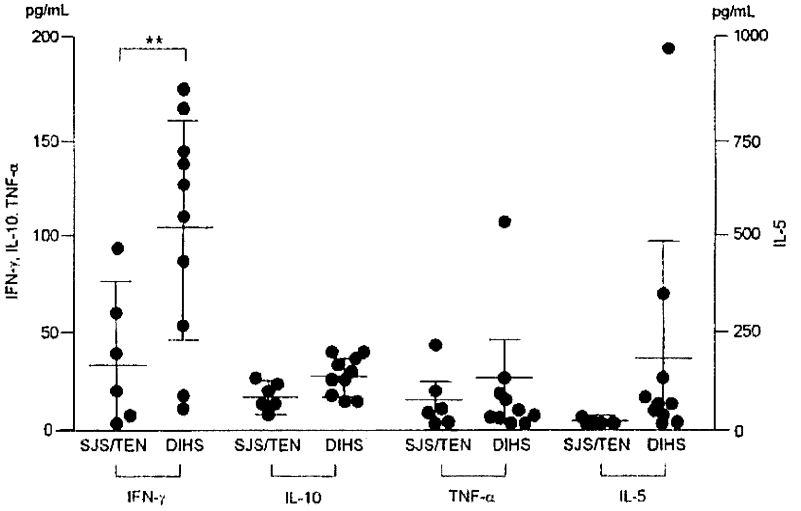

Figure 2 Comparison of serum cytokine levels at onset between Stevens–Johnson syndrome (SJS)/toxic epidermal necrolysis (TEN) and drug-induced hypersensitivity syndrome (DIHS). $^{**}P < 0.005$. IFN, interferon; IL, interleukin. TNF, tumour necrosis factor.

Table 2 Viral infections of patients.

	Patients positive/patients examined, *n*	
Type of drug eruption	SJS/TEN	DIHS
Persistent viral infection		
HBVs antigen	0/9	0/19 (3/5*)
HCV	1/9	1/19
HTLV-1	0/3	2/7†
Detection of viral DNA at onset‡		
HHV-6	0/9	1/19
EBV	7/9	3/10
Cytomegalovirus	0/3	0/9

EBV, Epstein–Barr virus; HBV, hepatitis B virus; HCV, hepatitis C virus; HHV, human herpesvirus; HTLV, human T-cell leukaemia virus. *The five patients who showed severe liver dysfunction (alanine aminotransferase > 300 IU/L) out of the total group of 19 underwent further investigations for anti-HBc and anti-HBs antibodies, and three of the five were positive. †One patient who was born in an area endemic for HTLV-1. ‡Detection of viral DNA using real-time PCR assay at onset.

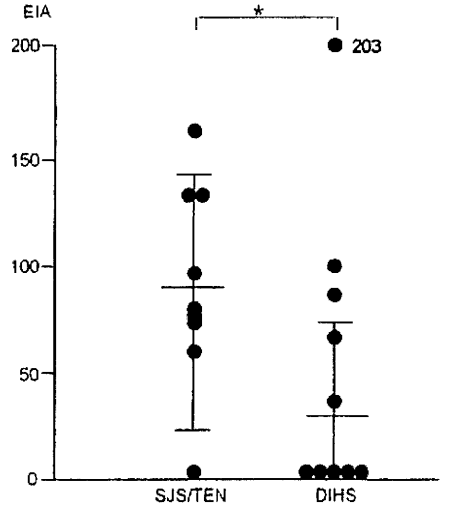

Figure 3 Comparison of antiherpes simplex virus IgG titres at onset between Stevens–Johnson syndrome (SJS)/toxic epidermal necrolysis (TEN) and drug-induced hypersensitivity syndrome (DIHS). $^{*}P < 0.05$. EIA, enzyme immunoassay.

infection is also likely to be important. High levels of anti-HSV IgG titres without occurrence of overt HSV lesions were preferentially detected in patients with SJS/TEN, and antibodies to HTLV-1 were detected in 2/7 patients with DIHS/DRESS examined (28.5%); the prevalence of antibodies was higher than that previously reported for DIHS/DRESS (1.56%) in a Japanese population,[20] although our groups were small. The unique biological properties of HSV, HTLV and HHV-6, particularly their 'immunotropic' nature and their possible interactions with other latent viruses, suggest that these viruses, differently detected in these patients with different clinical pictures, may act either indirectly by modulating immune responses to drugs or directly by attacking the immune system in synergy with other viruses. In particular, given the ability of HSV-1 to induce Toll-like receptor (TLR)2-dependent IL-15 responses[21] (which have been shown to enhance CD8 cytolytic activity[22]), it is likely that frequent reactivation of HSV provides a favourable milieu for selective stimulation of memory-type CD8+ T cells, which have been shown to be involved in severe drug eruptions. Alternatively, memory T-cell responses generated by repeated reactivation of HSV are likely to be crossreactive with drug-modified self antigens, as we proposed previously.[23] These observations certainly seem to

favour the 'p–i concept' proposed by Pichler: certain drugs can activate pre-existing, peptide-specific, cross-reactive T cells directly by binding to T-cell receptors.[24] Thus, persistent or acute viral infections could permit otherwise trivial drug antigens to initiate harmful inflammatory cascades and sustain tissue pathology. In addition, the nature and size of the memory T-cell pool established by previous exposure to viral infections are likely to be important determinants of the type and outcome of severe drug eruptions.

Further studies with large numbers of patients are needed to completely elucidate host factors that contribute to the variation in the pathological phenotype, which may provide a basis for new therapeutic approaches in patients with severe adverse drug reactions.

Acknowledgements

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REVIEW ARTICLE

Recognition of Immune Reconstitution Syndrome Necessary for Better Management of Patients with Severe Drug Eruptions and Those under Immunosuppressive Therapy

Tetsuo Shiohara[1], Maiko Kurata[1], Yoshiko Mizukawa[1] and Yoko Kano[1]

ABSTRACT

The immune reconstitution syndrome (IRS) is an increasingly recognized disease concept and is observed with a broad-spectrum of immunosuppressive therapy-related opportunistic infectious diseases and severe drug eruptions complicated by viral reactivations. Clinical illness consistent with IRS includes tuberculosis, herpes zoster, herpes simples, cytomegalovirus infections and sarcoidosis: thus, the manifestations of this syndrome and diverse and depend on the tissue burden of the preexisting infectious agents during the immunosuppressive state, the nature of the immune system being restored, and underlying diseases of the hosts. Although IRS has originally been reported to occur in the setting of HIV infection, it has become clear that the development of IRS can also be in HIV-negative hosts receiving immunosuppressive agents, such as prednisolone and tumor necrosis factor α inhibitors, upon their reduction and withdrawal. Drug-induced hypersensitivity syndrome, a life-threatening multiorgan system reaction, is another manifestation of the newly observed IRS. Clinical recognition of the IRS is especially important in improving the outcome for diseases with an otherwise life-threatening progenosis. Clinicians should be aware of the implications of IRS and recognize that relieving the symptoms and signs of immune recovery by anti-inflammatory therapies needs to be balanced with anti-microbial therapies aiming at reducing the amplitude and duration of tissue burden of preexisting microbes.

KEY WORDS

corticosteroids, drug-induced hypersensitivity syndrome, herpesviruses, immune reconstitution, TNF-α inhibitors

INTRODUCTION

Although underlying infections have been suggested to increase infected patients' susceptibility to severe drug eruptions, the relationship between infections and the development of severe drug eruptions has not been extensively explored until the time when we propose the intimate relationship between herpesvirus infections and severe drug eruption.[1,2] Since then, however, it has become clear that closely related bidirectional pathways exist in which infections and drug allergy are involved. Thus, physicians treating patients with severe drug eruptions need to be aware of underlying (virus) infections, particularly herpesvirus infections, as one of the most important aspects of management of patients with severe drug eruptions. Because those patients often receive immunosuprressive agents either early or later in the course of their illness, a wealth of information on the interaction between herpesviruses and the immune responses should be gathered to better manage those patient.

Immunocompetent subjects can largely control herpesviruses, such as cytomegalovirus (CMV) and Epstein-Barr virus (EBV), by cellular effector functions based on a repertoire of memory $CD4^+$ and $CD8^+$ T cells that develop and expand during lifetime.

[1]Department of Dermatology, Kyorin University School of Medicine, Tokyo, Japan.
Correspondence: Tetsuo Shiohara, MD, PhD, Department of Dermatology, Kyorin University School of Medicine, 6-20-2 Shinkawa, Mitaka, Tokyo 181-8611, Japan.
Email: tpshio@ks.kyorin-u.ac.jp
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Defects in these T cells are associated with increased occurrences of opportunistic infections, reactivation of latent viruses and chronic inflammatory and autoimmune disorders. In this setting, disease expression has typically been understood as microbial damage afflicted by these pathogens. However, an intriguing aspect that has received little attention so far is that restoration of host immunity may also have adverse sequelae, particularly when it occurs abruptly and rapidly. Indeed, when the timing of onset of an adverse cutaneous drug reaction was carefully evaluated in patients infected with HIV, the onset of a majority of the eruptions was found to be concentrated within 6-14 days of starting highly active antiretroviral therapy, (HAART),[3] coincident with restoration of host CD4 T-well number and reactivity. Indeed, during the early phase of immune restoration on HAART, a significant proportion of patients (15-25%) develop clinical deterioration due to restoration of the capacity to mount innate and adaptive immune responses against preexisting infectious agents. This clinical deterioration is called immune reconstitution syndrome (IRS). Clinical recognition of this syndrome is especially important in management of patients under immunosuppressive therapy, because this syndrome develop not only in patients with HIV infection but also in non-HIV immunocompetent hosts, such as patients with severe drug eruptions and those on immunosuppressive therapy, upon reduction or withdrawal of immunosuppressive agents or chemotherapy. More recently, the development of IRS has also been observed in lymphopenic and neutropenic patients,[4,5] and patients receiving tumor necrosis factor (TNF) α inhibitions.[6-8] The manifestations of this syndrome are diverse and depend on the tissue burden of the preexisting infectious agents involved under immunosuppressive conditions, the nature of the immune system being restored, and underlying diseases of the hosts. Because some cases with IRS are self-limited within a week while others are fatal or life threatening, it is difficult to predict the prognosis and suggest potential treatment options from the clinical manifestations in the early phase. Thus, management of this syndrome should be decided on an individual basis. In this review, we describe a variety of manifestations of IRS, particularly those associated with severe drug eruptions, and management options. This review also focuses exclusively on the spectrum of clinical manifestations of IRS occurring in the setting of therapy with immunosuppressive agents, whose clinical course is complicated by the development of IRS that is usually associated with the corticosteroid therapy on its reduction or withdrawal. Clinical recognition of the IRS is extremely important in improving the outcome for diseases with an otherwise life-threatening prognosis.

DEFINITION OF IRS

Several different terms other than IRS have been used to describe this syndrome: they include immune reconstitution inflammatory syndrome (IRIS), immune reconstitution disease (IRD), immune recovery disease, immune rebound illness, and steroid-withdrawal disease. IRS is originally defined as a paradoxical deterioration in clinical status attributable to the recovery of the immune response following institution of HAART in HIV patients.[9-11] Within 1-2 weeks of starting HAART therapy, a dramatic reduction (100-fold) in HIV RNA levels can be detected, coincident with the increase in circulating $CD4^+$ T cells with a memory phenotype in number. This rapid increase in $CD4^+$ T cell numbers is more likely to be due to redistribution of this population to the circulation rather than preferential cell proliferation. Not only the frequency but also functions of these memory $CD4^+$ T cells can be also restored to a clinically relevant degree after starting HAART therapy.[12] The numerical rise of $CD8^+$ T cells with a memory phenotype and naïve $CD4^+$ T cells also occurs within 1 week following the initiation of HAART.[13]

The interval between the start of HAART and the onset of clinical symptoms or signs of IRS is highly variable, ranging from <1 week to several months but the majority of IRS occur within the first 8 weeks after the initiation of HAART therapy.[5] In addition to the interval, the manifestations of IRS are also widely varied, depending on the particular infectious agent involved and the degree of the recovery of the immune system. Clinical symptoms of IRS is characterized by paradoxical deterioration of a preexisting, although previously unrecognized, microbial infection that is temporally associated with a decrease in the tissue burden of the preexisting pathogens (Fig. 1): this decrease is often reflected in paradoxical deterioration of laboratory findings. Thus, the patients usually present with worsening or new clinical manifestations of a previously preexisting infection that could be either asymptomatic or mildly symptomatic before developing IRS: the infection would be usually unrecognized by clinicians before starting HAART, or reduction or withdrawal of immunosuppressive agents.[14] The target of restored inflammatory reactions is not restricted to infectious pathogens, but also includes inert foreign antigens such as tattoo pigment[15] in the case of sarcoidosis and tumor antigens[16] in the case of Kaposi's sarcoma.

DIAGNOSIS OF IRS

The clinical symptoms of IRS range from a self-limited mild disease to a severely ill, life-threatening disease. Usually, IRS occurs as a paradoxical deterioration in clinical status associated with recovery of the immune response after initiating HAART in patients with HIV infection. Even in the absence of HIV

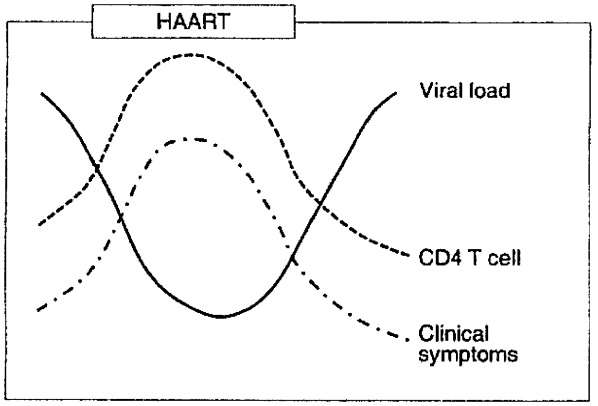

Fig. 1 IRS occurring after starting HAART in HIV-positive patients.

infection, however, IRS has been reported to develop on withdrawal of chemotherapy or reduction of immunosuppressive agents, such as prednisolone.[9,17] The new onset or exacerbation of the skin diseases known to develop as clinical manifestations of IRS, such as sarcoidosis, has been also reported to occur in association with TNF-α-blocking therapy in patients with rheumatoid arthritis.[18,19] In view of the fact that a similar sarcoid-like reaction occurred as a consequence of an immune reconstitution under HAART for HIV infection,[20,21] sarcoidal lesions may appear as clinical symptoms of IRS in these patients during the recovery of immune responses, although these lesions are generally perceived as undesired effects of treatment.

Unfortunately, there has been considerable confusion of the definition of IRS in the literature: some authors have used the strict criteria to define IRS, such as a paradoxical deterioration in clinical symptoms attributable to recovery of the immune system during HAART in HIV-positive patients.[22] In contrast, other authors have expanded the spectrum of IRS to include a clinical deterioration induced by reduction or withdrawal of immunosuppressive agents in HIV-negative individuals. To avoid confusion, this article includes both types of reactions, and emphasis is placed on the IRS in HIV-negative individuals. In summary, the clinical characteristics of IRS modified from criteria proposed by Shelburne *et al.*[23] are as follows: (1) paradoxical deterioration of a preexisting infection attributable to the recovery of the immune system; (2) a decrease in viral loads with or without an increase in $CD4^+$ T cell counts; (3) clinical symptoms not explained by a newly acquired infection, by the expected clinical course of a previously recognized infectious agent, or by side effect of therapy; and (4) any event occurring after initiation of HAART or after withdrawal or reduction of immunosuppressive agents including biologics, regardless of whether patients are HIV-positive or -negative.

DRUG ERUPTIONS AS A MANIFESTATION OF IRS

Drug-induced hypersensitivity syndrome (DIHS) is a life-threatening multiorgan system reaction caused by a limited number of drugs: they include carbamazepine, phenytoin, phenobarbital, zonisamide, alopurinol, dapsone, salazosulfapyridine and mexiletine.[1,2,24-31] However, this syndrome has several unique clinical features that cannot be solely explained by drug antigen-driven oligoclonal expansions of T cells, which have been implicated in the pathogenesis of other drug eruptions. They include a paradoxical deterioration of clinical symptoms, frequent flare-ups and a step-wise development of several organ system failures after withdrawal of the causative drugs,[26,30] and unexplained cross-reactivity to multiple drugs with structures totally different from the original causative drugs.[26,30] Close clinical similarities between DIHS and infectious mononucleosis suggested an additional role of viral infections.[1,2,26] Indeed, our recent studies have demonstrated that several herpesviruses including herpesvirus 6 (HHV-6), HHV-7, EBV and CMV can be reactivated during the course of this syndrome in a sequential order as in graft-versus-host disease.[29] However, several questions have been raised as to why HHV-6 reactivation, which is used as a specific marker for this syndrome,[25] occurs generally 2-3 weeks after the onset of this syndrome and why particular virus could not be detected coincident with the onset of severe symptoms. Based on these findings, reactivations of these herpesviruses observed in DIHS was generally thought to be the consequence of disease,[24] contrary to our hypothesis[30]: according to our hypothesis, reactivations of herpesviruses would represent the actual early events that trigger activation of drug antigen-specific T cells: however, this event would occur in an unrecognized fashion far before onset of clinical symptoms. In view of the observations that paradoxical worsening of clinical symptoms associated with reduction in viral loads is typically observed after withdrawal of the causative drug at onset of DIHS,[2,30] it is attractive to suppose that DIHS is a manifestation of the newly observed IRS (Fig. 2). These clinical observations may be explained by assuming that the rapid restoration of pathogen-specific immunity would reduce viral loads at onset, thereby rendering them undetectable in the blood.

In order to expand the spectrum of IRS to include DIHS, it was important to know to what extent DIHS resembles IRS by demonstrating similarities between both conditions. We analyzed a total of 12 patients (6 male, 6 female; age range 25-70 years, mean age 46.5 ± 15.3 years), who admitted to our Dermatology Department from 2001 to 2006 and met the criteria for DIHS.[25] Clinical status of these patients on day 3-4 was defined as a paradoxical deterioration despite

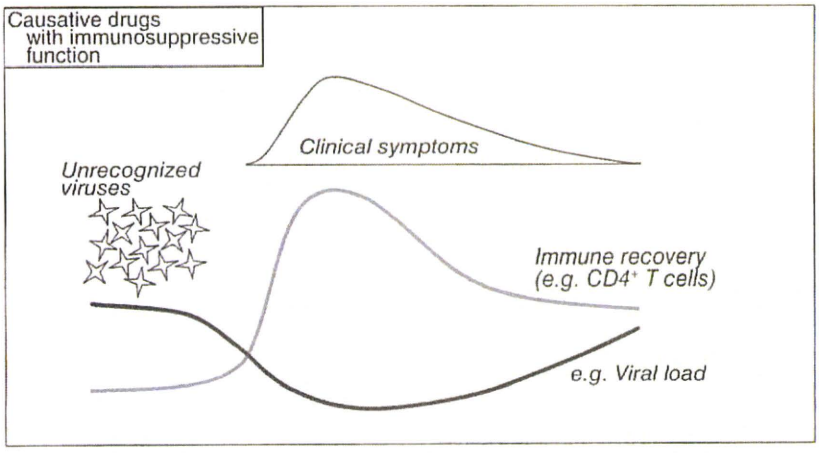

Fig. 2 DIHS is another manifestation of the newly observed IRS. The causative drugs of DIHS have immunosuppressive properties in common[2,26,30] and their protracted use results in the immunosuppressive state, thereby causing the increase in viral loads in an unrecognized fashion. Upon withdrawal of these drugs, antiviral immune responses are rapidly restored, thereby causing immunopathology and the reduction in viral loads.[30]

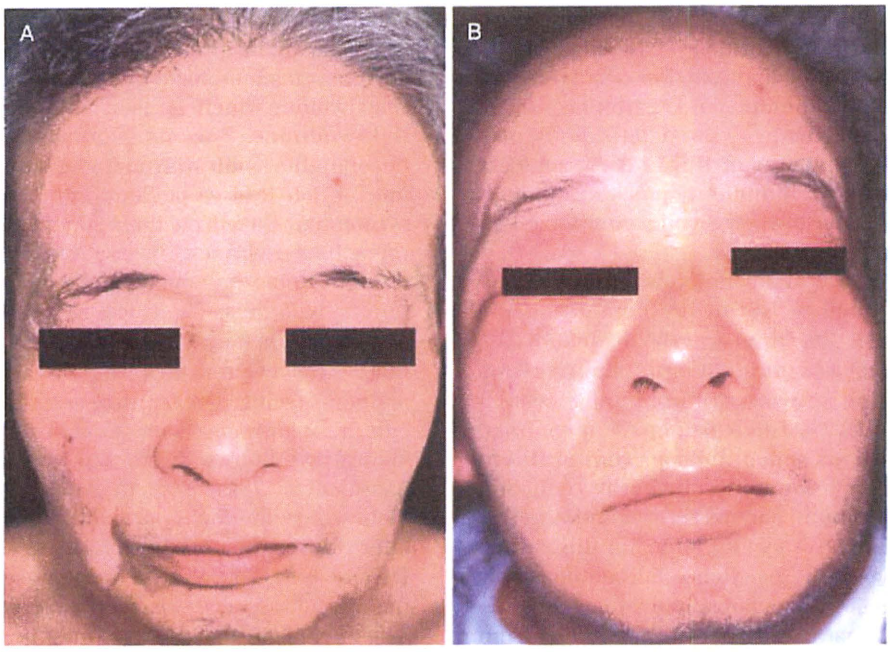

Fig. 3 Paradoxical deterioration of skin lesions in IRS observed after withdrawal of the causative drug. This patient with DIHS exhibited prominent paradoxical deterioration of facial edema and erythema (**B**) 4 days after the withdrawal, as compared with those at the initial presentation (**A**).

withdrawal of the causative drug, when the extent of skin involvement as evaluated by the body surface area (BSA) was 2 times more than their initial presentation; and an increase in their body temperature >1℃ from that at their initial presentation. According to this definition, 8 out of the twelve patients exhibited a paradoxical deterioration in clinical status despite withdrawal of the causative drug (Fig. 3). In the remaining four patients, oral prednisolone had been started at a dose of 40-60 mg/day at their initial presentation, because their skin lesions had rapidly progressed, in a few days before presentation, to over

Table 1 Reported clinical illness consistent with IRS in HIV-negative hosts

Mycobacterium avium complex infection
Tuberculosis
Cryptococcosis †
Herpes simplex †
Herpes zoster †
Hepatitis C virus infection
Hepatitis B virus infection
Cytomegalovirus infection †
Kaposi sarcoma
Sarcoidosis
Graves disease
Hashimoto thyroiditis †
Drug-induced hypersensitivity syndrome

† Infectious and autoimmune diseases often observed during the course of drug-induced hypersensitivity syndrome or long after its resolution.

60% or more of BSA, probably due to their earlier timing of withdrawal of the causative drugs: unfortunately, however, the exact time frames between withdrawal of the causative drug and their initial presentation was not available in these patients. In these patients, oral prednisolone given as initial therapy had a rapid response. In the eight patients with paradoxical deterioration in clinical symptoms, 5 cases that initially failed to respond to oral predonisolone subsequently improved with intravenous immunoglobulin (IVIG, 0.1 g/kg/day, 5-10 days).

According to the diagnostic criteria for IRS proposed by Shelburne *et al.*,[23] an increase in CD4$^+$ T-cell numbers is a prerequisite for the diagnosis of IRS. This prompted us to investigate whether an increase in CD4$^+$ T-cell numbers could be observed and onset in these patients. Because CD4$^+$ T-cell numbers before onset of DIHS were not available in the vast majority of patients, we sequentially analyzed lymphocyte subsets from the 10 patients at various time points after their initial presentation and compared CD4$^+$ T-cell numbers at onset with those on several occasions after onset. As previously descried,[31] a profound decrease in CD19$^+$ B-cell numbers and CD56$^+$ NK-cell numbers were observed at their initial presentation. In contrast, CD4$^+$ T-cell numbers initially increased in 9 of the 10 patients; they were gradually declined, reaching normal values by 2 months after onset. According to the original definition,[23] an increase in CD4$^+$ T-cell numbers is diagnostic of IRS and can typically be detected within 1-2 weeks of starting antiretroviral therapy in HIV-infected patients. Consistent with this, our sequential analyses showed that the initial increase in CD4$^+$ T-cell numbers was seen in many, if not all, patients with DIHS, followed by the subsequent decrease coincident with improvements in clinical status. In some patients, a concomitant increase in CD8$^+$ T-cell numbers was also noted. These alterations in lymphocyte subsets during the observation period were not related to our use of oral prednisolone for the treatment of DIHS, because similar alterations were observed in patients who never received prednisolone. The degree of the increase in CD4$^+$ T-cell numbers best correlated with the severity of clinical symptoms, such as the extent of skin lesions at the acute stage.

SKIN DISEASES AS MANIFESTATIONS OF IRS

The occurrence or recurrence of various infectious diseases and autoimmune diseases has been reported in many patients recently starting HAART, those with severe drug eruptions or those receiving immunosuppressive therapy on a reducing dose or withdrawal of immunosuppressive agents, as shown in Table 1.

HERPES ZOSTER

Herpes zoster (HZ) is caused by reactivation of latent varicella zoster virus (VZV) within a sensory ganglion. HZ is the most common manifestation of IRS in HIV-infected individuals and it counted for 40% of IRS events in one cohort[32]: the incidence of HZ is higher than immunocompetent healthy individuals; and the incidence is relatively consistent regardless of the stages of HIV infection.[33] HZ has been reported to occur two- to five-fold more frequently in HIV-infected patients treated with HAART than in those not receiving HAART.[34-36] The timing of HZ after the initiation of HAART has been highly variable, ranging from 4 weeks to 103 weeks.[34-36] Onset of HZ in 50% of cases occurred within the first 4 weeks after initiation of HAART and 86% occurred between week 4 and 16.[34] There was a significant increase in CD8$^+$ T cell numbers and percentages concurrent with HZ episodes, as well as reduction of HIV viral load,[35] while in other report, a marked increase in CD4$^+$ T cell numbers, but not CD8$^+$ T cells, was also observed during HZ episodes.[36] These results indicate that vigorous expansion of CD4$^+$ T cells may contribute to either the development of IRS or the decrease in HIV viral load. This effect may be mediated by IL-6 or IFN-α, both of which have been shown to play important roles in IRS events.[37,38] Alternatively, in view of tropism of VZV for CD4$^+$ T cells with a skin-homing phenotype,[39,40] expansion of CD4$^+$ T cells may be directly responsible for the development of HZ in this setting.

HIV-negative patients undergoing bone-marrow or organ transplantation and treated with immunosuppressive agents including corticosteroids, are also at increased risk of developing HZ as a manifestation of IRS. The timing of HZ after starting these treatments was more variable than in those treated with HAART. As compared with the setting of HAART-induced immune reconstitution, it is difficult to estimate when immune reconstitution occurs after starting these

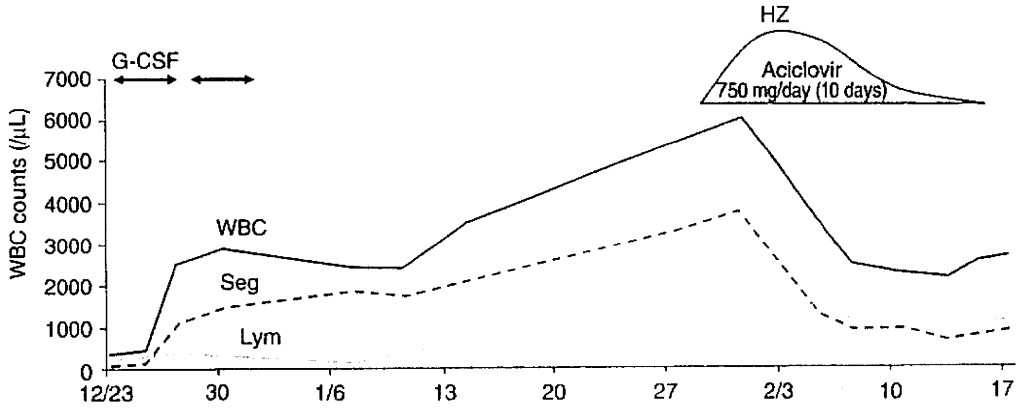

Fig. 4 HZ developing 2 months after the final course of chemotherapy. The onset of HZ is coincident with the restoration of immune responses as evidenced by the increase in neutrophil and lymphocyte counts.

treatments. Although these treatments themselves are thought to place some patients at increased risk of developing HZ, it may be noted that may if not all patients develop HZ after withdrawal or tapering dose of these immunosuppressive agents if the timing of HZ is carefully checked in relation to these treatments. Unfortunately, however, literature review on this issue is not possible at this time, because little attention has been focused on the timing of HZ in relation to these treatments. Although our series was not large enough to demonstrate the exact timing of HZ onset after the start of these treatments, we found that most cancer patients (35 cases) developed HZ 1 to 3 months after the final course of chemotherapy (Fig. 4) and that patients with rheumatoid arthritis or lupus developed HZ as well, 1 to 3 weeks after tapering dose of oral prednisolone (Kurata, M. *et al.*, unpublished data). Because recent studies have found no significant outcomes, such as HZ, associated with short-term use of prednisolone in advanced HIV infection,[41] short-term predonisolone therapy is unlikely the major cause of HZ in this setting. Interestingly, in the most HIV-negative cases of HZ occurring upon withdrawal or reduction in immunosuppressive agents, the rash generally appears on the trunk and extremities, but not on the face and head. Most cases had uncomplicated dermatomal HZ and none had severe complications, such as fatal disseminated HZ. Thus, VZV reactivation in the setting of immune reconstitution may elicit only a mild inflammatory reaction. Indeed, in the setting of DIHS, patients usually manifest a mild from of HZ before and after onset of DIHS: the onset of HZ is usually 2 to 3 months after onset of DIHS and often associated with the reduction of corticosteroids. There have been case reports of nondermatologic zoster, *zoster sine herpete*: they include stromal keratitis and iritis without concurrent HZ skin lesions. In addition, rare association of severe VZV vasculopathy involving the central nervous system in the setting of IRS has been also reported.

HERPES SIMPLEX

Frequent reactivations of herpes simplex virus (HSV) serve to increase the level of HIV viral load, with implications for HIV transmission and disease progression.[42] Although HAART is theoretically thought to have a beneficial effect on HSV reactivation, it remains to be established whether the incidence and severity of HSV disease could be decreased after HAART. Ratnam and colleagues[43] reported that HSV accounted for 50% of all IRS events and the onset to be a median of 12 weeks after starting HAART. However, reports regarding the timing and incidence of HSV onset after starting HAART have been diverse depending on the definition of IRS. In this regard, they used strict criteria for IRS: they defined HSV disease as a manifestation of IRS only when the frequency, severity, or poor response to treatment was significantly increased during the 6 months after starting HAART. Severe cases with extensive perianal lesions and fever, severe hemorrhagic nasolabial lesions, or encephalis, respectively, have been also reported after starting HAART.[43,44] Some cases have run a chronic course. The clinical course of these cases is likely to indicate that restoration of immune responses to HSV may remain partial despite successful control of HIV replication[45] thereby causing an imbalance between autoreactive and autoregulatory lymphocytes: this imbalance could result in the development of severe lesions.

Neurologic complications probably induced by reactivations of HSV or HHV-6 have been also reported to occur during the course of DIHS. Masaki *et al.* reported a patient with allopurinol-induced DIHS who developed encephalitis after the reduction of corticosteroids.[46] The cerebrospinal fluid (CSF) polymerase chain reaction (PCR) assay was positive for HHV-6 in this patient. We also described a patient

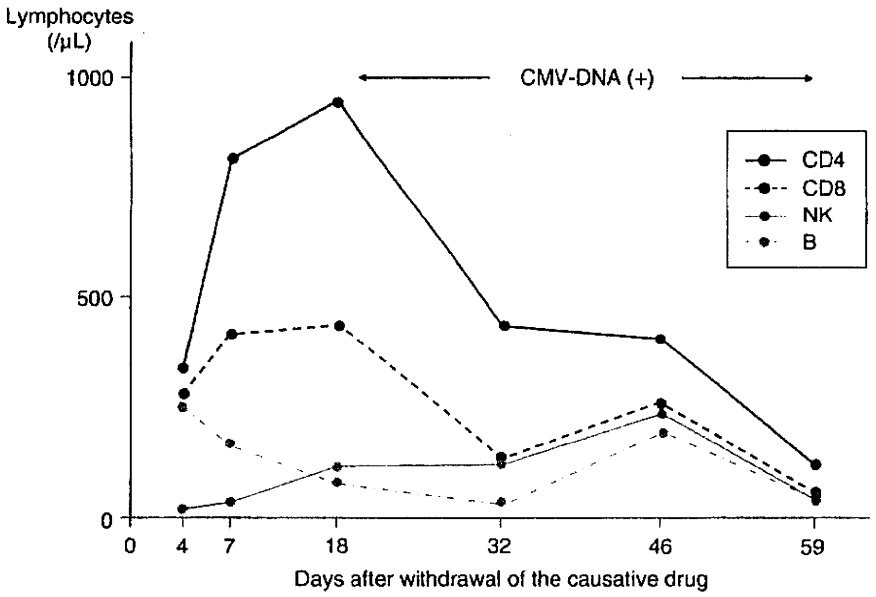

Fig. 5 CMV reactivation coincident with expansions of circulating CD4+ T cells in a HIV-negative patient with DIHS.[59]

with phenobarbital-induced DIHS who revealed syndrome of inappropriate secretion of antidiuretic hormone (SIADH) associated with limbic encephalitis.[47] However, no viral DNA was identified by PCR in CSF specimens repeatedly collected after the onset of encephalitis. Because of suspected herpetic encephalitis, empirical high-dose aciclovir (10 mg/kg every 8h IV) was started for 7 days with some effects. Although it remains to be determined whether SIADH and limbic encephalitis commonly have developed as a result of HHV-6 or HSV reactivation in our case, our failure to defect viral DNA in CSF may be explained by partial restoration of HHV-6 or HSV-specific immunity during the course of DIHS: immune reconstitution to HHV-6 or HSV in the central nervous system was the presumed cause. Interestingly, a similar unusual presentation of limbic encephalitis caused by HHV-6, associated with hyponatremia, has been previously described in several hematopoietic cell transplant recipients who developed a generalized skin rash suggestive of graft-vs.-host disease (GVHD).[48]

CYTOMEGALOVIRUS

CMV usually persists in a latent asymptomatic state after initial infection in the vast majority of individuals. Overt CMV disease predominantly induced by reactivation of latent CMV can be produced in an immunosuppressive host, such as organ transplant recipients, patients with AIDS, and those receiving immunosuppression agents. CMV disease can usually present as visceral diseases ranging from pneumonia to widely disseminated diseases,[49,50] cutaneous manifestations are rare and very variable, including ulcers, vesicles, purpuric macules, verrucous lesions, prurigo nodularis-like lesions, erythematous and crusted papules and digital infarct, regardless of whether it is specific or nonspecific.[51-54] These lesions occur as the late systemic manifestation of CMV infections and usually portend a fatal course.[55,56]

Regarding CMV infection as a manifestation of IRS in the setting of HIV infection, CMV retinitis is a common complication at the late stage.[23] The severity of clinical symptoms is far greater than that seen in the setting of non-HIV infection, and therefore it was termed "immune recovery retinitis".[57] CMV infection in the setting of IRS is also characterized by the systemic nature and cutaneous manifestations have been rarely reported. Qazi and colleagues,[58] however, reported a rare case of extensive CMV cutaneous ulceration occurring in a patient with HIV infection 3 months after starting HAART. Because the onset of CMV ulceration was associated with an increase in CD4+ T cell counts and a decrease in HIV viral load and the patient had a history of CMV retinitis, these features have fulfilled the criteria for IRS. This case was very unique in that the extensive CMV ulceration involved the back, both arms, and the left ear, instead of localized in the perianal region; that the patient had received maintenance prophylaxis with oral ganciclovir before the onset of the extensive CMV ulceration, and that the CMV ulcerations improved with addition of intravenous methylprednisolone to the treatment regimen. These features are consistent with CMV infection as a manifestation of IRS and are different from that occurring in immunocompromised patients not receiving HAART.

We have recently reported two HIV-negative patients with DIHS, who developed cutaneous CMV ulcers on the trunk (Fig. 5).[59] This event was eventually followed by the development of gastrointestinal manifestations which were fatal in one patient but not in another. In one patient, 74-year-old man, the eruption began suddenly, and the papules were distributed mainly over the upper back. There were no concomitant perianal ulcers. Within 2-3 days, the lesions became centrally ulcerated with a rim of erythema: the clinical features of the established lesions mimicked those of Degos' disease. Examination of a biopsy specimen of the ulcer showed eosinophilic intranuclear 'owl's eye' inclusions surrounded by a clear halo in the upper dermis: the CMV infection was confirmed by immunohistochemistry. Because of no improvement in his ulceration on oral prednisolone prescribed for drug eruptions, intravenous immunoglobulin (IVIG) was started with significant improvement in his ulcerations. Treatment with intravenous ganciclovir was also added and oral prednisolone was gradually tapered. Although the ulcers showed gradual signs of healing, the patient developed CMV enterocolitis. He eventually died of respiratory failure. In another case (81-year-old man), scratch dermatitis-like erythema developed on the back after 2 week of therapy with IVIG. Ulcerated erythematous papules were also detected on the shoulder. Histologic examination of the papules showed a few cytomegalic endothelial cells harboring eosinophilic intranuclear inclusions. The CMV infection was confirmed by immunohistochmistry. On the same day, he developed CMV gastritis. The patient was successfully treated with intravenous gancyclovir. Because it is widely believed that cutaneous, CMV disease arises from reactivation of a local latent virus or by autoinoculation in periorificial areas by faecal, urinary or salivary shedding of CMV,[60] CMV ulcers limited to the unusual sites such as trunk would go unrecognized. These cases indicate that a high index of suspicion and intervention may decrease morbidity and the need for monitoring of CMV reactivation even in immunocompetent patients, particularly when unexplained ulcers suddenly develop in patients with severe drug eruptions. In these cases, drug eruptions *per se* would provide a basis for immune reconstitutions as an etiologic factor.

TREATMENT OF IRS

Before starting treatment, it is important to exclude the possibility that paradoxical worsening of clinical symptoms of a preexisting infection regarded as signs of IRS could be a result of inadequate antimicrobial therapy or superinfection with other microorganisms,[9] because some individuals with IRS worsen clinical symptoms as a result of sub-optimal immune function associated with inadequate antimicrobial therapy. Although corticosteroids are most frequently used agent, there have not been clear guidelines for how patients with IRS are treated with corticosteroids. Because a mild form of IRS responds to specific treatment for the underlying pathogens, anti-inflammatory therapies are not generally required: thus, the management of patients with IRS is predominantly supportive. In patients with severe forms of IRS, however, anti-inflammatory therapies in addition to anti-microbial therapies are necessary to ameliorate clinical symptoms due to overshooting of immune recovery. Nevertheless, the need for relieving the symptoms and signs of immune recovery by anti-inflammatory therapies should be balanced with anti-microbial therapies aiming at reducing the amplitude and duration of tissue burden of preexisting microbes.

Corticosteroids have been the mainstay of treatment for IRS and are the only treatment for which clinical trial data exit.[61] Significant benefit was demonstrated in terms of symptom improvement in a range of infectious diseases: they include bacterial meningitis, tuberculous meningitis, pneumocystic pneumonia, microbacterial avium complex, leprosy, cryptococcosis, and *Pneumocystis jiroveci*.[61] Indeed, systemic corticosteroids gave promising results in terms of ameliorating vigorous restoration of immune responses to pathogens during the course of DIHS, as a manifestation of IRS. However, once systemic corticosteroids have started, drug dose should be reduced gradually even upon resolution of clinical manifestations in IRS, particularly in DIHS, because patients with DIHS are at greater risk of subsequently developing the wide spectrum of IRS ranging from CMV disease to autoimmune diseases[29,62,63] and the use of systemic corticosteroids represents an important factor that increases the risk of disease progression to full manifestations of IRS upon the withdrawal or reductions. Given the high risk of sequaelae from CMV reactivation in patients with DIHS, the direct anti-CMV medications with stepwise withdrawal of corticosteroids may help to avoid disease progression to full manifestations of IRS.

TNF-α plays a critical role in the initial host response to infection. Although it has been proposed that TNF-α inhibitors may be effective in the treatment of IRS, patients treated with TNF-α inhibitors have been reported to have developed IRS during anti-tuberculous treatment[64-67]: active tuberculosis occurred after a medium duration of 3.5 months of infliximab use. Mirmirani *et al.* reported that a HIV-infected patient developed active sarcoidosis soon after starting HAART.[68] Indeed, the histological hallmark of IRS is granuloma formation, which is mediated by Th1 cells[69] and the formation of granulomas is often observed in the late lesion of DIHS. Thus, TNF-α inhibitors could induce or precipitate sarcoidosis as a manifestation of IRS while they may benefit some patients with IRS.

CONCLUSION

Maintaining a fine balance between host and infectious agents, but not eradication of the latter, is the therapeutic goal of IRS. Although corticosteroids or TNF-α inhibitors may improve the clinical symptoms, one needs to be cautious in determining when a therapy that would abrogate the immune response to the infectious agents can be initiated.

Prompt recognition of DIHS as a new manifestation of IRS could help the physicians to determine the appropriate next step when a complex sequence of events described above occurs, thus improving the morbidity and mortality of otherwise life-threatening disease. Future studies of the appropriate management of IRS will need to establish a diagnostic tool that can distinguish whether clinical symptoms worsen as a result of an overwhelming inflammatory response or they do as a consequence of expansions of an opportunistic organism induced by sub-optimal immune function.

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アレルギーをめぐるトレンド

免疫再構築症候群

Immune reconstitution syndrome

今まで信じてきた概念を否定することは，誰にとっても容易なことではない．“免疫が高まる”とか“免疫が回復する”という言葉を聞けば，多くの人は良いイメージを抱くであろう．反対に，“免疫が抑制されている”というと，良いイメージをもつ人は少ないに違いない．実際多くの人は，免疫が抑制された状態ではさまざまなウイルスや細菌に感染しやすくなり，いろいろな病気が起こりやすくなると考えるはずである．しかし，実際には完全な免疫抑制状態では，感染症(の症状)はむしろ起こりにくい．たとえば，発熱したり，喉が痛くなったりすればわれわれは病気であると自覚するが，これらの症状は免疫反応が起こるからこそ生じてくる炎症症状にほかならない．

本症候群は，まさにこのように多くの人がもつ先入観を否定するところから始まる概念なのである．

Trend in Allergy

SHIOHARA TETSUO
塩原哲夫 杏林大学医学部皮膚科学教授

免疫再構築症候群とは?

免疫再構築症候群は，もともとAIDSなどの免疫不全患者に起こってくる病態で，それまで眠っていた病原体に対する免疫反応が抗ウイルス剤の開始などにより一時的に回復することにより生じる．Immune reconstitution syndrome(IRS)，Immune restoration syndrome，Immune recovery syndromeなどさまざまな名前で呼ばれてきたが，最近では炎症に注目して，Immune reconstitution **inflammatory** syndrome(IRIS)とも呼ばれている．

この概念を理解するためには，まず図1のウイルス感染後の免疫応答を理解しておく必要がある．ウイルス感染が起きたとき，大抵の人は何となくだるく，微熱がある程度の軽い全身症状を認めるのみである．しかし，実はこの潜伏期にウイルス量は最大になる．実際に高熱が出たり，皮疹を生じたり，肝障害が起こったりする時期には，ウイルスに対する特異的免疫応答(獲得免疫)が起こるため，ウイルス量自体はかえって低下する．つまり，ウイルスに対する特異的免疫応答が起こらない時期のほうが臨床症状は軽く，起こったあとのほうが症状ははるかに重くなる．免疫応答が強度に抑制されている個体では，たとえ病原体が増えていても，高熱のような感染症状は出てこない．それは病原体を認識する細胞は存在していても，冬眠状態になっているからなのである．それが，免疫能の回復とともに，病原体に対する特異的な免疫応答が高まる結果として(感染症を思わせる)臨床症状が生じ，一方で病原体の量は低下するのである．

もうひとつ，わかりやすい例を挙げてみたい．この症例はHIVとB型肝炎ウイルス(HBV)の両方に感染している(図2)．そのため，HBVに対する十分な免疫応答が起こらず，HBV DNAは高値となる一方で，肝機能障害を示すALTレベルは低値となる．ところが，抗ウイルス薬によりCD4陽性T細胞が増加しHBVに対する免疫応答が回復すると，ALTは上昇しHBVウイルス量は低下する．このデータだけみると，あたかも抗ウイルス剤が肝障害を起こしたようにみえてしまう．しかしこのALTの上昇も，CD4の減少とともに再び低下してくる．われわれは，つい皮疹，高熱，肝障害といったものを指標に感染症と診断しがちだが，病原体の量だけからすれば，特異的免疫反応が起こっているあいだ

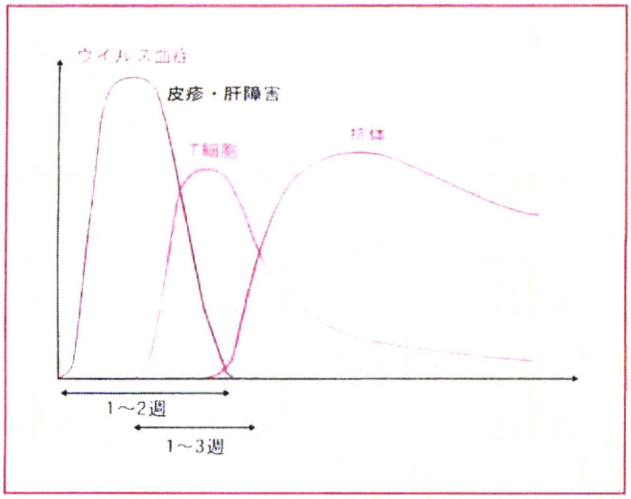

図1　ウイルス感染後の免疫応答と臨床症状

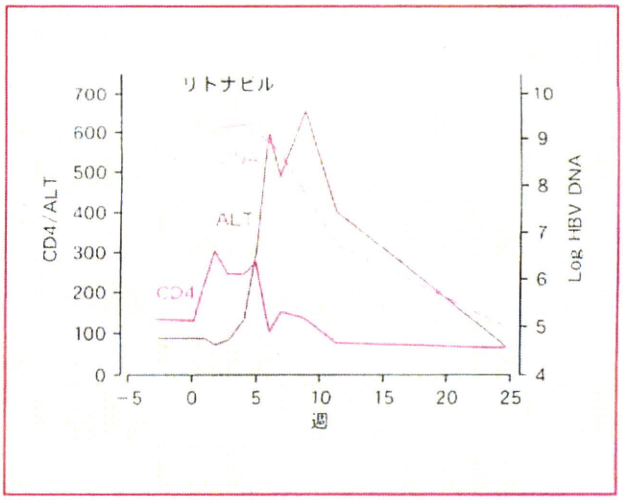

図2　HIVとB型肝炎ウイルスに感染した患者に抗ウイルス剤を投与した際の検査データの推移

(Carr A, Cooper DA : Lancet 349 : 995-996, 1997)

表1　IRSの生じやすい条件

・内服ステロイドの減量・中止後
・化学療法の終了後
・免疫抑制剤の減量・中止後
・生物学的製剤の中止後
・抗ウイルス剤の中止後(?)

表2　IRSとして発症する感染症，炎症性疾患

・Mycobacterium avium complex感染症
・結　核
・サイトメガロウイルス感染症
・クリプトコッカス感染症
・B型，C型肝炎
・帯状疱疹
・甲状腺疾患，自己免疫疾患
・サルコイドーシス

(つまりIRSが生じているあいだ)が最も低値になっているのである．

このように，IRSは当初AIDSなどの免疫不全患者でのみ生じる病態と考えられていた．そのため，診断基準もはっきりしたものがなく，①発症時，病原体が検出されないにもかかわらず，②時に感染症を思わせる臨床症状が増悪し，③それに伴いCD4陽性T細胞あるいはCD8陽性T細胞が増加する，といった程度のものが提唱されたに過ぎない．

IRSの概念の拡大

IRSが多くの臨床家の注目を集めるようになった(まだなっていないともいえるが)のは，IRSと同様の病態がHIV感染症以外のさまざまな状況で起こり得ることが明らかになったからである．IRS様の病態は，表1に示したような条件で生じてくる．とくにわれわれ皮膚科医がよく遭遇するのが，内服ステロイドの減量・中止後，あるいは化学療法の終了後である．表2にIRSとして生じてくる感染症を別記したが，そのほとんどは日和見感染として知られているものである．つまり，これらの疾患は一般的には免疫が抑制されたことにより生じると信じられているが，その発症の経過をよく検討してみると，実は免疫抑制状態からの回復に伴い生じていることがわかることがある．たとえば図3に示した症例は，化学療法後に生じた帯状疱疹であるが，終了後1カ月半ほどで発症している．その発症までの白血球とリンパ球数の推移をみてみると，白血球数が最低値(nadir)となっているときには発症せず，回復してきたことにより生じ，発症すると一転して低下しているのがわかる．しかも面白いことに，この症例ではVZV-IgGの上昇がほとんどみられなかったのである．一般にIRSとして生じた帯

免疫再構築症候群
Immune reconstitution syndrome

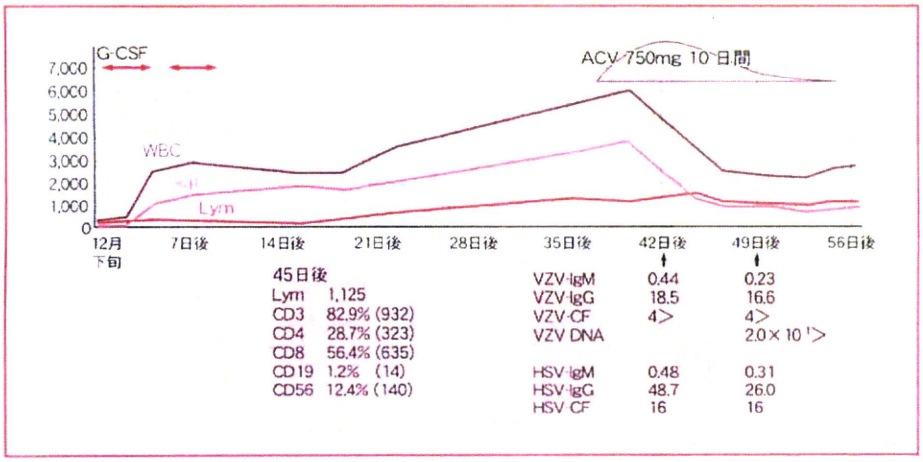

図3 化学療法後に発症した帯状疱疹
WBC：白血球数，
Seg：好中球数，
Lym：リンパ球数．

状疱疹の症状は軽く，経過も比較的短いとされているが，この症例では皮疹の程度も重篤で，経過もかなり遷延化した．

IRSとして生じる疾患

IRSとして生じる日和見感染症は，Highly Active Anti-retroviral Therapy(HAART)療法開始後比較的一定の時期に生じることが知られている．たとえば，クリプトコッカス症はHAART療法開始後数週間で発症するのに対し，サイトメガロウイルス感染症は数カ月後に発症しやすいとされている．それに対し帯状疱疹では幅があり，HAART開始4日目から640日後と，かなり発症が長期にわたっているのが特徴である．

ほかにIRSとして発症する疾患として重要なのがサルコイドーシスである．それはサルコイドーシスの発症の経過をよく考えてみれば，思い当たるはずである．皮膚サルコイドーシスが膝の瘢痕部に生じやすいことはよく知られているが，何十年も何ともなかった病変がなぜそんなに時間が経って生じてくるのかは筆者の長年の疑問であった．しかし，これはIRSにほかならない，と考えれば実にわかりやすい話になる．外傷により膝に入った異物は長いあいだそれに対する免疫応答が起こらなかったために，そのまま残ることになった．しかし，眠っていた免疫反応を呼び覚ますようななんらかの刺激がそこに加わったとき，肉芽腫の増悪となって認められることになる．われわれは，別の疾患の治療としてIL-2を投与するたびに，サルコイドーシス局面の増悪を認めた症例を経験している．

さらにサルコイドーシスに関して，われわれはきわめて興味深い症例を経験している．それは関節リウマチ(RA)の患者で，治療として白血球除去療法(L-CAP)を施行したところ，RAの症状は軽快したが，3カ月ほどして皮膚サルコイドと帯状疱疹を同時に発症したのである．この経過(図4)をAIDS患者のHAART療法後と対比して考えると，実に興味深い．RAに対しL-CAPを施行したということは，免疫を抑制する治療をしたということにほかならない．それが数カ月経過したあとは，AIDSにHAART療法をした時期に相当すると考えられる．つまり，この症例ではL-CAPにより抑制されていた免疫反応が回復してくる過程で，皮膚サルコイドと帯状疱疹を生じたことになる．面白いことにRA症状も増悪したため，L-CAPを再び施行したところ，RAだけでなく皮膚サルコイドも軽快したのであった．

同様の症例がすでに報告されていないか調べたところ，類似の症例がかなり多く報告されていることがわかった．しかし，それに関与しているのはL-CAPではなく，TNFα阻害剤であった．多くのRA患者はTNFα阻害剤を使用後に，サルコイドーシスを発症していたことがわかったのである．残念ながら，報告者自身がIRSとしてのサルコイドーシスに注目していなかったため，TNFα阻害剤投与後の免疫応答の回復期に一致してサルコイドーシスを発症していたかどうかは明らかではなかった．

何といっても筆者がIRSの病態に興味をもつようになったキッカケは，薬剤性過敏症症候群(drug-induced

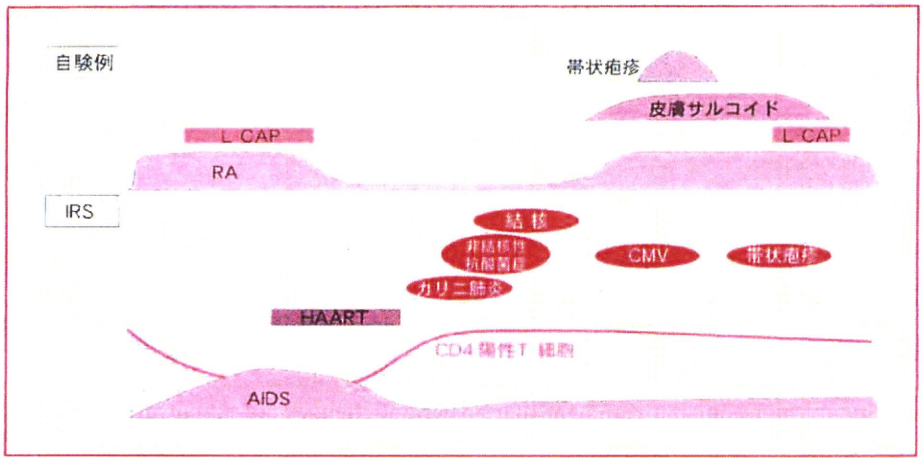

図4　RA患者に発症した帯状疱疹と皮膚サルコイド
（五味方樹ほか：臨皮 64：133-136，2010）

hypersensitivity syndrome；DIHS）であった．DIHSの病態を考えたときに不思議でならなかったのは，なぜこれだけの強い炎症症状を呈しながら，発症時に免疫グロブリンが低下し，薬剤特異的T細胞が検出されないなど，一見免疫が抑制されたような状態なのだろうかという点であった．免疫が活性化されているからこそ，このような症状（発熱，発疹，肝障害）が出ているはずではないのだろうか？ しかも原因薬を中止しているにもかかわらず，逆に著明な増悪が認められるのである．この疑問が解決できたのは，DIHSを起こす原因薬の多くがB細胞の分化を抑制する作用を有していることに気づいたときであった．つまり，“DIHSの発症前は免疫抑制状態にあり，原因薬の中止とともに免疫が回復し発症に至る”と考えるべきだったのである．そう考えると，DIHSの経過はまさにIRSそのものということになる．DIHSの発症時にウイルスが検出できないのも，CD4陽性T細胞が増加しているのも，まさにIRSにほかならないと考えれば納得のいく所見と言える．

IRSの病態を理解することの重要性

IRSという概念を理解して以降，筆者はステロイドの減量には人一倍気を使うようになった．なぜならステロイドの減量は，そのたびにIRSが起こりやすい状況をつくっているともいえるからである．実際，DIHSではステロイドの減量のたびに皮疹や肝障害の増悪を招くし，時にはCMV感染症や他の日和見感染症を起こす．IRSという概念を知らなければ，これらの日和見感染を起こした原因はステロイドの使用にあると考えて減量を急ぐであろう．それに対し，この感染症はIRSとして生じているのだと考えれば，ステロイドの量はそのまま維持することになる．このようにIRSの概念を臨床の場に取り入れることにより，治療に新しい視点をもつことができるようになったように思う．

まとめ

本来生体にとって良いはずの免疫反応の回復が，思いも寄らぬ感染症症状を引き起こす．長年，われわれ医師は目の前で起こっている症状を何とか軽減させるための最大の努力をしてきた．しかしIRSという立場に立つと，時にそういう努力は生体にとってマイナスにもなり得るということになる．まず考えるべきは免疫反応の回復をソフトランディングさせるような努力であり，そのためには時に何も治療を変えないという選択もあり得る．しかし何かをすることでしか安心できない医師という人種にとって，それはきわめて辛い選択ともなるのである．

CED
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Nonpigmenting fixed drug eruption as a possible abortive variant of toxic epidermal necrolysis: immunohistochemical and serum cytokine analyses

Y. Mizukawa and T. Shiohara

Department of Dermatology, Kyorin University School of Medicine, Tokyo, Japan

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Summary

Nonpigmenting fixed drug eruption (NPFDE) is clinically indistinguishable from Stevens–Johnson syndrome (SJS) or toxic epidermal necrolysis (TEN) in its initial presentation. The traditional paradigm that epidermal changes are absent in NPFDE cannot be easily reconciled with the clinical resemblance to SJS/TEN. We therefore investigated whether NPFDE is pathogenetically different from pigmented FDE (PFDE) or SJS/TEN and which factors are responsible for the lack of hyperpigmentation. NPFDE lesions before challenge were characterized by larger numbers of CD8+ intraepidermal T cells associated with a paucity of melanocytes, compared with those in PFDE. Very high levels of serum interleukin (IL)-10 were noted after clinical challenge. We conclude that NPFDE is a clinical syndrome with heterogeneous histological expression. NPFDE with epidermal involvement may be an abortive form of SJS/TEN, in which progression to TEN can be prevented by IL-10.

Nonpigmenting fixed drug eruption (NPFDE) can have multiple variants, all characterized by symmetrical, well-circumscribed, erythematous plaques resolving without pigmentation. It is clinically indistinguishable from Stevens–Johnson syndrome (SJS) or toxic epidermal necrolysis (TEN) in its initial presentation.[1] Additionally, a localized form of NPFDE has also been reported.[2] Because of the clinical similarity between these conditions, it has been suggested that the multiple variant represents the mild end of the spectrum of SJS/TEN. However, severe epidermal damage is absent in NPFDE, which seems inconsistent with this theory. Thus, it remains to be determined whether the multiple variant is a subtype of the FDE spectrum or an abortive variant of the TEN spectrum. We investigated lesions in a patient with NPFDE, which were initially thought to represent an early stage of TEN, and compared the results with lesions of pigmented FDE. We also measured the time course of serum cytokine levels sequentially obtained from this patient before and after clinical challenge.

Correspondence: Dr Yoshiko Mizukawa, Department of Dermatology, Kyorin University School of Medicine, 6-20-2 Shinkawa, Mitaka, Tokyo 181-8611, Japan
E-mail: ymizu@ks.kyorin-u.ac.jp

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Report

A 69-year-old woman presented with widespread, erythematous and Nikolsky-positive bullous lesions with fever and polyarthralgias (Figs 1a,b). She had noted the rapid appearance of the eruption 6 h after taking mefenamic acid. An initial presumptive diagnosis was of SJS/TEN or NPFDE. The patient recalled two previous similar eruptions involving similar areas after ingestion of mefenamic acid in the past. A biopsy specimen showed more severe epidermal damage than in PFDE, and a diagnosis of NPFDE was made.

Six weeks later, the patient underwent an oral challenge test with one-tenth (50 mg) of a single

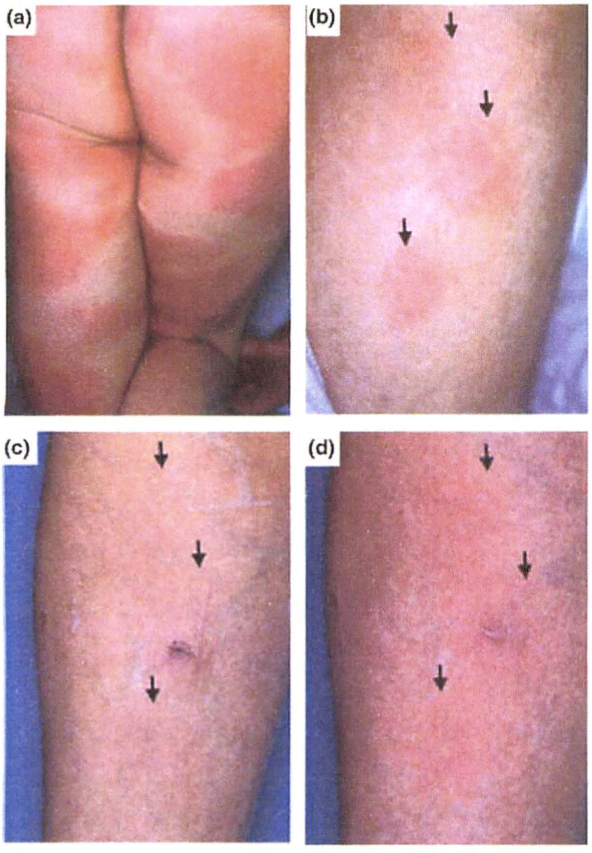

Figure 1 At onset, (a) large, well-demarcated erythematous areas on the buttocks and upper legs, and (b) erythematous plaques on the left lower leg were seen (arrows). (c) Six weeks later, the previously involved sites are barely recognized by faint residual pigmentation and a biopsy scar (arrows). The faint pigmentation faded completely 2 months later. (d) Three hours after oral rechallenge, erythematous lesions appeared at the previously involved sites (arrows).

therapeutic dose. At this time, the previous NPFDE lesions were clinically normal (Fig. 1c). After ingestion of the drug, erythematous plaques appeared in exactly the same sites as the previous lesions (Fig. 1d).

A brief description of the lymphocyte subsets in this patient has been previously reported.[3] Anti-CD8 and anti-Melan-A (melanocyte differentiation antigen) (both from Dako, Glostrup, Denmark) were used to identify intraepidermal CD8+ T cells and melanocytes, respectively. The number of intraepidermal CD8+ T cells along the basal layer in the resting NPFDE lesions was found to be higher than those in the resting PFDE lesions (NPFDE, 81.5 ± 10.7 cells/mm, $n = 4$; PFDE, 29.0 ± 3.7 cells/mm, $n = 11$, $P < 0.01$) (Figs 2a,b). In contrast, melanocytes and dermal melanophages in the NPFDE lesions were dramatically decreased in number compared with those in PFDE lesions (melanocytes in 6 NPFDE lesions 5.8 ± 0.5 cells/mm and in 9 PFDE lesions, 17.9 ± 2.2/mm $P < 0.01$; dermal melanophages in 8 NPFDE lesions 30.0 ± 12.3/mm^2 and in 11 PFDE lesions 151.3 ± 26.5/mm^2, $P < 0.01$) (Figs 2c,d). Thus, the lack of pigmentation after resolution in NPFDE is more likely due to the paucity of dermal melanophages resulting from the dramatic decrease in melanocyte number in the resting lesions before challenge, rather than to the absence of epidermal changes.

Serum concentrations of tumour necrosis factor (TNF)-α, interferon (IFN)-γ, interleukin (IL)-6, IL-8 and IL-10 in relation to the clinical variables are shown in Fig. 3. On first admission, marked increases in IFN-γ and IL-6 and a moderate increase in TNF-α were noted. IFN-γ and IL-6 levels rapidly fell on discontinuation of the causative drug. Three hours after challenge with the causative drug, marked increases in TNF-α and IL-8 were seen. The decrease in IL-8 levels at 5.5 and 7 h was associated with a rise in the IL-6 and IL-10 levels.

In this study, melanocytes in the NPFDE lesions were markedly decreased in number compared with those in the PFDE lesions, and this decrease was reflected in the paucity of dermal melanophages in the NPFDE lesions. However, dermal melanophages in NPFDE and PFDE lesions have not previously been quantitatively evaluated. As the number of intraepidermal CD8+ T cells was inversely increased in the basal layer of the resting NPFDE lesions, expansion of these CD8+ T cells with a tendency toward a basal location similar to melanocytes would be expected, and would be related to the decrease in melanocyte number. However, a small number of melanocytes also persisted despite the abundance of CD8+ T cells in the resting NPFDE lesions, which is different to the findings in vitiligo,[4] indicating that CD8+ T cells residing in the NPFDE lesions may not be so highly functional as those in vitiligo lesions. Given the variation in the number of intraepidermal CD8+ T cells and melanocytes in the resting lesions of NPFDE and PFDE, it appears likely that the frequency, functional activity and cytokine expression patterns of intraepidermal CD8+ T cells residing in the lesions cause variability in the clinical picture and histological patterns. It is possible therefore that the multiple variant of NPFDE as shown in this case could be seen as an intermediate condition between PFDE and SJS/TEN, as CD8+ T cells with a similar phenotype to those in the resting NPFDE lesions have also been

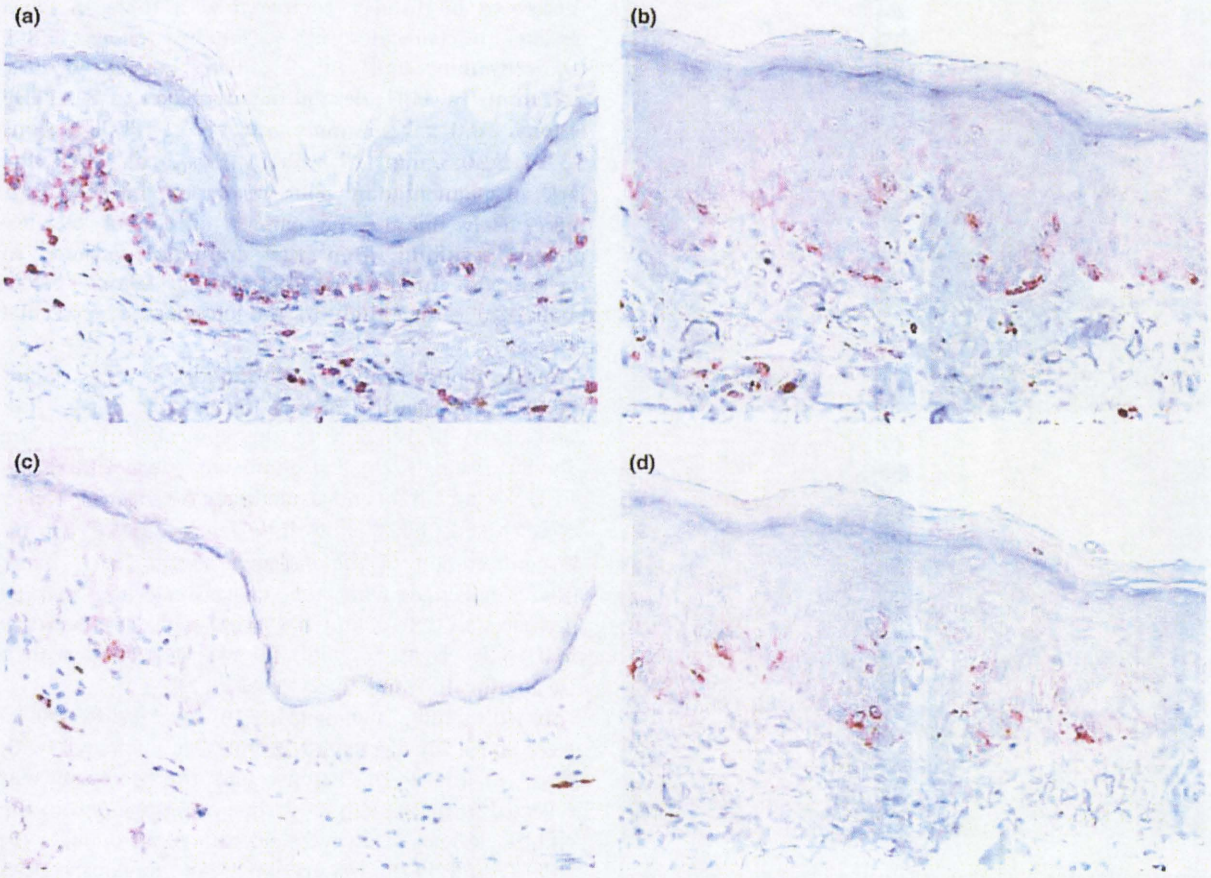

Figure 2 The distribution patterns of (a,b) intraepidermal CD8+ T cells and (c,d) melanocytes in (a,c) the resting nonpigmenting fixed drug eruption lesion and (b,d) the corresponding pigmenting fixed drug eruption lesion in a representative case. Biopsy specimens were obtained from the resting lesions before oral rechallenge. Both intraepidermal CD8+ T cells and melanocytes are predominantly located in the basal layer. Anti-CD8 and anti-Melan-A were used to identify intraepidermal CD8+ T cells and melanocytes, respectively (original magnification, × 132).

found in blister fluid from patients with TEN.[5] The existence and pathogenesis of a multiple variant of NPFDE clinically and histologically mimicking TEN needs verification in studies with a large number of patients.

The results presented in this study have important implications for factors that may serve to prevent disease progression to TEN. IL-10 levels at various time points showed a clear-cut inverse relationship with the corresponding proinflammatory cytokine levels. In view of the action of IL-10 on immune responses,[6] increased levels of circulating IL-10 during the development of drug eruptions could reflect an appropriate response that serves to protect tissues from destructive autoimmune attack by activated intraepidermal CD8+ T cells, and the relative balance between IL-10 and proinflammatory cytokines in diseased tissue would influence whether the inflammation progresses to the fatal outcome or is suppressed.

A multiple variant of NPFDE with systemic symptoms mimicking SJS/TEN in a useful disease model in which to study the mechanism whereby excessive activation of CD8+ T cells can be prevented in NPFDE, although it would be premature to conclude that NPFDE is an abortive form of TEN. Our data provide one potential explanation for why drug-induced immune responses in NPFDE resolve spontaneously upon discontinuation of the causal drug despite the clinical and histological resemblance to TEN; and indicate the clinical usefulness of monitoring levels of various cytokines in predicting the prognosis of drug eruptions.

