Title:

Eosinophilic annular erythema is clinically characterized by central pigmentation reflecting basal melanosis: A clinicopathological study of 10 cases

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ABSTRACT

BACKGROUND: Eosinophilic annular erythema (EAE) has been proposed as a clinical entity to describe annular skin lesions associated with tissue eosinophilia. However, systematic investigations on the histopathology of EAE have not been performed, and useful histopathological findings for diagnosis of EAE remain unknown.

OBJECTIVE: The aim of this study was to investigate the clinicopathological features of EAE.

METHODS: We retrospectively studied 10 patients at our hospital during a 5-year span who clinically showed annular or figurate lesions and histopathologically exhibited eosinophilic infiltration in the dermis.

RESULTS: Nine of the 10 cases had annular lesions with pigmentation on the interior side. Blood eosinophilia was found in only 1 patient. Histopathologically, basal melanosis was observed in 9 cases. Infiltration of eosinophils was confined to the dermis in 9 cases. Patients treated with systemic corticosteroid tended to show less recurrence than those treated with topical corticosteroid.

LIMITATIONS: The main limitation of our study is the small number of patients.
CONCLUSION: Skin biopsy should be performed when EAE is suspected, even in cases without blood eosinophilia. Basal melanosis and tissue eosinophilia confined to the dermis suggest the diagnosis of EAE. We recommend topical corticosteroids as the initial treatment for EAE.

**Key words:** eosinophilic annular erythema, figurate, pigmentation, basal melanosis, eosinophils, eosinophilia, corticosteroids
Introduction

As stated in the first report of eosinophilic annular erythema (EAE), the entity of EAE was proposed to describe annular skin lesions associated with tissue eosinophilia.\textsuperscript{1} To date 25 cases of EAE have been reported in the English literature.\textsuperscript{1–16} EAE is characterized by the appearance of persistent annular or figurate lesions, a chronic course with recurrent relapse and recalcitrance to various treatments.\textsuperscript{11,14} Typical EAE is histopathologically characterized by dense perivascular infiltrates with abundant eosinophils but without “flame figures.”\textsuperscript{15}

Some EAE cases have been clinically documented as being accompanied by a dusky-toned area and pigmentation.\textsuperscript{10,14,16} However, the frequency of discoloration has not been elucidated, and there have been no descriptions of histopathological examinations corresponding to the clinical pigmentation. Furthermore, the pattern and depth of eosinophilic infiltration in EAE has not been well investigated, which leaves the clinicopathological distinction between EAE and Wells’ syndrome (WS) unclear. To address these issues, we conducted a single-center, retrospective clinicopathological review of 10 cases of EAE. Our study demonstrates that most cases of EAE clinically
show pigmentation, and that the histological localization of eosinophils is limited to the
dermis, without peripheral eosinophilia.

**Materials and methods**

A single-center study of 10 patients diagnosed with EAE at Hokkaido University Hospital was performed. Their first visits were between 2011 and 2015. On the basis of the reports and studies in the past, we defined EAE as skin lesions that clinically show annular or figurate erythema and histopathologically exhibit abundant eosinophilic infiltration at least in the dermis. According to these criteria, we collected patients and retrospectively examined clinical features and histopathological findings. Data from the medical records included age, gender, past medical history, history of drug intake, disease duration, clinical features of lesions, symptoms, laboratory examination results (including whole blood cell count), and treatments and their responses.

Histopathological findings including epidermal changes, basal melanosis, vacuolar changes, melanin incontinence, patterns of eosinophilic infiltration, flame figures, coat
sleeve-like infiltration of lymphocytes around blood vessels, vasculitis and mucin deposition were reviewed.

Written consent for skin biopsy was obtained from each patient. All analyses in this study were performed in accordance with the ethical guidelines of Hokkaido University Hospital and the Declaration of Helsinki guidelines. The study was approved by the institutional review board of Hokkaido University Hospital (approval #015-0525; approval date: June 17, 2016).

**Report of Cases**

We highlight 2 representative cases of EAE from our 10 cases.

Case #2: A 42-year-old Japanese woman presented with a 1-year history of a pruritic rash on the four extremities. Treatment with systemic corticosteroid at the previous clinic brought temporary response. However, the rash recurred after the cessation of systemic corticosteroid. Physical examination revealed multiple annular erythema with peripheral infiltration on the extremities. Most of these lesions had brownish pigmentation (Fig. 1a). A biopsy specimen from the periphery of erythema on the left
thigh showed infiltration of inflammatory cells from the superficial to the mid dermis, including numerous eosinophils (Fig. 1b). The pattern of infiltration by the eosinophils was interstitial rather than perivascular (Fig. 1c). The epidermis presented basal melanosis and pigmentary incontinence (Fig. 1d). There were few inflammatory cells, including eosinophils, in the subcutis. Topical application of 0.05% difluprednate ointment was successful, and the rash had disappeared by the time of 5-week follow-up. However, the erythema relapsed and treatment with topical corticosteroid was restarted. The rash finally resolved 18 months after the first visit.

Case #8: A 31-year-old Japanese woman presented with a 2-month history of a pruritic eruption on the left lower leg. The eruption had gradually expanding before she visited our outpatient clinic. Examination revealed annular erythema with peripheral palpable infiltration and diffuse pigmentation on the left popliteal fossa and lower leg (Fig. 2a). Skin biopsy revealed perivascular and interstitial infiltration of inflammatory cells from the superficial to the mid dermis, including lymphocytes and eosinophils (Fig. 2b, c). Inflammatory cells, including eosinophils, did not extend to the subcutaneous tissue. The epidermis presented basal melanosis and mild focal spongiosis. There were mild
vacuolar changes and slight pigmentary incontinence (Fig. 2d). Mucin deposition was seen through the dermis. These annular erythema spontaneously regressed without treatment within 4 weeks, and no recurrence was noted.

Results

We present the clinical information of the patients in Table 1. There were 7 women and 3 men aged 27 - 82 years. Associated systemic disorders were recorded in 7 patients: asthma in 3 of these patients, and rheumatoid arthritis in 2 of these patients. Other items from the medical histories included cervical cancer, breast carcinoma, chronic gastritis, Hashimoto disease, hypertension and osteoporosis, in 1 patient for each. The duration of EAE from onset to first visit ranged from 2 weeks to several years. Itching was marked in all patients; however, tenderness of the lesion was not described. There was no history of preceding insect bite or contact dermatitis in any case. The descriptions and photographs of the lesions revealed that 9 cases had pigmentation mainly at the center of the lesions.
The histopathological findings of the skin biopsy are shown in Table 2. The skin biopsy specimens were taken from erythema in each case. Three specimens included flat, pigmented central areas with slight erythema. Basal melanosis was observed in 9 cases and melanin incontinence was noted in 3 cases. According to findings of flat pigmented central areas, basal melanosis was shown in all 3 specimens and pigment incontinence in 1 specimen. Vacuolar change was observed in 5 cases. Eosinophils infiltrated the superficial dermis in all cases and the deep dermis in 7 cases. Infiltration of eosinophils into the subcutis was noted in only 1 case. The pattern of eosinophilic infiltration was a mixture of perivascular and interstitial in 9 cases (Fig. 3a, b) and was exclusively perivascular in 1 case (Fig. 3c, d) (case #4). Inflammatory infiltrates including lymphocytes and eosinophils with coat-sleeve distribution were seen in 4 cases. Mucin deposition was observed in 2 cases. Flame figures and vasculitis were not seen.

Elevated blood eosinophilia (>500/μl) was observed in only 1 of the 10 cases. The patient was associated with asthma and eosinophilic granulomatosis with polyangiitis, and showed marked blood eosinophilia of up to 2.3x10³/μl (case #10).
According to serologic tests, anti-BP180 antibodies, anti-SS-A antibodies and anti-SS-B antibodies were negative in all 4, 7 and 6 patients tested for them, respectively.

As for treatments, 4 patients were treated with systemic corticosteroid (prednisolone 20-40 mg/day), 4 patients with topical corticosteroid and 1 patient with topical tacrolimus. The 1 remaining patient spontaneously resolved without treatment. 5 of the 9 patients showed a favorable course with no recurrence after cessation of the intervention. The mean duration of these 5 patients from the start of initial treatment to significant response was 3.8 weeks. 3 of these 5 patients were treated with systemic corticosteroid (the mean duration to significant response was 2.0 weeks) and 2 others with topical corticosteroids (6.5 weeks). In contrast, 1 of 4 patients treated with systemic corticosteroid and 3 of 5 patients treated with topical corticosteroid relapsed.

For the 1 patient whose initial treatment with topical corticosteroid was ineffective, the treatment was changed to topical tacrolimus with immediate effect and no relapse (case #4). The 2 remaining refractory patients treated with topical corticosteroid finally resolved with 1 or 2 repetitions of the same therapies. However, a male patient who was initially treated with systemic prednisolone at 40mg/day showed a persistent course of
the disease with remission and exacerbation (case #6). No cases were treated with hydroxychloroquine or other antimalarials.

Discussion

This study has elucidated the following. 1) Most cases clinically exhibited pigmentation that histopathologically resulted not from melanin incontinence but from basal melanosis. 2) Prominent eosinophilic infiltration was observed in the dermis, whereas eosinophils were scarce in the subcutis and peripheral blood. Flame figures were not shown in any of the cases. 3) EAE tends to respond more rapidly and relapse less frequently with systemic corticosteroid therapy than topical corticosteroid. 4) EAE tends to affect women more often than men.

Even though some case reports of EAE have noted a dusky tone or pigmentation, our study clearly demonstrates for the first time that EAE is clinically characterized by central pigmentation. Since several previous EAE cases noted the histopathological finding of vacuolar change, we expected melanin incontinence would be a predominant finding corresponding to clinical pigmentation.
However, our study unexpectedly demonstrated that basal melanosis (9 of 10) was observed more frequently than melanin incontinence (3 of 10), and vacuolar change was found in only 30% of EAE cases. Therefore, basal melanosis is considered to contribute mainly to clinical pigmentation. Since melanocytes were not increased in our study, some factors may exist to activate melanogenesis of melanocytes in the pathophysiology of EAE. Melanocytes express IL-5 at a low level, and it is possible that IL-5, which attracts eosinophils in the dermis, also acts on melanocytes. On the other hand, it can be also considered that melanogenesis of normal human melanocytes is inhibited by IL-4, which is produced by eosinophils (Fig. 4). Further studies are needed in order to clarify the relationship between melanocytes and eosinophilic infiltration.

In previous reports and studies of EAE, elevated levels of blood eosinophils tended to be found in cases without underlying disease. However, except for 2 cases associated with underlying diseases, our cases showed no blood eosinophilia, despite there being active skin lesions. As for histological eosinophilic infiltration, El-Khawalany et al. reported that the dermal eosinophils extended into the subcutis in
well-developed and long-standing lesions. Conversely, most cases of EAE in the literature did not show abundant eosinophilic infiltration into the subcutis. In our study, eosinophilic infiltration into the subcutaneous tissue was noted in only one in 10 cases. Some previous reports of EAE described the presence of flame figures, whereas our cases did not show flame figures in specimen tissues.

Although the predominant opinion is that EAE represents a variant of WS with an annular or figurate clinical appearance, the relationship between EAE and WS remains a matter to be discussed further. As WS is usually accompanied by blood eosinophilia, the absence of blood eosinophilia can be crucial in distinguishing EAE from WS. Furthermore in WS, the inflammatory cells, including eosinophils, often involve the subcutis as well as the dermis, and flame figures can be found as characteristic features. The localization of eosinophils to the dermis and the absence of flame figures suggest EAE rather than WS (Fig. 4).

In previous reports, EAE patients frequently showed prolonged courses, resistance to various treatments and high relapse rates. Contrary to these facts, however, our study demonstrated that 3 out of 4 cases treated with systemic
corticosteroids resolved without recurrence. In addition, although recurrence was observed in 3 out of 5 cases initially treated with topical corticosteroids, all 4 cases of EAE treated with long-term topical corticosteroids finally resolved in our study. As in one previous report,12 1 patient underwent spontaneous regression. From what has been discussed above, EAE has a moderate therapeutic response and is similar to WS in this respect; most WS patients have a benign course.20 EAE should be treated with potent or superpotent topical corticosteroids as the initial treatment. If topical treatment for several months is ineffective, systemic corticosteroid could be administered for additional treatment. Antimalarials have been suggested as the drug of choice in EAE1,11,15, although we did not choose them for treatment.

The male:female ratio of EAE was 3:7 in our cases and 13:15 in previous reports; there is a slight predominance in females1–16. The reason is yet to be elucidated, but 3 EAE female cases had a history of autoimmune disorders in our study. Also, histories of thyroiditis were found in previous female cases1,3. Therefore, autoimmunity might be involved in the pathophysiology and female predominance of EAE.
Conclusion

EAE should be included as a differential diagnosis of annular figurate erythema, in addition to major skin disorders such as erythema annulare centrifugum, drug eruption, subacute cutaneous lupus erythematosus and bullous pemphigoid, even if there is no blood eosinophilia. Skin biopsy is needed to confirm the diagnosis of EAE. Eosinophilic infiltration confined to the dermis and basal melanosis suggest the diagnosis of EAE. Systemic corticosteroid is recommended for EAE if treatment with topical corticosteroid is ineffective.
Abbreviations used:

EAE: eosinophilic annular erythema WS: Wells’ syndrome
References


Figure legends

**Fig 1.** Clinical presentation and histopathological features of case #2.

A, Annular erythema with peripheral infiltration on the right shoulder. B, Inflammatory cells have infiltrated the superficial to mid dermis but do not extend to the subcutaneous tissue. C, Interstitial infiltration of inflammatory cells, including eosinophils, is seen in the dermis. Mucin deposition is also observed. D, The epidermis presents basal melanosis (arrows). Superficial perivascular infiltration is also observed. (B, C, and D, hematoxylin and eosin staining; original magnifications: B, x12.5; C, x400; D, x100)

**Fig 2.** Clinical presentation and histopathological features of case #8.

A, Annular erythema with peripheral palpable infiltration and diffuse pigmentation on the left popliteal fossa and lower leg. B, Inflammatory cells have infiltrated the superficial to mid dermis but do not extend to the subcutaneous tissue. C, The epidermis presents basal melanosis (arrows) and mild spongiosis. There are also mild vacuolar changes and slight pigmentary incontinence. D, Interstitial infiltration of inflammatory cells, including eosinophils, is seen in the dermis. Mucin deposition is also observed. (B,
C, and D, hematoxylin and eosin staining; original magnifications: B, x12.5; C, x400; D, x100)

**Fig 3.** Pattern of histopathological eosinophilic infiltration. A and B, Case #9 show a mixture of perivascular and interstitial patterns. C and D, Case #4 shows an exclusively perivascular pattern. (hematoxylin and eosin staining; original magnification: A and C, x40; B and D, x200)

**Fig 4.** An illustration of the pathophysiology of EAE and the differences between WS and EAE. In WS, the inflammatory cells, including eosinophils, often involve the subcutis as well as the dermis, and flame figures can be found as characteristic features. In EAE, eosinophils are limited to the dermis, and flame figures do not appear in specimen tissue. In the pathophysiology of EAE, IL-5 might activate the melanogenesis of melanocytes and attract eosinophils in the dermis. On the other hand, it could be also considered that IL-4 produced by eosinophils might inhibit the melanogenesis of melanocytes.
Table legends

Table 1 Clinical data and therapeutic responses of the 10 patients with EAE

Table 2 Histopathological profiles of the 10 patients with EAE
<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Gender</th>
<th>Past medical history</th>
<th>Duration from onset to first visit</th>
<th>Initial location</th>
<th>Description of lesions</th>
<th>Peripheral blood eosinophils (%)</th>
<th>Peripheral blood eosinophil count</th>
<th>Initial treatment</th>
<th>Significant response (weeks)</th>
<th>Relapse</th>
<th>Follow-up period (weeks)</th>
<th>Duration from first visit to resolution (weeks)</th>
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<td>nothing of note</td>
<td>2-3 months</td>
<td>face, palm, back, extremities, sole</td>
<td>edematous annular erythema with pigmentation</td>
<td>6.1</td>
<td>330</td>
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<td>2</td>
<td>42</td>
<td>F</td>
<td>asthma, cervical cancer, rheumatoid arthritis</td>
<td>1 year</td>
<td>extremities</td>
<td>annular erythema with pigmentation</td>
<td>0</td>
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<td>topical corticosteroid</td>
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<tr>
<td>3</td>
<td>68</td>
<td>F</td>
<td>rheumatoid arthritis</td>
<td>2 weeks</td>
<td>scalp, hand, forearm, abdomen</td>
<td>annular erythema with central pigmentation</td>
<td>4.0</td>
<td>290</td>
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<td>2 months</td>
<td>trunk, extremities</td>
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<td>6.3</td>
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<td>F</td>
<td>asthma, breast carcinoma</td>
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<td>lower leg</td>
<td>light-brownish plaque encircled by erythematous papules</td>
<td>7.6</td>
<td>460</td>
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<td>6</td>
<td>31</td>
<td>M</td>
<td>chronic gastritis</td>
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<td>whole body</td>
<td>edematous erythema enlarging in an annular pattern</td>
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<td>+</td>
<td>126</td>
<td>over 126 **</td>
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<td>over 10 ***</td>
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* In case 4, treatment with topical tacrolimus was followed by cessation of topical corticosteroid and was effective.
** In case 6, the patient showed a persistent course of the disease until the end of the research period.
*** In cases 7 and 10, the patients were referred to other clinics or hospitals for personal reasons.
PSL: prednisolone
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<td>IgM and C3 deposition in the dermal vessels</td>
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P: peripheral elevated erythema, C: central pigmentation with slight erythema, PC: an area including both P and C