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Serum anti-*Staphylococcus pseudintermedius* IgE and IgG antibodies in dogs with atopic dermatitis and nonatopic dogs

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Background – Dogs and humans with atopic dermatitis (AD) are predisposed to colonization and recurrent infection with *Staphylococcus* spp. Studies in humans suggest that staphylococcus-specific immunoglobulin E (IgE) plays a key role in disease pathogenesis. Few such studies have been undertaken in dogs.

Hypothesis/Objectives – The aim of this study was to compare levels of staphylococcus-specific IgE and immunoglobulin G (IgG) in dogs with AD, nonatopic dogs with staphylococcal pyoderma, and nonatopic and non-infected control dogs.

Animals – Sera were collected from 108 dogs with AD, 39 nonatopic dogs with staphylococcal pyoderma secondary to different underlying conditions, 67 age-matched nonatopic control dogs, and nine control dogs reared in minimal disease conditions.

Methods – Serum *Staphylococcus pseudintermedius*-specific IgE and IgG antibodies were measured by enzyme-linked immunosorbent assay.

Results – Dogs with AD had significantly higher levels of anti-staphylococcal IgE than nonatopic dogs with staphylococcal pyoderma and the two groups of control dogs. Levels of anti-staphylococcal IgG were significantly higher in atopic dogs and nonatopic dogs with pyoderma compared with nonatopic control dogs and control dogs reared in minimal disease conditions, but there was no significant difference in levels of anti-staphylococcal IgG between dogs with AD and nonatopic dogs with pyoderma.

Conclusions and clinical importance – A significantly increased IgE response to *S. pseudintermedius* antigens in atopic dogs suggests an immunopathogenic role for anti-staphylococcal IgE. The finding of elevated IgE and IgG in atopic dogs is also important as a prelude to studies on antigenic specificity and possible correlations with disease phenotype.

Introduction

Staphylococcal infection is a major complicating factor in both canine and human atopic dermatitis (AD).[1,2] Furthermore, it is increasingly recognized that the immunoglobulin E (IgE) response to staphylococcal antigens in humans plays an important role in the pathogenesis of the disease.[3] There are, in fact, two conditions in humans associated with anti-staphylococcal IgE and recurrent staphylococcal skin infections, namely AD and hyper-IgE syndrome.[1] However, no condition analogous to the latter has yet been reported in dogs.

Numerous studies have investigated the IgE response to *Staphylococcus aureus* antigens in human AD.[1,4–6] Amongst the atopic diseases, the production of IgE directed against microbial antigens appears to be limited to AD, and there is no such response in patients suffering from atopic respiratory diseases.[6,7] In most studies, allergen-specific IgE levels correlate with disease severity, which is suggestive of a significant immunopathogenic role.[5,6] More recently, attention has focused on soluble staphylococcal toxins, particularly superantigens, which are documented in >50% of cases.[6,8] Not only are superantigens capable of inducing inflammation through polyclonal B and T cell activation, but they also provide a rich source of allergen to the skin immune system.[8,9] It

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is suggested that the combination of superantigen-producing staphylococci and the subsequent IgE response may be very important factors in determining the severity of AD.[6,8,9]

The major canine skin pathogen is *Staphylococcus pseudintermedius*,[10] and its complete genomic sequence has been recently published.[11] It is known that dogs suffering from canine AD have a higher rate of carriage of *S. pseudintermedius* than do normal dogs, and that lesional skin of affected dogs is frequently colonized by this organism.[12] *Staphylococcus pseudintermedius* produces a range of exotoxins, including superantigens. In one study, 25 of 96 isolates from cases of canine pyoderma in the UK were shown to produce multiple superantigens, usually staphylococcal enterotoxin A (SEA) and C (SEC).[13] In another study, a novel enterotoxin-related gene, *se-int*, found in all 44 isolates examined, shared >50% homology with both SEC and staphylococcal enterotoxin B (SEB).[14]

There are few published studies on the immune response to staphylococcal antigens in canine AD and other canine skin conditions. One study examined the IgE and IgG response to staphylococcal antigens in 31 dogs with pyoderma secondary to AD, 34 cases of recurrent idiopathic pyoderma, 14 cases of idiopathic deep recurrent pyoderma, 15 cases of single-episode pyoderma, and 39 healthy control dogs that were not age matched.[15] Both dogs with AD and those with recurrent superficial pyoderma had significantly higher levels of anti-staphylococcal IgE than did the healthy dogs. Levels of IgG antibody appeared to be much higher than those of IgE, and were found to increase with increasing chronicity of the infection. A later study examined the IgG and IgA response to staphylococcal antigens in dogs suffering from AD with and without concomitant pyoderma, as well as cases of idiopathic deep pyoderma, pustular demodicosis, flea-allergy dermatitis with pyoderma and anal furunculosis, and in healthy control dogs (albeit not age matched).[16] All affected animals had significantly higher levels of IgG antibody than the healthy control animals, but no significant differences were found between the affected groups. However, the significance of this study, which did not assess IgE levels, for the pathogenesis of AD is unclear.

Canine AD and human AD share many common features.[17] The most recent research in human AD has emphasized the very important role of staphylococcal infection and the subsequent immune response; thus, there is a need to revisit this in canine AD, employing age-matched control animals and more refined methods of antigen extraction. The aim of this study was to measure levels of staphylococcus-specific IgE and IgG in a large population of dogs suffering from AD and compare them with levels in dogs suffering from staphylococcal infection secondary to other causes and in two control groups with no history of skin disease or infection. We hypothesized that if an immunopathogenic role for anti-staphylococcal IgE in canine AD exists, anti-staphylococcal IgE levels would be greater in atopic dogs than in age-matched nonatopic dogs, irrespective of their pyoderma status.

Materials and methods

Serum samples

Sera were assayed from the following groups.

1. Group 1, AD dogs, comprising 108 dogs including 43 dogs with a clinical diagnosis[18] of canine AD and secondary pyoderma (confirmed by cytology and isolation of *S. pseudintermedius*) seen at the Small Animal Teaching Hospital, University of Liverpool, UK over a 4 month period and 65 dogs suffering from chronic dermatitis whose sera had been submitted to Avacta Animal Health UK over a 1 year period for serological testing for environmental allergen-specific IgE, and that subsequently underwent immunotherapy. The latter were diagnosed with canine AD after exclusion of other causes of pruritus by the submitting veterinarian, and sera selected for the study showed positive reactions to one or more relevant allergens following confirmation by one of the authors (REH) that the history, clinical signs and investigation detailed on the submission form were compatible with a diagnosis of canine AD using appropriate criteria.[18,19] Dogs with any present or past history of flea-allergy dermatitis or that had shown any response to ectoparasiticidal therapy were excluded. The presence and type of pyoderma in the latter dogs was, however, not always documented.
2. Group 2, nonatopic dogs with pyoderma, comprising 39 dogs with pyoderma (confirmed by cytology and isolation of *S. pseudintermedius*) seen at the Small Animal Teaching Hospital, University of Liverpool UK over a 4 month period. Of these, 11 had atopic-like dermatitis, 11 had demodicosis, seven had a seborrhoeic disorder, three had recurrent idiopathic pyoderma, two had hypothyroidism, three had an adverse food reaction, and two had nonrecurrent idiopathic pyoderma.
3. Group 3, nonatopic control dogs, comprising 67 age-matched control dogs with no history or clinical signs of skin disease at time of sampling. These sera were submitted by veterinarians over a 1 year period for investigation of gastrointestinal problems (chronic vomiting and/or diarrhoea).
4. Group 4, minimal disease (MD) control dogs, comprising nine laboratory-bred dogs that were reared in minimal disease conditions at Charles River Laboratories (Ballina, Co. Mayo, Ireland).

The number, sex and ages of dogs in each group are shown in Table 1. The study was approved by The University of Liverpool School of Veterinary Science Ethics Committee. In the case of Groups 1–3, all sera were derived from excess serum that was drawn for diagnostic purposes. In the case of Group 4, sera were obtained and supplied under the appropriate licence (Charles River Laboratories via the Minister of Health and Children, Ireland).

Antisera

An alkaline phosphatase-conjugated monoclonal antibody (mAb, clone 5.91; North Carolina State University, Raleigh, NC, USA) was used to detect staphylococcus-specific IgE. This antibody has been shown to be specific for canine IgE with no cross-reactivity to IgG.[20] Staphylococcus-specific IgG was detected using alkaline phosphatase-conjugated goat anti-dog IgG (γ-chain specific; Kirkegaard and Perry Laboratories, Gaithersburg, MD, USA).

Preparation of *Staphylococcus pseudintermedius* antigen extract

Fifteen *S. pseudintermedius* isolates from cases of canine pyoderma were used in initial studies. Soluble and cell wall-associated antigens from both stationary and exponential growth phases were prepared as previously described.[21] The extracted proteins were assessed for protein A content by PAGE and western blotting using a chicken anti-protein A (IgY; Gallus Immunotech, Fergus, ON, Canada). The specificity of the chicken anti-protein A was shown using *S. aureus* Newman SpA (protein A-producing) and *S. aureus* Newman Δ SpA

Table 1. Number, sex and age of dogs in the study

Group*	Number of dogs	Sex ratio, males:females (no. neutered, N)	Median age (months)	Mean age (months)	Age range (months)
1	108	70 (29 N):38 (19 N)	53	58†	8–147
2	39	28 (5 N):11 (3 N)	58	63†	7–132
3	67	37 (19 N):30 (16 N)	42	53†	4–144
4	9	2:7	5	5	4–5

*Group 1, dogs with atopic dermatitis; Group 2, nonatopic dogs with staphylococcal pyoderma; Group 3, nonatopic control dogs; and Group 4, control dogs reared in minimal disease conditions.
† Significantly different from Group 4, $P < 0.001$.

(nonprotein A-producing) positive and negative controls, respectively. Three strains that were protein A negative using this criterion were further assessed for IgG binding. The preparation derived from a strain (8012) that showed minimal binding to serum from a MD dog was selected for use in the study.

Assessment of *Staphylococcus pseudintermedius* strain 8012 for *se-int* gene

Strain 8012 was assessed for the presence of the superantigen *se-int* gene by PCR. Genomic DNA was extracted from 500 μL of stationary-phase culture grown in tryptic soy broth at 37°C using the Edge Biosystems PurElute Bacterial Genomic kit (Edge Biosystems, Gaithersburg, MD, USA) following the manufacturer's instructions, with the addition of 250 μg/mL (final concentration) of lysostaphin (Ambi Products, Lawrence, NY, USA) prior to incubation. The PCR was performed using Promega GoTaq DNA Polymerase (M8301) with the Promega dNTP mix (U1511; Promega UK Ltd, Southampton, UK), employing the following primers (Invitrogen, Life Technologies Ltd, Paisley, UK): *se-int* forward 5′-TATAGGTACCCTTGGACTTTTGGATG-3′; and *se-int* reverse 5′-TGGCGAGCTCCAAATCCATTAGCC-3′. Appropriate positive (genomic DNA from *S. pseudintermedius* strain ED99) and negative controls (no template) were included.

Enzyme-linked immunosorbent assay (ELISA)

Serum staphylococcus-specific antibodies were assayed by ELISA using protocols modified from previous studies.[20,22] Briefly, microtitre plates (Greiner Labortechnik, Frickenhausen, Germany) were coated with *S. pseudintermedius* extract diluted 1:1000 (IgE ELISA) and 1:3000 (IgG ELISA) in 0.05 M carbonate/bicarbonate buffer, pH 9.6, and blocked with phosphate-buffered saline containing 0.5% polyvinylpyrrolidone (average molecular weight 10,000) and 0.5% sucrose. All dilutions of serum and secondary antibodies were in Tris-buffered saline containing 0.05% Tween-20 (TBST) and 0.5% human serum albumin. Samples were assayed in duplicate at dilutions of 1:10 (IgE) and 1:400 (IgG). Immunoglobulin E was detected with 1 μg/mL phosphatase-conjugated mAb (clone 5.91); IgG was detected with 0.125 μg/mL phosphatase-conjugated goat anti-dog IgG (γ-chain specific). Between incubation steps, plates were washed three times with TBST using an automated plate washer (Bio-Tek, Winooski, VT, USA). Colour was developed using AP Yellow One Component Microwell Substrate (pNPP; BioFx Laboratories, Owings Mills, MD, USA) for 30 min at room temperature before the reaction was stopped by the addition of 1 M NaOH. Absorbances were determined at 405 nm using a microplate reader (Tecan, Männedorf, Switzerland). Results were expressed as optical density (OD) units at 405 nm, determined as an average of duplicate results after correction by subtracting the mean OD value of duplicate blank wells.

Statistical analysis

All data were analysed using SPSS 20.0 (IBM UK Ltd, Portsmouth, UK). Differences were considered statistically significant when the *P*-value was <0.05. After testing for normality, differences in age and levels of antibodies between groups were tested by one-way ANOVA followed by Dunnett's *post hoc* test for multiple comparisons, assuming unequal variance between groups. Linear regression was used to assess whether there was any statistically significant association between duration of staphylococcal infection and levels of anti-staphylococcal antibodies.

Results

PCR results for strain 8012

The PCR results were positive for the superantigen gene *se-int*.

Reproducibility

From the assay controls, the mean intra-assay variations were 6.3 and 9.7% for IgE and IgG ELISAs, respectively. Mean interassay variations were 11.6 and 12.2% for IgE and IgG ELISAs, respectively.

Serum anti-*Staphylococcus pseudintermedius* IgE

There was a highly significant difference in anti-staphylococcal IgE levels between the four groups ($P < 0.009$, ANOVA; Figure 1). Group 1 atopic dogs had significantly higher levels of anti-staphylococcal IgE than Group 2 nonatopic dogs with pyoderma ($P < 0.05$, Dunnett's *post hoc* test) and both the age-matched Group 3 nonatopic control dogs and Group 4 MD control dogs (both $P < 0.05$, Dunnett's *post hoc* test). Significantly higher levels of anti-staphylococcal IgE were also seen in the Group 2 nonatopic dogs with pyoderma and Group 3 nonatopic dogs compared with the Group 4 MD dogs (both $P < 0.05$, Dunnett's *post hoc* test). There was no significant difference in IgE levels between the Group 2 nonatopic dogs with pyoderma and the Group 3 nonatopic dogs without pyoderma.

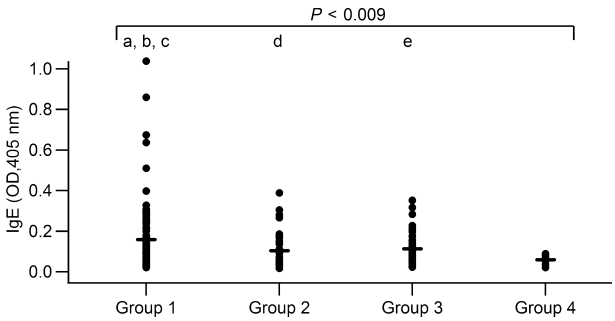

Figure 1. Anti-staphylococcal IgE in Group 1 dogs with atopic dermatitis, Group 2 nonatopic dogs with pyoderma, Group 3 nonatopic control dogs, and Group 4 minimal disease control dogs. Bars indicate the mean of each group. [a] Significantly different from Group 2, $P < 0.05$; [b] significantly different from Group 3, $P < 0.05$; and [c,d,e] significantly different from Group 4, $P < 0.05$.

Serum anti-*Staphylococcus pseudintermedius* IgG

There was a highly significant difference in anti-staphylococcal IgG levels between the four groups ($P < 0.0001$, ANOVA Figure 2). Group 1 atopic dogs had significantly higher levels of serum staphylococcus-specific IgG than Group 3 nonatopic control dogs and Group 4 MD control dogs (both $P < 0.05$, Dunnett's *post hoc* test). In addition, Group 2 nonatopic dogs with pyoderma and Group 3 nonatopic control dogs had significantly higher levels of serum staphylococcus-specific IgG than Group 4 MD control dogs (both $P < 0.05$, Dunnett's *post hoc* test). There was no significant difference in IgG levels between the Group 1 atopic dogs and the Group 2 nonatopic dogs with pyoderma, or between the Group 2 dogs and the Group 3 nonatopic dogs without pyoderma.

Duration of infection

The duration of infection was not correlated with levels of either anti-staphylococcal IgE or IgG antibodies in dogs with clinically diagnosed pyoderma ($R^2 = 0.178$ and 0.032 for IgE and IgG, respectively).

Discussion

This study compared levels of staphylococcus-specific IgE and IgG in dogs with AD and those suffering from staphylococcal pyoderma secondary to other causes with levels in two groups of control dogs. Some Group 1 dogs with AD were not seen by the authors, but all were suffering from chronic pruritic dermatitis, had IgE to one or more relevant environmental IgE allergens, were diagnosed as suffering from canine AD by the submitting veterinarian, and subsequently underwent immunotherapy. Compatibility with a diagnosis of canine AD was confirmed by one of the authors by perusal of the clinical and historical data on the submission forms. The Group 3 nonatopic control dogs were also not seen by the authors, but were age-matched dogs reported as suffering from gastrointestinal problems manifested by chronic and recurrent diarrhoea and/or vomiting. These dogs had no known history or clinical signs of skin disease. The MD control dogs (Group 4) were of a young age and reared in minimal disease conditions and thus likely to have had limited exposure to staphylococci. Group 1 atopic dogs, Group 2 nonatopic dogs suffering from staphylococcal pyoderma, and Group 3 nonatopic control dogs were age matched, with no significant differences between the means, but the Group 4 MD control dogs were significantly younger (Table 1). These were nevertheless included as negative controls because they were likely to have low to undetectable levels of serum anti-staphylococcal antibody. The pyoderma status of the 65 atopic dogs in Group 1, whose sera were submitted to Avacta Animal Health, was not always known. It is, however, well established that staphylococci colonize lesional skin and mucosal sites in >90% of atopic dogs,[12] and in one study 74% of dogs with AD undergoing allergen-specific immunotherapy required treatment for pyoderma when followed over a 9 month period.[23] Furthermore, levels of anti-staphylococcal IgG were significantly higher in the Group 1 atopic dogs than the two groups of control dogs, suggesting that staphylococcal infection may have been recurrent in these atopic dogs for a number of years. It can thus be assumed that most, if not all, of these dogs were exposed to antigens of *S. pseudintermedius* at some point during the course of their disease.

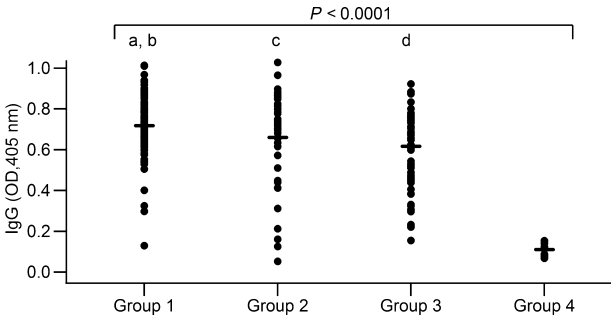

Figure 2. Anti-staphylococcal IgG in Group 1 dogs with atopic dermatitis, Group 2 nonatopic dogs with pyoderma, Group 3 nonatopic control dogs, and Group 4 minimal disease control dogs. Bars indicate the mean of each group. [a] Significantly different from Group 3, $P < 0.05$; and [b,c,d] significantly different from Group 4, $P < 0.05$.

Similar to studies in human AD,[1,4,24] significantly higher levels of staphylococcus-specific IgE were found in dogs with AD than in nonatopic, noninfected control dogs. Moreover, IgE levels were significantly higher in dogs with AD than in dogs with staphylococcal infection secondary to other causes. In contrast, the level of anti-staphylococcal IgG in the two groups was not significantly different. This suggests that anti-staphylococcal IgE may have an important role in the pathogenesis of canine AD. As will be discussed later, it is possible that it is a reflection of superantigen production by the strain involved and a resultant T-helper 2 (Th2) skewing of the immune response.[25] In a previous study, higher levels of staphylococcus-specific IgE were found not only in dogs with AD, but also in dogs with recurrent idiopathic pyoderma, although the dogs were not age matched.[15] It was concluded that hypersensitivity reactions to staphylococcal antigens could be contributing to the inflammatory process in those dogs. In the same study, there was also some evidence that chronicity led to increased levels of anti-staphylococcal antibody, although this apparent trend was not subjected to statistical evaluation. There was no evidence of a relationship between staphylococcal antibody levels and duration of infection in our study (although duration in our study refers to the overall history of pyoderma, not the duration of each occurrence). The presence of high levels of staphylococcus-specific IgE in some nonatopic dogs with pyoderma in this and other studies[15] emphasizes that anti-staphylococcal IgE is not restricted to dogs suffering from canine AD. It is, of course, possible that some of these dogs were subclinically atopic dogs, although intradermal and serological allergen tests were negative at presentation.

Microbial colonization aggravates the clinical signs of AD in humans and dogs. The role of superantigens is of particular interest, because their presence is associated with particularly severe AD in humans.[6] Superantigens

induce polyclonal T cell and B cell activation, and topical application to both mice[25] and humans[26,27] induces inflammation. Furthermore, they may favour a Th2-skewed immune response, facilitating an IgE response to staphylococcal antigens and possibly other environmental allergens. Simultaneous cutaneous application of SEB together with house dust mite antigen lowers the threshold for a positive reaction in humans.[28] Epicutaneous application of SEB to mice increases expression of the Th2 cytokine interleukin-4, with no detectable interferon-γ.[25] A later study using the same model yielded evidence of a mixed T-helper 1 (Th1) and Th2 response, but application of SEB led to a heightened IgE response to ovalbumin that was attributable to the superantigen.[29] Finally, addition of toxic shock syndrome toxin-1 to peripheral blood mononuclear cells (PBMC) cultures from atopic patients significantly increased pollen-specific IgE production.[30] Similar superantigens are produced by canine staphylococcal isolates, and further studies to show whether they influence IgE responses in canine AD are required.

As with humans,[31] no particular strain of *S. pseudintermedius* is associated with colonization of the skin of atopic dogs.[12] Although the superantigen profile of canine isolates has been the subject of a number of recent studies, the differing methodologies employed make conclusions difficult to interpret. A study in which SEA, SEB, SEC, SED and toxic shock syndrome toxin-1 were reported in canine isolates was undertaken using a commercial reversed passive latex agglutination toxin detection kit;[13] most of the other reports, in contrast, employed PCR. As *se-int* shares >50% homology with SEC and SEB, and this enterotoxin-related gene is present in all isolates according to one study[14] (and, indeed, was present in the strain used for the studies reported herein), this could raise questions regarding studies employing less specific methodology. Recently, a novel exfoliative toxin (EX1), which selectively digests canine desmoglein 1, was reported from an isolate from a dog with impetigo.[32] This is distinct from the previously described *S. intermedius* exfoliative toxin (SIET) that is reportedly produced by all canine strains.[33] It is clear that much more work is necessary to identify all of the superantigens present in canine isolates of *S. pseudintermedius* precisely, to document their prevalence and to assess their biological activity and possible correlates with disease phenotype.

In conclusion, this study has shown that dogs suffering from canine AD show a significantly increased IgE response to staphylococcal antigens. It is likely that this response plays an important role in the pathogenesis of canine AD. Further studies are, however, required to define the immune response to specific staphylococcal antigens and superantigens involved in canine AD.

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Résumé

Contexte – Les chiens et les hommes atteints de dermatite atopique (AD) sont prédisposés à la colonisation et aux infections récurrentes à *Staphylococcus* spp. Les études chez l'homme suggèrent qu'une immunoglobuline E (IgE) spécifique de staphylococcus joue un rôle clé dans la pathogénie de la maladie. Peu d'étude de ce genre ont été menées chez le chien.

Hypothèses/Objectifs – Le but de cette étude était de comparer les taux d'IgE spécifiques de staphylococcus et les immunoglobulines G (IgG) chez les chiens atopiques (AD), non-atopiques avec pyodermite staphylococcique et contrôles non-atopiques et non-infectés.

Sujets – Les sera ont été prélevés sur 108 chiens atopiques, 39 chiens non-atopiques avec pyodermite staphylococcique secondaire à différentes conditions sous-jacentes, 67 chiens contrôles non-atopiques et neufs chiens contrôles élevés dans des conditions infectieuses minimales.

Méthodes – Les anticorps sériques IgG et IgE spécifiques de *Staphylococcus pseudintermedius* ont été mesurés par ELISA (enzyme-linked immunosorbent assay).

Résultats – Les chiens avec AD avaient des taux d'IgE anti-staphylococciques significativement plus élevés que les chiens non-atopiques avec une pyodermite et que les deux groupes de chiens contrôles. Les taux d'IgG anti-staphylocoques étaient significativement plus élevés chez les chiens atopiques et non-atopiques avec pyodermite comparé aux chiens contrôles non-atopiques et contrôles élevés dans des conditions infectieuses minimales mais il n'y avait aucune différence significative des taux d'IgG anti-staphylococciques entre les chiens avec AD et non-atopiques avec pyodermite.

Conclusions et importance clinique – Une réponse significativement augmentée des IgE aux antigènes de *S. pseudintermedius* chez les chiens atopiques suggère un rôle immunopathogénique des IgE anti-staphylococciques. L'élévation des IgE et IgG des chiens atopiques est également important en prélude aux études de la spécificité antigénique et des corrélations possibles avec le phénotype de la maladie.

Resumen

Introducción – perros y humanos con dermatitis atópica (AD) están predispuestos a la colonización e infección recurrente con *Staphylococcus spp*. Estudios en humanos sugieren que la inmunoglobulina E específica de estafilococos (IgE) juega un papel decisivo en la patogenia de la enfermedad. Pocos estudios se han realizado en perros.

Hipótesis/objetivos – el propósito de este estudio fue comparar niveles de IgE específica de estafilococos e inmunoglobulina G (IgG) en perros con AD, perros no atópicos con pioderma estafilococica, y perros no atópicos no infectados como control.

Animales – se obtuvo suero de 108 perros con AD, 39 perros no atópicos con pioderma estafilococica secundaria a otras diferentes condiciones, 67 perros control no atópicos pareados por edad, y nueve perros control alojados en condiciones de mínima enfermedad.

Métodos – los anticuerpos IgE e IgG específicos frente a *Staphylococcus pseudintermedius* se midieron en el suero mediante ensayo de inmunoabsorción ligado a enzimas.

Resultados – los perros con AD tenían niveles significativamente mayores de IgE frente a estafilococos que los perros no atópicos con pioderma estafilococica y los dos grupos control. Los niveles de IgG frente a estafilococos fueron significativamente mayores en perros atópicos y no atópicos con pioderma, comparados con perros control no atópicos y perros control mantenidos en condiciones de mínima enfermedad,

pero no hubo diferencias significativas en los niveles de IgG frente a estafilococos entre perros con AD y perros no atópicos con pioderma.
Conclusiones e importancia clínica – una respuesta significativamente aumentada de IgE frente a antígenos de *S. pseudintermedius* indica un papel inmunopatogénico para la IgE frente a estafilococos. El hallazgo de niveles elevados de IgE e IgG en perros atópicos también es importante como preludio para estudios acerca de la especificidad antigénica y una posible correlación con el fenotipo de la enfermedad.

Zusammenfassung
Hintergrund – Hunde und Menschen mit atopischer Dermatitis (AD) sind für eine Kolonisierung und wiederkehrende Infektion mit *Staphylokokkus* spp. prädisponiert. Studien beim Menschen liefern Hinweise dafür, dass Staphylokokken-spezifisches Immunglobulin E (IgE) eine Schlüsselrolle in der Pathogenese der Erkrankung spielt. Bei Hunden wurden erst wenige Studien dieserart durchgeführt.
Hypothese /Ziele – Das Ziel dieser Studie war es, die Werte von Staphylokokken-spezifischem IgE und Immunglobulin G (IgG) bei Hunden mit AD, bei nicht atopischen Hunden mit Staphylokokkenpyodermie, sowie bei nicht-atopischen und nicht-infizierten Kontrollhunden zu vergleichen.
Methoden – Es wurden spezifische IgE und IgG gegen *Staphylokokkus pseudintermedius* im Serum mittels Enzyme-linked Immunosorbent Assay gemessen.
Ergebnisse – Hunde mit AD hatten signifikant höhere Werte an Anti-Staphylokokken IgE wie nicht-atopische Hunde mit Staphylokokkenpyodermie und wie die zwei Gruppen an Kontrollhunden. Die Werte an Anti-Staphylokokken IgG lagen bei atopischen und nicht atopischen Hunden mit Pyodermie signifikant höher als bei den nicht atopischen Hunden und den Kontrollhunden, die unter geschützten Bedingungen aufgewachsen waren; es bestand kein signifikanter Unterschied zwischen den Werten der Anti-Staphylokokken IgG bei den Hunden mit AD und den nicht-atopischen Hunden mit Pyodermie.
Schlussfolgerungen und klinische Bedeutung – Eine signifikant erhöhte IgE Antwort auf *S. Pseudintermedius* Antigene bei atopischen Hunden weist auf eine immunpathologische Rolle des Anti-Staphylokokken IgE hin. Das Vorkommen von erhöhten IgE und IgG bei atopischen Hunden spielt auch eine wichtige Rolle als Vorläufer für Studien über die Spezifität des Antigens und die möglichen Korrelationen mit dem Phänotyp der Erkrankung.

要約
背景 – ヒトと犬のアトピー性皮膚炎（AD）では*Staphylococcus* spp.による再発性感染症や定着が起こりやすくなる。ヒトの研究ではブドウ球菌特異的免疫グロブリンE（IgE）が疾患の発生の鍵となる役割を果たしていることが示唆されている。同様の研究が犬でおこなわれたことはほとんどない。

仮説/目的 – この研究の目的はAD群、ブドウ球菌性膿皮症の非アトピー犬群、対照の非アトピー性皮膚炎群ならびに非感染犬群の間でブドウ球菌ブドウ球菌特異的IgEと免疫グロブリンG（IgG）を比較することである。

供与動物 – 108頭のAD犬、39頭のアトピー性皮膚炎以外の基礎疾患を持ち二次的なブドウ球菌性膿皮症に罹患した犬、67頭の年齢の一致した非アトピー性皮膚炎の対照犬、9頭のほとんど疾患を示さない対照犬の血清を採取した。

方法 – *Staphylococcus pseudintermedius*-特異的IgEとIgG抗体を酵素免疫測定法で測定した。

結果 – AD群の抗ブドウ球菌IgEの抗体価は，ブドウ球菌性膿皮症群ならびに対照群と比較し有意に高かった。抗ブドウ球菌IgGの抗体価は，アトピー群と膿皮症群では，非アトピー性皮膚炎対照群と疾患をもたない群と比較し有意に高かったが、AD群と膿皮症の非アトピー群との間では有意差はなかった。

結論と臨床的な重要性 – 犬のアトピー性皮膚炎群で *S. pseudintermedius* 抗原に反応して有意に上昇したIgEは，抗ブドウ球菌IgEに対して免疫病因的な役割を果たしていることが示唆された。アトピー性皮膚炎群でのIgEとIgGの上昇の所見も抗原特異性と疾患表現型との考えられる相関を研究するための準備段階として重要である。

摘要

背景 – 犬和人的异位性皮炎异位性皮炎（AD）容易被葡萄球菌定植和复发性感染。人类研究表明葡萄球菌特异性免疫球蛋白E（IgE）在疾病发病机制起着关键作用。而犬这方面的研究较少开展。

假设/目的 – 本研究旨在比较异位性皮炎、葡萄球菌脓皮病无异位性皮炎患犬和无异位性皮炎且未受感染的健康犬，其葡萄球菌特异性IgE和免疫球蛋白G（IgG）的水平。

动物 – 血清收集自108只异位性皮炎患犬、39只继发于不同潜在病因的葡萄球菌脓皮病无异位性皮炎患犬、67只年龄一致的无异位性皮炎的健康犬和9只后躯少量病变的对照犬。

方法 – 使用酶联免疫吸附试验测定血清假中间型葡萄球菌特异性IgE和IgG抗体。

结果 – 异位性皮炎患犬抗葡萄球菌IgE水平显著高于葡萄球菌脓皮病无异位性皮炎患犬和两个对照组的犬。异位性皮炎患犬和无异位性皮炎的脓皮病患犬与无异位性皮炎对照犬和后躯少量病变的对照犬相比，抗葡萄球菌IgG水平明显较高，但在异位性皮炎患犬和无异位性皮炎的脓皮病患犬之间，抗葡萄球菌IgG水平没有显著差异。

结论和临床价值 – 异位性皮炎患犬对假中间型葡萄球菌抗原反应的IgE显著升高，显示抗葡萄球菌IgE是一个免疫病因。异位性皮炎患犬中IgE和IgG升高也一样重要，因此拉开了抗原特异性和疾病表型相关性的研究序幕。