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Correlation Between Serum and Salivary House Dust Mite Specific Immunoglobulins in Allergic Rhinitis (AR) Patients and Non-Allergic Rhinitis Matched Controls

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Abstract

Background and objectives: Allergic rhinitis (AR) is characterised by inflammation of the nasal mucosa associated with IgE mediated immune response to specific allergens. Studies have shown that the most commonly implicated aeroallergens in AR are house dust mites. *Dermatophagoides pteronyssinus* (Dp), *Dermatophagoides farinae* (Df) and *Blomia tropicalis* (Bt) are the three most common mite species in Malaysia. Previous studies have reported the presence of high IgE and non-IgE antibodies in both serum and saliva samples of AR patients, but the correlation between them is not clear. The objective of this study was to determine the levels and correlation of mite specific IgE and IgA against *D. farinae* and *B. tropicalis* in serum and salivary samples of AR patients and non-allergic rhinitis matched controls.

Methods: A total of 205 adults were studied, they included 103 with AR and 102 healthy controls matched for age and gender. Among the 103 AR patients, 20 had concomitant asthma. Indirect ELISA was used to measure the levels of serum and salivary IgE and IgA respectively.

Results: Correlation between the serum and salivary antibody levels was analysed using Spearman correlation test, while the differences between groups were analysed using Mann-Whitney test and Kruskal Wallis test. Serum IgE and IgA levels against *D. farinae* and *B. tropicalis* were higher in AR patients. Salivary IgA against *D. farinae* and salivary IgE against *B. tropicalis* were significantly higher in AR patients. Serum and salivary IgE levels were positively correlated with serum and salivary IgA levels in AR subjects against both mite species. There was no significant difference in antibodies levels between asthmatic AR and non-asthmatic AR to both mite species in serum and saliva samples. Antibodies levels were not correlated with severity of signs and symptoms in AR patients.

Conclusion: The presence of high IgA level in saliva might be a potential investigation tool to test for allergic rhinitis when blood sampling is not an option.

Keywords: Allergic rhinitis; *Dermatophagoides pteronyssinus*; *Dermatophagoides farina*; *Blomia tropicalis*; Serum immunoglobulins; Salivary immunoglobulins

Introduction

Allergic rhinitis is clinically characterised by watery runny nose with two or more of the following symptoms such as sneezing, nasal obstruction and nasal itching [1]. Allergic rhinitis is estimated to affect 20% of the population in the USA and Europe [2] and in some other countries it can affect up to 50% of the population [3]. Nevertheless, the prevalence of this condition is increasing over time. Allergic rhinitis often co-exists with asthma and it increases the risk for asthma exacerbations. In a study done in Malaysia, it revealed that 28.8% of the adult rhinitis patients had concomitant history of asthma [4]. The prevalence of allergic rhinitis in asthmatic patients is as high as 80-90% [5]. There are many allergens found in the environment that can cause allergic rhinitis such as house dust mites, cockroach, cat or dog's dander, pollens, food and also mould spores. According to the Allergy Centre of Malaysia, house dust mite is the most common allergen which causes 85% of all allergic rhinitis cases [6]. The most common house dust mite species found worldwide include *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae* and *Euroglyphus maynei* [7]. In Malaysia, Blomia tropicalis was found to be the most densely populated species followed by *D. pteronyssinus* [8]. Malaysia is located at tropical region, thus the risk of exposure to house dust mites is a major concern. Nonetheless, house dust mites are also well-known to induce other atopic diseases such as asthma, atopic conjunctivitis and atopic dermatitis [9]. Allergic rhinitis is a response ultimately mediated by IgE but studies have shown that allergens derived from house dust mite are potential immunogens that are recognised not only by IgE but also IgA and IgG subclasses in allergic individuals [10]. Several studies

have reported that serum IgA and IgG levels were significantly increased in allergic patients [10,11]. A previous study has managed to detect a 928.4% mean augmentation of IgE in saliva of allergic patients compared to healthy subjects [12]. Similar findings were also reported for IgA and IgG in saliva samples [10,13]. Kitani et al. demonstrated that mite-specific IgA in serum and sputum samples were higher in mite-sensitive patients than in normal controls [11]. Although many studies have been done on allergic rhinitis but the idea of association between serum and salivary immunoglobulins in these patients is still vague. One of the studies has managed to detect a correlation between IgE levels of salivary and nasal symptoms in allergic rhino-conjunctivitis patients [14], whereas in the other study, remarkable increase of salivary IgE in allergic syndromes was reported [12]. Moreover high IgA levels were detected in serum and sputum samples in allergic patients. All these evidences lead to the idea of using salivary antibodies in the diagnosis of allergic rhinitis when blood samples are not available in any circumstances.

Methodology

The institutional ethical Committees approved this descriptive comparative study. Informed consent was obtained from the patients as well as all the control subjects. A total of 103 allergic rhinitis patients with and without mild to moderate asthma who attended the otolaryngology outpatient clinic was recruited. The inclusion criteria included male and female patients from three major ethnic groups who aged from 18-65 years old. Besides that, allergic rhinitis was diagnosed clinically according to ARIA guidelines.

Patients were allowed to clarify any of their concern before giving consent. Finally, a detailed history taking and endoscopic nasal examination on those who agreed to participate were performed by a qualified physician. Patients who are pregnant or lactating, have a previous history of anaphylaxis and severe chronic obstructive pulmonary disease (COPD) were excluded from this study. Besides that, 102 of gender and age matched healthy controls who consented to participate in this study were also recruited. The matched healthy controls must not have history of asthma, allergic rhinitis, skin allergies, anaphylaxis and COPD.

A data collection sheet was prepared to record the patient's demographic and epidemiological data. The clinical history and physical examination findings were also recorded by a qualified physician. Based on ARIA 2008 updated guidelines, the patients were categorised into intermittent or persistent, mild to moderate-severe according to the severity of their symptoms and how badly it affected their lifestyle.

Collection of blood and saliva

After demographic data collection and physical examination, 5 mL of blood was withdrawn from median cubital vein of each subject. The blood was transferred into IMPROVACUTER® Blood Collection Tube without additive (Improve, China) and allowed to clot for 30 min at room temperature. The samples were then kept in a cooler box while transferred from the clinic to the laboratory. The serum was collected after centrifugation at 3000 rpm at 4°C for 10 min using a refrigerated centrifuge (Sigma, USA). The serum was stored in -20°C freezer until further uses.

Subject was instructed to pool his/her saliva in the mouth and allowed the saliva to drool down through a straw into a sputum container (Gongdong, China). This step was repeated until approximately 5 mL of sample was collected. The supernatant was collected after centrifuging the saliva at 5000 rpm at 4°C for 15 min. The supernatant was stored in -20°C freezer until further immunological assay.

Culturing and harvesting of house dust mites

The live mites (*Dermatophagoides farinae* and *Blomia tropicalis*) were cultured and maintained in fish flasks (TetraMin Crisps, Germany) at 25°C and 75% relative humidity. The cultures were checked regularly under a stereomicroscope (Nikon, Japan) to ensure maximal growth and to prevent any contamination. Routine sampling (once a week) of the mites from the culture flasks for cross-contamination was performed by clearing and placing the mites on a drop of Hoyer's medium on a microscope slide.

Live mites were harvested using the floatation technique. The floating layer of mites and faecal pellets were filtered through filter paper of 10 µm pore size (Whatman, England) with multiple rinses of ultrapure water in order to remove the residual salt. The mites and faecal pellets were air-dried and were either placed into 1.5 mL microcentrifuge tube (Eppendorf, Germany) to be stored at -80°C freezer for further use or proceed to homogenising process.

The protein concentration of the mite extract was quantified using Quick Start™ Bradford assay (Bio-Rad Laboratories, Hercules, CA) according to manufacturer's protocol.

Quantification of mite specific immunoglobulins

Mite specific serum and salivary IgE and IgA were determined using indirect ELISA method. Immunolon-2HB Removable strips (Sigma-Aldrich Corporation, USA) were coated with crude mite extract prepared earlier in coating buffer at concentration of 0.1 µg/µL (50 µL) per well overnight at 4°C.

Data analysis

Statistical analysis was performed using IBM® SPSS® Statistics version 20 (IBM cooperation, US). Since the antibody levels were not distributed normally, therefore non-parametric test was used to analyse the data. Correlation between the serum and salivary antibody levels were analysed using Spearman correlation test, whereas the differences between groups were analysed using Mann-Whitney test and Kruskal Wallis test.

Results

Concentration of crude mite extracts

The concentrations of mite extracts were determined using Bradford assay. *D. farinae* and *B. tropicalis* were found to have concentration 15.4 and 1.74 µg/µL respectively.

Subject data

The demographic and clinical characteristics of the recruited subjects are shown in Table 1. A total of 103 allergic rhinitis patients with mean age of 37.70 years (Standard deviation, SD=13.62) were successfully recruited based on their clinical signs and symptoms. Besides that, 102 of age and gender matched healthy control subjects were also recruited. The majority of the patients (n=35, 33.98%) fell into the youngest age group (18-26 years), a steady increase of number

of patients were observed as the age increased from age groups 27-53 except for the oldest age group . Of all the allergic rhinitis patients, 66% of them were female and 34% were male. Malay (~ 44%) patients made up the most for the recruited cohort, followed by Indian (~ 37%), Chinese (~ 17%) and others (~ 2%). Most of the allergic rhinitis patients were on antihistamines (82.5%) and nasal steroids (74.8%) (Table 1).

	Groups	
Characteristics	**Allergic Rhinitis**	**Control**
Number of subjects, n	103	102
Gender (M:F)	34: 66	35: 65
Age, years	37.70 ± 13.62	38.36 ± 13.63
(Mean ± SD)		
Asthma	19.00%	
Clinical symptoms		
Sniffling, nasal block	74.80%	
Throat clearing		
Allergic shiners	31.10%	
Nasal crease	19.40%	
Nasal examination		
Mucosal swelling	78.20%	
Pale thin secretions	60.80%	
Other abnormalities	60.80%	
Cobble stone appearance	42.60%	
Post nasal drip	34.30%	
Rhonchi	2.00%	
ARIA classification		
Persistent moderate-severe	49.51%	
Intermittent moderate-severe	29.13%	
Intermittent mild	14.56%	
Persistent mild	6.80%	
Medication history		
Antihistamines	82.50%	
Nasal steroids	74.80%	
Nasal decongestants	5.80%	
Steroid inhaler	3.90%	
Leukotriene antagonist	2.90%	

Table 1: Demographic data and clinical characteristics of the recruited subjects.

Patients mainly suffered from sneezing (95.1%) followed by nasal discharge (84.5%), nasal block (79.6%), nasal itching (73.8%) and eye symptoms (72.8%). Among the 103 allergic rhinitis patients, 20 of them were diagnosed with asthma. Additionally, 74.8% of the allergic rhinitis patients showed signs of sniffling or throat clearing during clinic visit. Most of the patients were found to have mucosal swelling (78.2%) and pale thin secretions (60.8%) during ear, nose and throat examination (Table 1).

About half of the patients (~ 50%) were having persistent moderate-severe symptoms, followed by intermittent moderate-severe (~ 29%), intermittent mild (14%) and persistent mild (7%) as shown in Table 1.

The most common allergenic triggers recalled by the majority of the patients were dust (72.82%) and temperature change (59.22%). Furthermore, food (15.33%), strong smell (8.74%), smoke (2.91%), trauma (2.91%) and pet's dander (0.91%) were other allergenic triggers that affected minority of the patients.

Looking at the impact of daily activities due to allergic rhinitis by life style factors listed in ARIA 2008 guidelines, the majority of the patients agreed that the symptoms were troublesome (73.70%). In addition to that, more than half of the patients complained that allergic rhinitis lead to impairment to their daily activities (63.20%), work or school performance (61.10%) and sleep disturbances (51.60%).

Sensitisation profiles to *D. farinae* and *B. tropicalis* of the recruited subjects

The sensitisation rate of allergic rhinitis patients and control subjects to *D. farinae* and *B. tropicalis* in serum and saliva samples are summarized in Table 2. ELISA results of the allergic rhinitis patients revealed higher sensitisation to *B. tropicalis* (23.5%) than to *D. farinae* (20.6%). Similar sensitisation rates were observed for *B. tropicalis* (13.9%) and *D. farinae* (5.9%) determined using saliva samples. However, this was the opposite for the control serum (*D. farinae*: 5.8% versus *B. tropicalis*: 2.0%) and salivary (*D. farinae*: 13.0% versus *B. tropicalis*: 9.0%) samples. All subjects in both groups had serum and salivary IgA above cut-off points to *D. farinae* and *B. tropicalis*.

		Groups		
	Allergic rhinitis		**Controls**	
	Df	**Bt**	**Df**	**Bt**
Serum IgE	20.60%	23.50%	5.80%	2.00%
Salivary IgE	5.90%	13.90%	13.00%	9.00%
Serum IgA	100.00%	100.00%	100.00%	100.00%
Salivary IgA	100.00%	100.00%	100.00%	100.00%

Table 2: Sensitisation rates of the recruited subjects against D. farinae and *B. tropicalis*, Df - *D. farina*, Bt - *B. tropicalis*, Cut-off point Df IgE=0.0716*, Cut-off point Df IgA=0.0463*, Cut-off point Bt IgE=0.0580*, Cut-off point Bt IgA=0.0438*, *Mean ± 3 Standard Deviations.

IgE levels against *D. farinae* and *B. tropicalis*

Levels of serum IgE against *D. farinae* extract were significantly higher in allergic rhinitis patients (OD geometric mean [gm]: 0.0552) than control subjects (OD gm: 0.0288; $p<0.01$). Similarly, this was also

observed for the levels of serum IgE against B. tropicalis (OD gm: 0.0413 versus 0.0171; p<0.01). The levels of mite-specific salivary IgE were higher in allergic rhinitis patients compared with control subjects. However, the results were only significant for B. tropicalis (OD gm: 0.0426 versus 0.0382; p<0.05) but not for *D. farinae* (OD gm: 0.0414 versus 0.0407; p>0.05) (Table 3).

		Groups		
Antibodies	**Allergic (N=103)**		**Control (N=102)**	
	Mean rank	**Mean ± SD**	**Mean rank**	**Mean ± SD**
			(OD)	**(OD)**
Serum anti-Df IgE	140.12**	0.063 ± 0.049	63.50**	0.037 ± 0.057
Salivary anti-Df IgE	105.71	0.045 ± 0.026	96.25	0.051 ± 0.046
Serum anti-Df IgA	111.44*	0.970 ± 0.400	92.47*	0.840 ± 0.400
Salivary anti-Df IgA	123.22**	2.200 ± 0.500	74.54**	1.780 ± 0.390
Serum anti-Bt IgE	145.36	0.048 ± 0.036	58.21**	0.019 ± 0.012
Salivary anti-Bt IgE	109.50*	0.045 ± 0.016	92.42*	0.041 ± 0.016
Serum anti-Bt IgA	113.77**	0.520 ± 0.350	90.11**	0.390 ± 0.230
Saliva anti-Bt IgA	92.53	1.140 ± 0.490	105.68	1.250 ± 0.490

Table 3: Mean rank and mean of different antibodies in allergic rhinitis patients and control subjects against *D. farinae* and *B. tropicalis* (Mann Whitney U Test), *Mean rank difference was significant at the 0.05 level (2-tailed), **Mean rank difference was significant at the 0.01 level (2-tailed), OD=Optical density.

The correlation of antibodies level between *D. farinae* and *B. tropicalis* in allergic rhinitis and control subjects are shown in Table 4. When analysing correlation of IgE levels between *D. farinae* and *B. tropicalis* in allergic rhinitis patients, the levels of serum anti-*D. farinae* IgE showed weak positive correlation with serum anti-*B. tropicalis* IgE (r=0.254; p<0.05). However, there was no correlation found for saliva IgE samples.

Whereas in control subjects, serum anti-*D. farinae* IgE was weakly correlated with serum anti-*B. tropicalis* IgE (r=0.458; p<0.01) and moderately correlated for saliva samples (r=0.520; p<0.01) (Table 4).

Correlation between different antibodies to *D. farinae* and *B. tropicalis* in patients and control subjects were also determined (Table 5). It was found that serum IgE levels were weakly and positively correlated to IgA for both allergens in allergic rhinitis (Df: r=0.247, p< 0.05; Bt: r=0.331, p<0.01) and control subjects (Df: r=0.294, p<0.01; Bt: r=0.423, p<0.01). Similarly, correlation between salivary IgE and IgA also shared the same findings in allergic rhinitis (Df: r=0.434, p<0.01; Bt: r=0.488, p<0.01) and control subjects (Df: r=0.207, p<0.05; Bt: r=0.375, p<0.01).

The correlation between serum and salivary antibodies against *D. farinae* and *B. tropicalis* in allergic rhinitis and control subjects are summarized in Table 6. There were no correlations between serum and salivary IgE levels against *D. farinae* (r=-0.009; p>0.05) and *B. tropicalis* (r=0.010; p>0.05) in allergic rhinitis patients. However, a weak correlation was found between serum and salivary IgE levels against *D. farinae* (r=0.346; p<0.01) but not for *B. tropicalis* (r=0.154; p>0.05) in control subjects.

Levels of serum IgA against *D. farinae* and *B. tropicalis* were significantly higher in allergic rhinitis patients (OD gm: 0.8913 and OD gm: 0.4339, respectively) than control subjects (OD gm: 0.7289, p<0.05 and OD gm: 0.3320, p<0.01 respectively). Likewise, salivary IgA levels against *D. farinae* were significantly higher in patients (OD gm: 2.1349) compared with control subjects (OD gm: 1.7184, p<0.01). There was no difference between salivary IgA levels against B. tropicalis in allergic patients (OD gm: 1.0356) and control subjects (OD gm: 1.1505, p>0.05).

Correlation of serum and salivary IgA levels between *D. farinae* and *B. tropicalis* in patients and control subjects are shown in Table 4. There was a strong positive correlation between levels of serum IgA against *D. farinae* and *B. tropicalis* in allergic rhinitis patients (r=0.810; p<0.01) and control subjects (r=0.782; p<0.01). Furthermore, the correlations found in salivary IgA against *D. farinae* and *B. tropicalis* in patients (r=0.698; p<0.01) and control subjects (r=0.568; p<0.01) were moderately positive.

					D. farinae			
	Allergic rhinitis				**Controls**			
	Serum		**Saliva**		**Serum**		**Saliva**	
	IgE	**IgA**	**IgE**	**IgA**	**IgE**	**IgA**	**IgE**	**IgA**
	r=0.254*	r=0.810*	r=0.122	r=0.698*	r=0.458*	r=0.782*	r=0.520*	r=0.568*
B. tropicalis	p<0.05	p<0.01	p>0.05	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01

Table 4: Spearman correlation of antibodies levels between *D. farinae* and *B. tropicalis* in allergic rhinitis patients and control subjects, *Mean rank difference was significant at the 0.05 level (2-tailed), **Mean rank difference was significant at the 0.01 level (2-tailed).

There were weak and positive correlations between serum and salivary IgA against B. tropicalis in both allergic rhinitis patients (r=0.280; p<0.01) and control subjects (r=0.257; p<0.05). On the other hand, there were no correlations between serum and salivary IgA against *D. farinae* in both patient and control groups (Table 6).

IgE & IgA	Correlation (r)	
	Patients	Controls
Anti-Df IgE vs Anti-Df IgA	0.247*	0.294**
Sal- Anti-Df IgE vs Sal- Anti-Df IgA	0.434**	0.207*
Anti-Bt IgE vs Anti-Bt IgA	0.331**	0.423**
Sal- Anti-Bt IgE vs Sal- Anti-Bt IgA	0.488**	0.375**

Table 5: Spearman correlation for serum and salivary (Sal-) IgE and IgA against *D. farinae* and *B. tropicalis* in allergic rhinitis patients and control subjects, *Correlation was significant at the 0.05 level (2-tailed), **Correlation was significant at the 0.01 level (2-tailed).

IgE and IgA levels of asthmatic allergic rhinitis patients

A subset of allergic rhinitis patients with asthma (N=20) was used for the comparison of the difference in mite-specific antibodies levels with patients who were suffering allergic rhinitis alone. There were no differences in serum and salivary IgE and IgA levels between the two subsets against *D. farinae* and *B. tropicalis*. There was also no correlation between serum and salivary mite-specific antibodies in the asthmatic subset.

	Allergic rhinitis (serum)				Control (serum)			
	IgE		IgA		IgE		IgA	
	Anti-Df	Anti-Bt	Anti-Df	Anti-Bt	Anti-Df	Anti-Bt	Anti-Df	Anti-Bt
	r=0.009	r=0.010						
Saliva	p>0.05	p>0.05	p>0.05	p<0.01	p<0.01	p>0.05	p>0.05	p<0.01

Table 6: Spearman correlation between serum and salivary IgA and IgE levels against *D. farinae* and *B. tropicalis* in allergic rhinitis patients and control subjects, *Correlation was significant at the 0.05 level (2-tailed).

Interpretation of clinical signs and symptoms of allergic rhinitis patients

Serum and salivary antibodies levels against *D. farinae* and *B. tropicalis* between different severity levels of the clinical signs and symptoms were analysed. It was found that there were no significant differences between antibodies levels in different severity levels for nasal discharge, sneezing, nasal block and nasal itching. There were no differences in serum and salivary IgE and IgA levels against both mite species between different ARIA subgroups. Additionally, no correlation was found between antibodies levels and ARIA subgroups.

Discussion

The knowledge regarding allergen specific antibodies level especially IgE subclass was well-known to be associated with the manifestation of atopic diseases. Although many articles have confirmed that mite-specific serum IgE has increased remarkably in patients that were sensitised to house dust mites, the presence of salivary IgE antibody and other subclass such as IgA was less studied, not to mention about the relationship between serum and salivary antibodies or among antibody isotypes. Furthermore, as the prevalence of allergic diseases especially allergic rhinitis is on the rise, symptomatic treatment will not be the best solution to effectively halt the progress of this disease. Studies in the field of atopic diseases were more commonly done for younger age groups such as infants and children as compared to adults.

In the current study, house dust mite specific antibodies levels were assessed in allergic rhinitis patients of young adult to middle aged groups. The majority of the allergic rhinitis patients fell into the youngest age group (18-26 years) and lesser patients in the older age groups. In our study, dust appeared to be the predominant trigger among allergic rhinitis patients. A previous study in Malaysia showed that house dust mites accounted for 70% of the positive skin prick test which again confirmed that it was the most commonly implicated aeroallergen [15]. Besides that, several studies that looked into the house dust mite fauna in Malaysia and Singapore homes found that *B. tropicalis* was the most prevalent species followed by *D. pteronyssinus* [8,16]. Furthermore, regarding the sensitisation profiles of Malaysian and Singaporean subjects, Yeoh et al. (2003) concluded that dual sensitisation to both *D. pteronyssinus* and *B. tropicalis* were common in the general populations [17]. Although the current study was conducted on a different Dermatophagoides species, sensitisation to *B. tropicalis* was still found to be higher compared with *D. farinae* which again confirmed that Malaysian are sensitised more to Blomia species than Dermatophagoides species.

Patients who were suffering from allergic rhinitis had significant higher serum IgE levels against *D. farinae* and *B. tropicalis* compared with control subjects. Besides that, IgE level in saliva was found to be higher in allergic rhinitis patients which suggested that IgE might be produced locally at the oral mucosa or passively transferred from serum or nasal secretions. However, this was only true in patients that were sensitised to *B. tropicalis* but not *D. farinae*. This result favours the finding from one of the previous study which showed increased salivary and tear IgE levels in allergic group [14].

In the current study, serum IgA levels to both species were higher in allergic rhinitis patients as compared with control subjects. This is also true for salivary IgA against *D. farinae* but not *B. tropicalis*. A few studies reported similar results where IgA levels were higher in allergic patients compared with non-allergic subjects [11,13]. Furthermore, in the present study detection rate for IgA level was higher compared with IgE and the positive correlation between both antibodies were also recorded. Possible explanation for those findings can be due to better stimulation of specific IgA by the allergen or probably reflecting a persistent antigenic stimulation of the respiratory mucosa. Despite of the similar results from previous studies, there are actually few studies that reported contrasting results. Ludviksson et al. found that the correlation of lower IgA and increase allergy manifestation is stronger at age of 2 but this association is no longer present after 2 years of follow-up [18] which suggested that levels of IgA also depend on the maturation of immune system. Thus, the role of non-IgE antibodies in pathogenesis of allergic diseases and their interaction with the immune system remains to be studied.

A weak but significant correlation was observed between serum and salivary IgA levels against *B. tropicalis* species in the current study. This corresponded to the results found in a cohort study that studied the serum and salivary immunoglobulins in pre-school children [18]. These findings probably suggest that secretory immune responses were also stimulated together with systemic immune responses in allergic subjects during the course of disease. However, this correlation is not found in patients sensitised to *D. farinae*. A difference in the sensitisation rates for both species was noted in allergic rhinitis patients. Therefore, this might account for the positive findings in the correlation between serum and salivary antibodies of *B. tropicalis* but not *D. farinae*. On the other hand, regarding IgE subclass, no correlation was found between serum and salivary antibodies. In addition to that, positive moderate to strong correlation between anti-D. farinae antibodies and anti-*B. tropicalis* antibodies were noted in the present study. These perhaps indicated that the allergenic cross-reactivity between both species was present to some extent.

Among the 103 allergic rhinitis patients, about 20% of the patients were found to be concomitantly affected by asthma. Since the relationship between allergic rhinitis and asthma is prominent, it is also interesting to find out whether patients who suffered from allergic rhinitis alone and those affected by both diseases has any difference in their antibodies level.

When patients with allergic rhinitis and asthma were studied separately, surprisingly, there were no differences regarding serum and salivary IgE and IgA levels against *D. farinae* and *B. tropicalis* in asthmatic and non-asthmatic rhinitis. Furthermore, no correlation was found between serum and salivary specific antibodies in asthmatic and non-asthmatic rhinitis patients. Possible explanation that accounted for these findings might be the relative small sample size of patients having allergic rhinitis and concomitant asthma.

When the patients in the current study were categorised according to ARIA guidelines, it was found that most patients were in the persistent moderate-severe category. There were no significant difference between the antibodies level and the severity of the signs and symptoms. Additionally, no correlation was found between severity of signs and symptoms and antibodies levels. There were also no differences in regards of the antibodies levels and the number of lifestyle factors affected. Most of our study subjects were on antihistamines and nasal steroids which might also account for the negative findings. Nonetheless, none of the patients were on systemic steroids.

Conclusion

The potential relationship between serum and salivary antibodies proposed that salivary IgA might be a useful tool to monitor levels of IgA during allergen-specific immunotherapeutic procedures when serum is not readily available.

Limitations of Current Study

Both allergic rhinitis patients and controls should be screened for their allergenic profiles using skin prick test prior to recruitment, so that same amount of patients that are allergic to each species can be selected accordingly to make valid comparison regarding the correlation of serum and salivary antibodies. Furthermore, patients on medication are not advisable to be recruited as their clinical signs and symptoms may be suppressed, thus interfering with the outcome of the results.

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