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Research Article

External Otitis Associated with Atopy Disease in Dogs: A Case-Control Study

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Abstract

Skin is an organ of living beings afflicted with various disorders such as atopic disease. Atopic disease results from an excess of immunoglobulin E produced due to excessive exposure to non-harmful environmental allergens that affect the skin of various organs, including the ear, leading to external otitis. During this case-control study, 50 dogs referred to clinics in Mazandaran province in Iran with symptoms of atopic otitis were the case group, and 50 dogs with healthy ears were considered the control group. The diagnosis was derived from the clinical findings of the case group, which included itchy skin, redness in the pubic and abdominal area, and ear swelling. The results indicated that 66% of dogs with atopic otitis were in the chronic stage of the disease. Furthermore, there is 4.63 times greater odds of wax secretions in cases of atopic otitis. Additionally, in the case of atopic otitis, the odds of odorous secretions is 5.1 times greater than that of odorless secretions. Lastly, most dogs with this condition had significantly dark ear secretions. Atopic otitis, therefore, is characterized by waxy, odorous and dark secretions in the ears of animals. In general, identifying the causative agent for this disease in dogs is extremely important and can prevent the application of costly and blind treatments. We conducted the first epidemiological study in Iran of external otitis associated with atopy in dogs. These results support a better understanding of the disease.

Keywords: Ear; Atopy; Dog; Otitis; Iran

Introduction

Skin is the largest and perhaps the most complex body organ, containing at least five types of cells in addition to immune and circulatory cells. The skin's primary function is to protect the body from chemical and physical agents, ultraviolet radiation, and free radicals. Moreover, it also plays a significant role in regulating body temperature, sensing and performing hormonal functions (vitamin D production). The skin consists of two distinct layers. Dermis contains connective tissue components and epidermis, which does not have blood vessels and is mainly made up of keratinocytes [1].

Atopic disease is an overproduction of immunoglobulin E in response to non-harmful allergens in the environment [2]. Despite the etiology of atopy being unclear, studies suggest genes are crucial in the development of the condition. Furthermore, epidermal destruction is also a contributing factor to the development of this complication. Upon destroying this layer, allergens penetrate underneath the epidermis into deeper layers [3]. The histopathological features of this complication include inflammation and urticaria in the skin, which are caused by the release of mediators, dilated blood vessels, proteins, and fluids from the arteries, as well as swelling and redness in the area [4] and affect as much as 10% of dogs [5]. As a result of this complication, various parts of the body are affected, including the external ear. Otitis externa is an inflammation of the outer ear canal that may cause pain, swelling of the ear canal, and hearing loss [6]. It is usually exacerbated by the movement of the outer ear [7]. Depending on the severity of the complication, it can be acute (lasting less than 6 weeks) or chronic [6]. Acute cases usually result from bacterial infections, and chronic cases are caused by allergies and autoimmune conditions [6,7]. The phenomenon of otitis externa is widespread in dogs and cats it should not only be considered as a local condition but also as the result of underlying factors as well. This condition may manifest as redness, cerumen discharge, itching, odor, and degrees of external ear canal stenosis. In these cases, the discharge appears pasty and ranges from yellow to brown, but no pus is present. Atopic dermatitis is the most common cause of otitis externa; however, food allergies, Demodex parasites, inadequate keratinization, hormonal imbalances, and neoplasms can also cause this condition [8].

Few epidemiological studies have investigated the predisposing factors for atopic otitis in dogs based on population in a case-control study method. Therefore, it is necessary to conduct an epidemiological study targeting a population in order to identify the predisposing factors of atopic otitis in dogs.

Materials and Methods

In the present study, a case-control design was used. This study was performed on 50 dogs with atopic otitis referred to Mazandaran province clinics as case groups and 50 dogs referred to these clinics without any ear disease as the control group. In the period between October 2020 and April 2022, we recorded the symptoms and factors. According to clinical signs, the cases were diagnosed as itching the body, redness in the abdominal and inguinal areas, and the ears. Research questions regarding risk factors associated with atopic otitis were compiled in a questionnaire developed by researchers. An analysis was conducted of the relationship between independent variables such as age, gender, breed, body size, ear condition, color, type, and smell of discharge with atopic otitis. To investigate the relationship between different independent variables associated with atopic otitis, such as age, sex, breed, body size, ear condition, color, type, and smell of discharge, Chi-square test ($\chi 2$ test), Fisher exact test, and logistic regression were conducted. Statistical analysis was performed using SPSS statistical software version 26 (SPSS Inc., Chicago, IL, USA). All analyses were conducted with a significance level of less than 0.05.

Results and Discussion

This study sampled one hundred dogs, including 50 with atopic otitis and 50 without it. Table 1 provides information about the relationship between independent variables and atopic otitis. It is evident from the table that there is no statistically significant difference between the studied groups in terms of age ($P > 0.05$). Furthermore, there was no statistically significant difference in gender between the groups ($P > 0.05$). Breed-wise, despite Terriers having the highest frequency, no significant relationship existed between these groups ($P > 0.05$). Additionally, a higher percentage of dogs in the case group (85%) and the control group (100%) had small body sizes, and the relationship between body size and the study groups was not statistically significant ($P > 0.05$). The results indicated that 66% of dogs with atopic otitis were in the chronic stage

of the disease. Atopic otitis, therefore, is characterized by a chronic form of otitis that usually lasts for several months. Using Fisher's exact test, the association between ear shape and otitis externa was not significant (P > 0.05). In addition, dogs with atopic otitis presented with dropped ears in 94% of cases, compared to 80% in the control group. This study shows a statistically significant correlation between the color, type, and smell of secretions (P < 0.05). The dogs suffering from otitis had a dark discharge of 60%, while the non-otitis dogs had a light discharge of 90%, indicating a statistically significant difference (P < 0.05). Regarding the consistency of secretions, most dogs with otitis had waxy cerumen; however, non-otitis dogs had dry cerumen, which showed a statistically significant difference (P < 0.05). Concerning the odor of secretions, however, a significant number of dogs with otitis had odorous secretions, whereas most dogs without otitis had odorless secretions, indicating a statistically significant difference (P < 0.05).

Variable	Category	Atopic Otitis		Normal	
		Absolute Frequency	Relative Frequency (%)	Absolute Frequency	Relative Frequency (%)
Age (years)	<2	28	56	15	30
	2-5	18	36	23	46
	5-8	4	8	12	24
Gender	Male	30	60	23	46
	Female	20	40	27	54
Breed	Terrier	33	66	25	50
	Shih tzu	3	6	5	10
	Shih tzu-Terrier	14	28	20	40
Body size	Large	8	16	0	0.0
	Small	42	84	50	100
Disease Stage	Acute	17	34	-	-
	Chronic	33	66	-	-
Ear Shape	Erected	3	6	10	20
	Pendant	47	94	40	80
Discharge color*	Dark	30	60	5	10
	Light	20	40	45	90
Type of discharge*	Waxy	46	92	4	8
	Dry	4	8	46	92
Discharge odor*	Negative	7	14	45	90
	Positive	43	86	5	10

Table 1: Descriptive and univariable logistic regression results for independent variables associated with atopic otitis in the two studied groups.

* P < 0.05 was considered statistically significant.

In order to identify the variables associated with atopic otitis, factors that had a P-value of less than 0.2 in the univariable analysis were included in the multivariable logistic regression analysis. The correlations between the variables in atopic otitis and non-otitis are shown in table 2, where a significant association between consistency, and odor of secretions and atopic otitis was found (P < 0.05). Based on the logistic regression analysis results, there is a 4.63 (95% CI: 1.02-21.02) times greater odds of wax secretions in cases of atopic otitis (P < 0.05). Additionally, in the case of atopic otitis, the odds of odorous secretions are 5.1 (95% CI: 7.56-20.73) times greater than that of normal dogs (P < 0.05). Lastly, most dogs with this condition had significantly dark ear secretions (P < 0.05).

Atopic otitis is therefore characterized by the presence of dark waxy secretions, and odorous secretions in the ears of infected dogs.

Atopy is an excessive production of immunoglobulin E in response to non-harmful allergens in the environment [2]. Atopic dermatitis and, less frequently, adverse food reactions are regarded as the most common primary causes of otitis externa in dogs [9]. Approximately 90% of the bilateral or unilateral external otitis cases in referring animals are caused by atopic dermatitis or food allergies [10]. In most referral cases, history and clinical examination indicate that the patient has inflammation and itching in other parts of the body concerning issues with atopic dermatitis and food allergies. In addition, it has been reported that up to 55% of dogs suffering from atopic dermatitis also suffer from otitis externa at the same time, of which 3 to 5% are the only clinical sign [10]. Furthermore, a study found that among dogs with Pseudomonas infections, allergies, masses, endocrine conditions, and autoimmune diseases are the most common causes of otitis. Compared to allergies and endocrinopathies, secondary infections with Pseudomonas develop more rapidly if there is a mass or autoimmune disease [11]. The predisposing factors for otitis externa are the conditions that increase the likelihood that this complication will occur and, when combined with the primary factors, may transform this complication into a clinical condition. Recognizing and controlling these factors is essential in order to carry out a treatment plan.

The external ear's anatomical and structural features which can cause external otitis, include drop auricles, narrow canals, and dense hair growth in ear canal. Furthermore, patients with external otitis may experience discharge in their ears, which can be distinguished from other diseases based on the characteristics of the discharge, such as the odor, color, and type (waxy or dry) [8]. It is questionable whether either of these causes is sufficient to produce external otitis. In the present study, atopic dogs were significantly found to have moist, dark and foul-smelling ear secretions. The presence of external otitis may explain these characteristics, according to recent studies. Furthermore, according to a study in 2004 of the ear, referral cases with these anatomical and structural conditions are more frequent in cases that have never had otitis externa than in dogs with these conditions that do not have otitis externa. This condition was finally determined to be due to a cause other than anatomical problems in these patients [10]. Furthermore, a study conducted in 2007, which focused on 464 dogs and 105 cats, found that 73.2% of drop-ear dogs and 26.8% of erect ear dogs are likely to develop external otitis [12]. In 2013, a study conducted on the microbiological agents and treatment of otitis externa, 22 of the 48 dogs showed with drop ears, 14 presented with semi-erect ears, and 12 presented with pendulous ears. Drop ear dogs may be at greater risk of developing external otitis due to inadequate ventilation and a high presence. Due to the tortuous shape of the ear canal and the blood supply it receives, the environment is conducive to the growth of fungi and subsequent disease [13]. In this study as well, the prevalence of dogs with drop ears was higher in the case group than in the control group. However, it was not considered significant. It seems that although the drooping of the ear increases the chance of developing otitis due to providing a dark and moist environment for microorganisms, in the case of otitis caused by atopy due to the systemic nature of this disease, the shape of the ear cannot play a significant role in increasing the probability of ear involvement.

On the other hand, according to a study observing 80 dogs from 1995 to 2001 identified Cocker spaniel dogs as having a higher risk for chronic otitis media, with 48 cases in the study [14]. Otitis externa is also more prevalent in breeds with drop ears, such as the Cocker spaniel, and breeds with hairy ears, such as the miniature Poodle breed [15]. The terrier breed had the highest referral rate in the present study, both in the case and control groups. As a result, this breed had the highest incidence of atopic otitis. In spite of this, it was not considered significant that this breed has a higher incidence of atopic otitis than other breeds.

In terms of the relationship between the incidence of atopy and body size, limited research has been conducted. Based on a study conducted on the rat model, obesity can cause aggravation of atopic dermatitis by reducing immunological tolerance [16]. In addition, there is the opinion that small bodies, due to the smaller ear canal, may be more susceptible to complications associated with external otitis [17]. However, according to this study's results and statistical analysis, it is impossible to consider body size as a significant factor in predicting the occurrence of atopic otitis.

A time period of more than 2 months to more than 6 months of continuous ear canal inflammation has been proposed as a criterion of chronicity for canine otitis externa [18]. In both acute and

chronic-recurrent otitis externa, ear canal stenosis may result from changes in the epidermis (hyperplasia, folding), dermis (inflammatory cell infiltration, oedema, fibrosis), and the adnexa (hypertrophy, hyperplasia, ectasia) [19]. The majority of the dogs with atopic otitis in this study were in the chronic stage of the disease. It was also statistically significant. There appears to be a correlation between the stage of the disease and the presence of atopic otitis. Acute ear involvement usually results in more severe clinical symptoms and a quicker visit to the veterinarian [19]. It is well-known that the owner often diagnoses chronic ear problems at a later stage, and they are typically referred for treatment in their final stages. In addition, as discussed earlier, most dogs with atopic otitis produce waxy and dark odorous secretions. This issue appears to be caused by a higher prevalence of chronic otitis.

In contrast, a study found that ageing alters immunity, inflammation patterns, and susceptibility to allergic rhinitis and otitis media with effusion [20]. In older patients, reduced physical barrier function is traditionally associated with ageing skin, contributing to the exacerbation of atopic dermatitis. The skin becomes thinner, more transparent, and undergoes elastosis as it ages, making it more susceptible to physical damage [21]. At the dermo-epidermal interface, epidermal stem cells replenish keratinocytes regularly [22]. The number of stem cells in the skin declines as it ages; although they are still present in standard numbers, they are no longer capable of migrating and responding to proliferative signals [23]. During ageing, the rate of keratinocyte production in the epidermis decreases, and collagen fibres that comprise the dermal extracellular matrix become fragmented and disordered [22,24]. According to the present study, dogs under two years of age and dogs between two and five years of age had the highest incidence of atopic otitis. Nevertheless, in general, based on the comparison of the statistics with the age group of the control group, it cannot be concluded that age plays a significant role in the occurrence of this complication.

Atopy disease has not been definitively shown to be associated with gender [19]. However, it is questionable whether gender plays an essential role in developing external otitis associated with atopy. A study has demonstrated that sex hormones may contribute to allergic diseases [25]. Furthermore, an investigation of 149 dogs conducted in 2011 suggests that underlying and predisposing causes are not usually the cause of external otitis media, and hormonal factors may also be involved [26]. In a retrospective study of 100 dogs in 2007, it is observed that otitis externa in dogs with atopic dermatitis and food allergies was higher among females and dogs with a history of severe pruritic skin disease. There is a paucity of information on the effect of sex hormones on allergic disorders in animals [19]. According to a study examining the sterilization status and the gender of dogs with atopic dermatitis, spayed dogs (male and female) and neutered female dogs showed a higher likelihood of suffering from atopic dermatitis than spayed male dogs. Sex hormones may affect allergic disorders in dogs, cats, or horses. Since most companion animals are sterilized, this research could provide crucial insights into human allergies [25]. Despite the fact that male dogs were more likely to suffer from atopic otitis than female dogs in this study, this difference was not considered significant in the comparison of the two groups, which confirms previous findings.

A study conducted in 2022 demonstrated the presence of inflammatory biomarkers in atopic otitis in dogs, particularly the chemokine IL-8 [27]. Unlike on the skin, inflammatory biomarkers have never been identified in the ear canals of atopic dogs. In their study, the overexpression of IL-8 was associated with the severity of otitis, particularly the hyperplasia score. Furthermore, investigating the atopic otitis, considering the biomarkers associated with the disease is recommended. Moreover, for more profitable and favorable comparisons, we recommend that the exact measurement methods be applied to other regions of Iran based on the climate so that even factors like climate change can be compared.

Conclusion

Investigating the role of various risk factors of atopic otitis, can be particularly important in the use of disease prevention strategies. In conclusion, no age and sex positivity for atopic otitis association were detected in all dogs' breeds in this study. As a result of the statistical analysis of this study, it appears that dogs with atopic conflicts have a significantly increased risk of chronic otitis. It is also important to note that ear secretions are mostly waxy, dark, and highly odorous. Therefore, it is essential to determine the underlying cause of this disease in dogs to avoid applying costly and ineffective therapies.

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