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Evaluation of salivary gland function in allergic rhinitis patients by [^{99m}Tc] pertechnetate salivary gland scintigraphy

Research Article

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Abstract: The purpose of this study was to compare the quantitative parameters of salivary gland functions in patients with allergic rhinitis and healthy volunteers using [99mTc] pertechnetate salivary gland scintigraphy. Thirty-six patients with allergic rhinitis (14 males and 22 females, mean age 30.6 ± 5.2 years) and thirty-nine healthy controls (18 males and 21 females, mean age 32.2 ± 5.6 years) were evaluated. Dynamic salivary gland scintigraphy was performed after intravenous administration of 185 MBq (5 mCi) of [^{99m}Tc] pertechnetate for 25 minutes. Lemon juice was used to stimulate the salivary glands. On the basis of the time–activity curves, the following glandular function parameters were calculated for the parotid and submandibular salivary glands: uptake ratio, maximum accumulation, and ejection fraction. Statistically, all the functional parameters of the parotid and submandibular glands obtained for the allergic rhinitis patients were significantly lower than those of the healthy controls group ($p < 0.05$). This study demonstrated that there was a significant difference in salivary gland function between patients with allergic rhinitis and healthy controls, which can easily be evaluated by [^{99m}Tc] pertechnetate salivary gland scintigraphy.

Keywords: *Allergic rhinitis • Salivary function • Salivary gland scintigraphy*

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1. Introduction

Xerostomia, a subjective feeling of dry mouth, may arise from decreased production of saliva. Sjögren's syndrome, external radiation to the head and neck, chemotherapy, anticholinergic effects of many drugs, and various viral infections have all been attributed to the presence of xerostomia [1-3].

Allergic rhinitis is an extremely common health problem with an incidence rate of approximately 10-25% [4-6]. It is characterized by antigen-mediated inflammation of the nasal mucosa. It usually presents with sneezing, watery rhinorrhea, nasal congestion and itching, postnasal drip, and red watery, itchy eyes [7]. Nevertheless, patients with allergic rhinitis were found to have lower salivary flow rates [8].

As a diagnostic tool for allergic rhinitis, [^{99m}Tc] pertechnetate salivary gland scintigraphy is an easy, readily available, safe and non-invasive method. It is well tolerated by patients because it has a low dosimetry and does not interfere with the normal physiology [9-12]. In addition, using this method, quantitative data about the major functions of salivary glands can be obtained [3,13,14].

The aim of this study was to compare the quantitative parameters of salivary gland functions in patients with allergic rhinitis and healthy volunteers using [^{99m}Tc] pertechnetate salivary gland scintigraphy.

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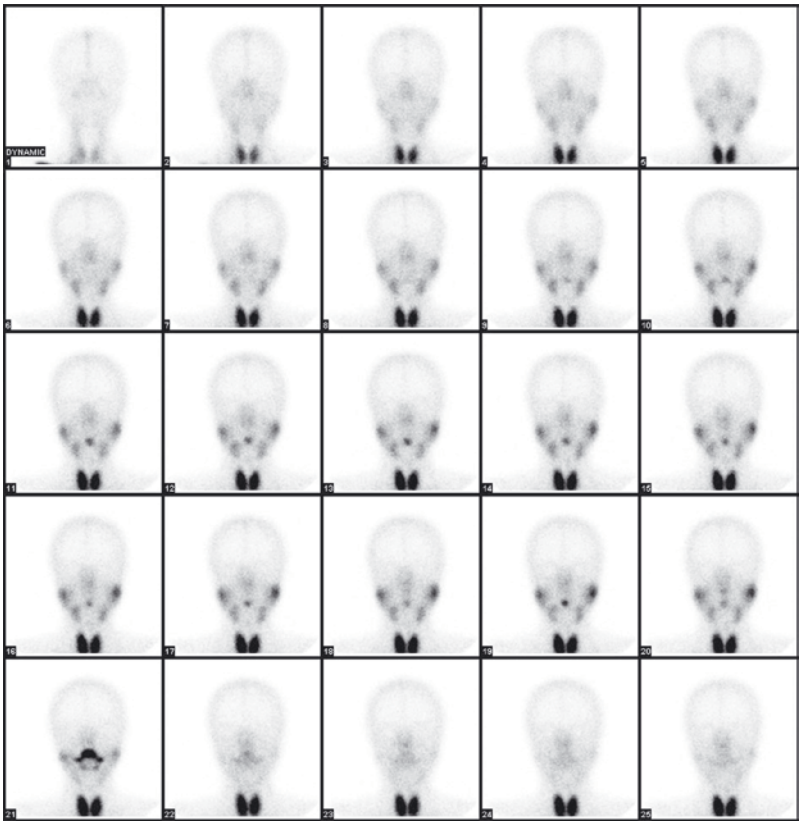
Figure 1. [^{99m}Tc] pertechnetate dynamic salivary gland scintigraphy study showing a normal distribution of radiotracer in a healthy control group subject. Dynamic imaging over a 25 min period is shown.



2. Material and Methods

2.1. Patients

We studied 36 patients with allergic rhinitis (14 males and 22 females ranging in age from 20 to 42 years) and 39 healthy controls (18 males and 21 females ranging in age from 19 to 46 years). The local ethics committee approved the study for both patients with allergic rhinitis and healthy controls. Patients with allergic rhinitis had to show a positive skin test to common inhalant allergens and have perennial nasal symptoms in order to be placed in the non-control group. None of the patients or healthy controls had a history of head and neck surgery or radiation therapy. Additionally, no participants had a connective tissue or other systemic disease, nor were they taking any prescribed medication.

2.2 Salivary gland scintigraphy

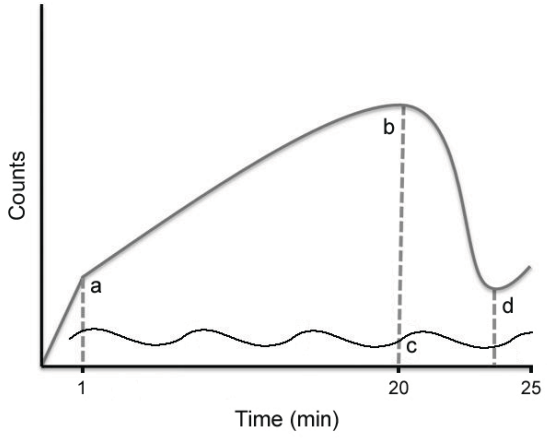
Dynamic salivary gland scintigraphy was performed after intravenous administration of 185 MBq (5 mCi) of [^{99m}Tc] pertechnetate using a single-head gamma camera with a parallel-hole, low-energy, high-resolution collimator (GE-Starcam 4000 XR/T, St Albans, Hertfordshire, UK). The photopeak was centered at 140 keV with a 20% window. Twenty-five (25) frames of 60 s each were acquired in the anterior position of the head and neck during the 25 min study with a zoom 1.33, matrix of 128 x 128 (Figure 1). Salivary gland secretion was stimulated with 3 ml oral concentrated lemon juice instilled with a syringe at 20 min. All patients and healthy controls tolerated the study well.

2.3. Semi-quantitative analysis

For semi-quantitative analysis, regions of interest (ROIs) were drawn around the right and left parotid glands and the right and left submandibular glands on summation images of dynamic scintigraphy (Figure 2). A background ROI was placed in the temporal region. A time-activity curve of each salivary gland was created (Figure 3). As shown in Figure 4, the following points were designated on the time–activity curve: point a, initial shoulder, representing a vascular perfusion, or, in cases of an unclear shoulder, at 1 min; point b, the maximum count before stimulation; point c, the background count at the time of peak activity; and, point d, the minimum count after stimulation.

Figure 2. Regions of interest on a scintigraphic image. RP, right parotid; LP, left parotid; RSm, right submandibular gland; LSm, left submandibular gland; B, background.

Figure 4. Schematic presentation of time–activity curve in normal pattern on salivary gland scintigraphy. Point a, initial shoulder, representing a vascular perfusion, or, in cases of an unclear shoulder, at 1 min; point b, the maximum count before stimulation; point c, the background count at the time of peak activity; point d, the minimum count after stimulation.



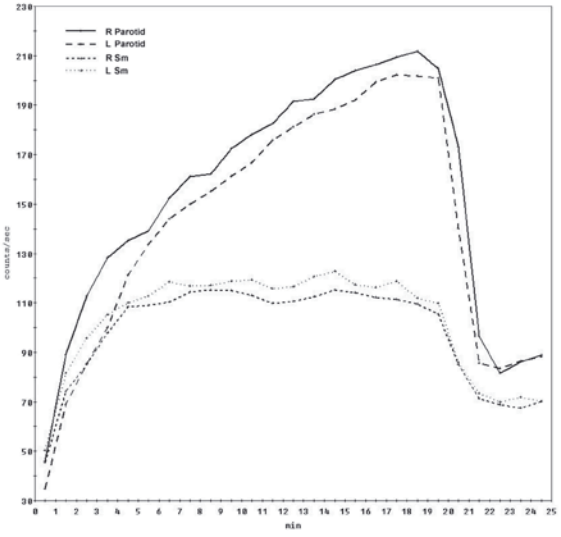
The following glandular function parameters were calculated using the time-activity curves for each salivary gland:

Uptake ratio (UR) = b / c

Maximum accumulation (%MA) = (b – a) / b

Ejection fraction (%EF) = (b – d) / b

Figure 3. Time-activity curves of parotid and submandibular glands.



2.4. Statistical analysis

The Kolmogorov-Smirnov test of the normality of the distribution led to the use of the nonparametric method. The Mann-Whitney U test was used for comparison of scintigraphic parameters between patients with allergic rhinitis and healthy controls. Differences with a *p*-value less than 0.05 were accepted as significant, with data in the text presented as mean ± standard deviation (SD). SPSS version 11.5 (SPSS Inc., Chicago, IL) software program was used for statistical analysis.

3. Results

Thirty-six (36) patients with allergic rhinitis were included in this study (14 males and 22 females). The mean age was 30.6 ± 5.2 years with a range of 20 to 42 years. The control group was composed of 39 healthy volunteers (18 males and 21 females). The mean age was 32.2 ± 5.6 years with a range of 19 to 46 years. Table 1 lists the characteristics of patients and healthy controls.

Comparison of scintigraphic parameters such as UR, %MA and %EF values of patients with allergic rhinitis and healthy controls is summarized into Table 2. UR, %MA and %EF values for bilateral parotids and submandibular glands in the allergic rhinitis group were significantly lower than those of the healthy controls group ($P < 0.05$) (Figs 5a-5c).

Table 1. Characteristics of patients and healthy controls.

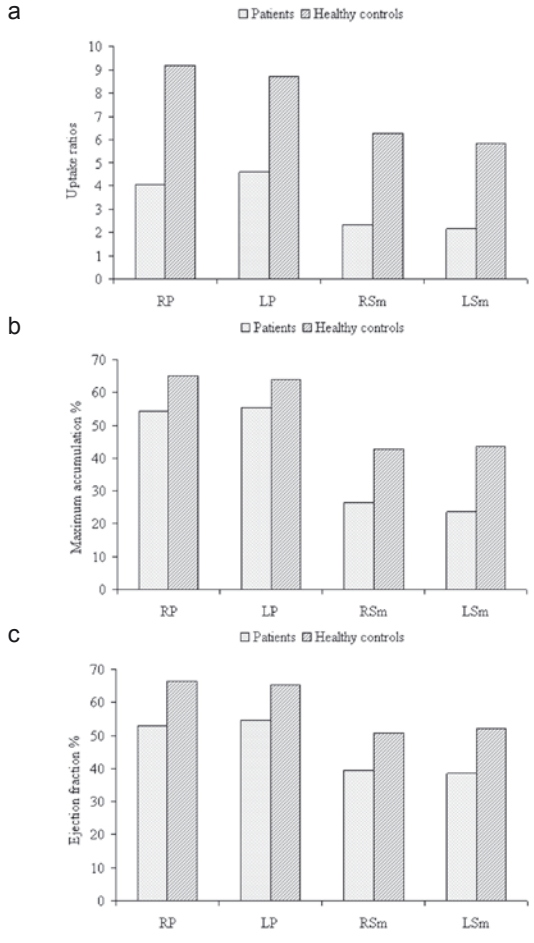
Characteristic	Allergic rhinitis (n = 36)	Healthy controls (n = 39)
Mean age ± SD (range) (years)	30.6 ± 5.2 (20-42)	32.2 ± 5.6 (19-46)
Sex (male/female)	14 / 22	18 / 21

Table 2. Comparison of scintigraphic parameters in patients with allergic rhinitis and healthy controls.

		Group		
Parameter	Gland	Allergic rhinitis (n = 36)	Healthy controls (n = 39)	*P*
UR	RP	4.04 ± 1.46	9.16 ± 2.19	0.0001
	LP	4.59 ± 1.67	8.71 ± 2.19	0.0001
	RSm	2.33 ± 1.02	6.27 ± 2.03	0.0001
	LSm	2.16 ± 0.91	5.86 ± 1.74	0.0001
%MA	RP	54.30 ± 9.04	65.09 ± 9.55	0.001
	LP	55.53 ± 9.74	63.84 ± 9.34	0.006
	RSm	26.37 ± 10.53	42.76 ± 9.17	0.0001
	LSm	23.56 ± 10.66	43.51 ± 8.29	0.0001
%EF	RP	53.07 ± 13.78	66.41 ± 9.16	0.001
	LP	54.52 ± 11.30	65.21 ± 8.51	0.001
	RSm	39.59 ± 11.39	50.79 ± 9.31	0.003
	LSm	38.37 ± 12.65	52.24 ± 10.03	0.001

UR, uptake ratio; %MA, maximum accumulation; %EF, ejection fraction; RP, right parotid; LP, left parotid; RSm, right submandibular; LSm, left submandibular. Data are expressed as mean ± SD.

Figure 5. Calculation of uptake ratio (a), percentage maximum accumulation (b) and percentage ejection fraction (c) for patients and healthy controls. RP, right parotid; LP, left parotid; RSm, right submandibular gland; LSm, left submandibular gland.



4. Discussion

In this study, we compared the quantitative parameters of salivary gland functions in patients with allergic rhinitis and healthy controls using [^{99m}Tc] pertechnetate salivary gland scintigraphy. Allergic rhinitis, an inflammation of the upper airway mucous membranes, is mediated by the binding of antigens to specific immunoglobulin E antibodies. The most common symptoms have been reported to be sneezing, sniffing, watery rhinorrhea, nasal congestion and itching in patients with allergic rhinitis. However, there have also been reports of allergic conjunctivitis, characterized by red watery and itchy eyes [7]. Additionally, dryness of the mucous membrane in the nasal cavity has been described [8,15]. Thus, subsequent to the allergic watery discharge, a dry mouth sensation may be expected. The anatomical proximity between the nasal cavity and the oral cavity may also lead to the patient's perception of dry mouth [8,16]. Compared to healthy controls, lower salivary flow rate was found among patients with allergic rhinitis [8]. In this study, similar findings were also found, the differences were statistically significant.

The salivary glands can be evaluated through computerized tomography and sialography. However, the effectiveness of these methods have been debated because they do not reflect structural abnormalities in most cases [3,17]. On the other hand, salivary gland scintigraphy enables a functional evaluation of the salivary glands, making it a valuable tool. Salivary gland scintigraphy can be performed easily and quickly, and is non-invasive. It is well tolerated by patients because it has a low dosimetry and does not interfere with the

normal physiology [9-12]. Salivary gland scintigraphy, used in this study to evaluate the salivary glands, can provide quantitative data about glandular function as percent uptake and concentration and excretion fractions [3,13,14].

In conclusion, this study showed that there were statistically significant differences in salivary gland function parameters between patients with allergic rhinitis and healthy controls. The affect of allergy on salivary gland function can easily be evaluated by [^{99m}Tc] pertechnetate salivary gland scintigraphy, a reliable, easy and safe method. However, we suggest that further studies involving larger cohorts of patients should be performed.

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