Effects of temperature changes on nasal patency

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ABSTRACT

Introduction: This study aims to assess the difference in nasal patency and resistance to temperature changes objectively and subjectively.

Methods: This cross-sectional study involved 50 subjects without nasal obstruction. All these subjects were given a questionnaire to determine nasal obstruction subjectively on a visual analogue scale. Acoustic rhinometry was performed in all these subjects for objective measurement of nasal obstruction. The study was conducted in two separate rooms in the departmental laboratory where the temperatures were maintained at 30-33 degrees Celsius and an air-conditioned room at 18-22 degrees Celsius, respectively.

Results: The objective measurement to two different temperature exposures showed differences in nasal patency and resistance. There was an increase in nasal resistance and a decrease in nasal patency to air-conditioned air compared to room temperature air. Subjective assessment also showed significant correlation to the two temperature exposures. However, independent sample test only showed significant difference in the subjective questionnaire (p-value equals 0.001). Objective acoustic rhinometry did not show significant difference.

Conclusion: There is no significant difference in objective acoustic rhinometry with regard to nasal resistance and patency with environmental temperature changes in the tropics.

Keywords: acoustic rhinometry, nasal obstruction, nasal patency, temperature changes

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INTRODUCTION

A patent nasal passage is needed for the important physiological functions of the nose, which includes air conditioning and filtering of inspired air. Nasal obstruction is a common symptom which is difficult to quantify clinically, unless obstruction is nearly complete. Furthermore, perception of nasal obstruction varies considerably, often bearing no relationship to the actual resistance to airflow in the nose. Several factors that decrease nasal resistance include exercise, sympathomimetics, erect posture and warm air. On the other hand, factors increasing nasal resistance include infective rhinitis, allergic rhinitis, vasomotor rhinitis, alcohol, aspirin and cold air. Several studies to date suggest that the sensation of nasal patency may be related to temperature changes and nasal resistance decrease in warm air and tends to increase in cold air. Previous studies have subjected patients to extremes of temperature of -4ºC or -10°C, to room air at 23°C or hot air at 40°C–44°C to study nasal patency.

In this study, a temperature range of 30ºC–33°C was chosen to reproduce the environmental conditions found here in our tropical country and compared to temperatures about 10ºC–15°C lower (18ºC–22ºC), which happens to be the common temperature in an air-conditioned room. Many methods have been devised to quantify nasal patency. At present, acoustic rhinometry and the subjective sensation of nasal obstruction as measured by the visual analogue scale appear to be used most frequently. In this present study, eupneic nasal ventilation in normal subjects was done to analyse the changes in nasal patency to common temperature differences in the environment here. The aim of the study is to assess the difference in nasal patency and resistance to various ranges of temperature changes objectively and subjectively.

METHODS

The study was conducted at the departmental laboratory at the University of Malaya Medical Centre, where the temperatures of two rooms were maintained at around 30ºC–33ºC (room temperature) and 18ºC–22ºC (air-conditioned temperature). This is a cross-sectional study involving 50 subjects without nasal obstruction. All these subjects were given a questionnaire to determine nasal obstruction subjectively while acoustic rhinometry was performed in all these subjects to maintain an objective account of presence of the nasal obstruction.

The volunteer subjects were medical students. The

Table I. Comparison of nasal patency at different temperatures.

	Air-conditioned temperature			Room temperature		
	Objective		Subjective	Objective		Subjective
No	Left	Right	%	Left	Right	%
1	0.34	0.40	25	0.41	0.48	10
2	1.31	0.33	10	0.61	0.47	5
3	1.06	0.62	10	0.72	0.51	25
4	0.76	0.42	15	0.67	0.48	5
5	0.44	0.34	40	0.89	0.63	0
6	0.50	0.45	40	0.57	0.63	0
7	0.60	0.49	5	0.48	0.49	10
8	0.89	0.48	65	0.46	0.44	10
9	0.13	0.15	20	0.24	0.32	5
10	1.37	0.72	15	0.69	1.03	0

subjects were given 15 minutes to acclimatise to room temperature (30℃–33℃). For subjective measurement, subjects were asked to assess the patency of their nose as a whole and to indicate this on visual analogue scale, similar to Jones et al.[1] The total length of scale was 10 cm, with one extreme being an entirely clear nose (i.e. 0 cm scoring 0%) to a completely blocked nose (10 cm scoring 100%), and centre with 50% blockage. Subjects were instructed not to breathe in deeply but to breathe quietly at their normal depth and rate while making this assessment. Objective measurement was done by using acoustic rhinometry with an external nose piece on the right nostril, and repeated on the left nostril. This procedure was then repeated in the air-conditioned room maintained at 18℃–22℃.

The inclusion criteria were no prior nasal surgery and no antecedent symptoms of asthma or rhinitis, while the exclusion criteria were history of nasal disease and treatment for allergic rhinitis. An outdoor thermometer was used to ensure the desired temperature was maintained. Acoustic rhinometer was used to evaluate the nasal resistance (RhiniMetrics A/S SRE 2100, Lynge, Denmark, 2002). The parameters measured were minimal cross-sectional area, MCA 1 (nasal valve), MCA 2 (inferior turbinate, MCA 3 (nasopharynx), units (volume, cm^3). Pre-designed format consisted of clinical data. The duration of this study was one year. The data collection started in October 2003 and ended in September 2004.

All the subjects were volunteer medical students who had no symptoms pertaining to the nose. Clinical examination was also normal with minor septal deviation. The power of study in this study was 80% for the sample size of 50 subjects. Statistical analysis were performed using the Statistical Packages for Social Sciences version 11.0 (SPSS Inc, Chicago, IL, USA). Statistical analyses such as t-test and correlation were utilised in this study. Correlations were used to measure the strength of the relationship between the predictive factors and the outcome. A p-value of less than 0.05 (two-tailed t-test) was considered significant.

RESULTS

The results were grouped into room and air-conditioned temperature values based on objective and subjective assessments. The results were tabulated according to the two different temperature ranges and compared (Table I). The temperature data of the right and left nostrils to two different temperature exposures showed a significant difference in nasal patency and resistance. There was an increase in nasal resistance to air-conditioned air compared to room temperature air (Table I). No significant correlation was observed between the left and right nostrils between the two temperatures ($r = 0.12$, $p = 0.40$). However, there was a significant correlation between left and right nostrils at room temperature ($r = 0.40$, $p = 0.004$).

Subjective assessments also showed a significant correlation to the two temperature exposures ($r = 0.54$, $p = 0.001$). However, independent sample t-test showed a significant difference in the objective assessment between room temperature and air-conditioned temperature on the right nostril and subjective values (Table II). From the results, in the air-conditioned environment, 50 healthy subjects showed an increase in nasal resistance and a decrease in nasal patency. Two patterns of nasal resistance to the air-conditioned environment were obtained. One was increased nasal resistance after exposure and the other was no increase in resistance despite cold exposure.

DISCUSSION

From the study, the sensation of nasal patency is related to temperature changes. However, no statistical difference

Table II. Mean objective and subjective values of nasal patency at room temperature and air-conditioned temperature.

		n	Mean	SD	SEM	p-value
RTACLEFT	RT	50	0.7834	0.33233	0.04700	0.06
	AC	50	0.6680	0.26994	0.03818	
RTACRIGHT	RT	50	0.6586	0.30904	0.04370	0.047
	AC	50	0.5520	0.21134	0.02989	
RTACSUBJ	RT	50	6.4200	10.43951	1.47637	0.001
	AC	50	18.4600	17.23216	2.43700	

RT: room temperature; AC: air-conditioned temperature; Left: left nostril; Right: right nostril; SUBJ: subjective

was found to nasal resistance. Generally, it is the subjective sensation of nasal patency that is of paramount importance to both the physician and the patient. Previously published work had shown no changes in nasal resistance despite changes in symptoms.[1] Decrease in nasal patency and increase in nasal resistance can be demonstrated when patients are exposed to extreme cold temperature. Nasal resistance occurred when the inspired temperature ranged between -3ºC and -10ºC.[2] Presence of temperature receptors within the nasal lining subserving the sensation of nasal patency has been mentioned.[3] The effect depended on the flow rate and temperature of air, where it is most marked with cold air.[3]

Inhaling the vapour of certain volatile oils, local anaesthesia of nasal vestibule and topical anaesthesia of nasal mucous membrane have increased the sensation of nasal patency with no objective changes in resistance.[1] Humidity changes, age, sex and race had no significant effect on nasal patency and resistance.[4] The effects of elevated temperature on subjective and objective findings in perennial rhinitis have been studied.[5] Studies have shown that hot humid air shows a tendency towards a decreased production of histamine, sneezing and nasal pruritis in seasonal allergic rhinitis. Studies done on animals have shown that increased temperature decreases histamine release from mast cells. Since the temperature of nasal mucosa under normal ambient condition is between 30.4ºC at inspiration and 32ºC at expiration, it has been proposed that the optimal functioning temperature of mast cells is in this range and increasing nasal mucosal temperature above 32ºC may have inhibited histamine release. However, the reason why the increase in temperature results in the decrease of mast cell degranulation is still unknown.[6] It has been postulated that mast cells are temperature sensitive and that cooling the airways leads to mast cell degranulation. Even hot air may have a clinical application in providing symptomatic relief in perennial rhinitis.[5]

Further studies need to be carried out based on these two difference ranges of temperature, 30ºC–33ºC and 18°C–22°C, and the correlation of temperature and histamine release needs to be ascertained for its effect on the nose. In this study, the two different temperature ranges, 18°C–22°C and 30ºC–33ºC, were chosen to reflect the environmental conditions here in Malaysia. It revealed that subjective nasal patency is reduced and increased in nasal resistance in air-conditioned environment compared to room temperature.

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