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Specific airway resistance in healthy young Vietnamese and Caucasian adults

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ABSTRACT

In healthy Vietnamese children the respiratory resistance has been suggested to be similar at 110 cm height but larger at 130 cm when compared with data in Caucasians from the literature, suggesting smaller airways in older Vietnamese children (Vu et al., 2008). The hypothesis tested here is whether the difference in airway resistance remains consistent throughout growth, and if it is larger in adult Vietnamese than in Caucasians. Airway resistance and Functional Residual Capacity were measured in healthy young Caucasian and Vietnamese adults in their respective native country using identical equipment and protocols. Ninety five subjects in Vietnam (60 males) and 101 in France (41 males) were recruited. Airway resistance was significantly larger in Vietnamese than in Caucasians and in females than in males, consistent with difference in body dimensions. Specific airway resistance however was not different by ethnicity or gender. The findings do not support the hypothesis that airway size at adult age – once normalized for lung volume – differs between Vietnamese and Caucasians.

1. Introduction

A better identification of asthma prevalence around the world following the ISAAC studies has indicated a similar incidence of paediatric asthma in Vietnam compared to European countries, in contrast to other developing countries that show comparatively low prevalence (Nga et al., 2003). To optimize the care of asthmatic children in Hanoi, collaborative studies have been undertaken to better characterize lung function in this population (Vu et al., 2008, 2010). Close assessment of the respiratory resistance relationship to body height of healthy Vietnamese children suggests differences with previous values reported in the literature in Caucasians. While the respiratory resistance appeared similar in both groups at 110 cm body height, a larger apparent difference at 130 cm suggested smaller airways in older Vietnamese children (Vu et al., 2008). It was reasoned that, should such a difference in airway calibre be consistent and significant later throughout growth, young healthy Caucasian and Vietnamese adults should demonstrate a similar trend. This hypothesis prompted us to characterize airway mechanics in healthy young Caucasian and Vietnamese adults, in a comparable manner. The repeated observation that lung function differs between Caucasian and Asian subjects (Ip et al., 2000a,b; Quanjer et al., 2012; Strippoli et al., 2013; Yang et al., 1991) further encouraged the study.

Body plethysmography is a unique methodology to assess airway calibre in relation to lung volume. Because the technique is based on measuring a relatively small amount of gas compressed or expanded in the lung, significant metrological care is required, and equipment standardization is mandatory.

The aim of this study was to compare airway resistance measured by plethysmography between healthy young Vietnamese and Caucasian adults. The study was conducted at the lung function laboratory in Hanoi Medical University, in Vietnam (HMU) using a body plethysmograph identical to that used in the lung function department, children's hospital in Nancy, France. The null hypothesis was that airway calibre would be similar in Vietnamese subjects compared with Caucasians. The main end points were the airway resistance and the specific airway resistance.

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2. Materials and methods

2.1. Subjects

Healthy young adults aged 18–30 years were recruited among students from HMU and from the Faculté de Médecine, Université Lorraine, France. Subjects were included on the basis of a history negative for hospital admittance or medical consultation for asthma and past year asthma related symptoms, tobacco smoking, and past month respiratory tract infection. They were otherwise free of chronic respiratory or systemic disease. Physical respiratory and cardiac examinations were normal. Body weight, standing, and sitting height were measured. The protocol was approved by ethical committees from both institutions, and informed consent was obtained from all subjects.

2.2. Equipment and study set up

Two Jaeger MedGraphics 1085 plethysmographs were customized in the department of physiology, Faculté de Médecine, Université Lorraine, France. Body boxes were equipped with similar transducers, electronics, filtering, acquisition procedures, and mathematical handling that have been described previously (Peslin et al., 1987). Briefly, the acquisition frequency was 100 Hz. The time drift in the box volume change was corrected, but no attempt was made to eliminate the looping in the X–Y display vs flow.

One plethysmograph was set in the lung function department, Hôpital d'Enfants, CHU de Nancy France (HELFD) and the other shipped to the department of physiology, HMU. In both locations, ambient temperature and relative humidity were respectively about 25 °C and 60%, the conditions in HMU being maintained in a climate room.

Body boxes were serviced on site by the research engineer (BD) that developed them. A calibration check was performed by this operator on initiating the study, by compressing the gas of a 2.92 L container connected to a 4.3 hPa s/L resistor. The measurements of the mock thoracic gas volume (TGV) and airway resistance (Raw) expressed as percentage of the corresponding nominal value were respectively 105% and 93% in HELFD and 104% and 95% in HMU. The latter body box was subjected to a mid-study on site visit, and remote on demand technical assistance was available via an internet connection. Daily quality control procedures included adjusting the gain of the pressure transducer against a water manometer, calibrating the pneumotachograph by the integral method and the plethysmograph signal using the built-in 50 mL reciprocating pump.

The first author of this report (TL) spent a 2 year fellowship in the department of physiology, Faculté de Médecine, Université Lorraine and in HELFD where he was trained with the measuring equipment and technique, before returning to HMU and completing the Vietnamese side of the study.

2.3. Measurements

The subject was coached with the relevant respiratory manoeuvres and placed in the plethysmograph. After about 1 min to achieve temperature equilibration, the subject was connected to the breathing apparatus of the plethysmograph through a bacterial filter (PALL filter pro-tec PF 30 SG, USA). During a quiet breathing period, the end-expiratory position was determined and the subject was then asked to pant at around 2 Hz, to continue the efforts during closure of the shutter and finally to perform a full inspiration followed by a full expiration. Specific airway resistance (sRaw), thoracic gas volume (TGV) and vital capacity were thus obtained consecutively, in the same order. The sRaw and TGV acquisitions each lasted 2 s, and the signals were digitized at 100 Hz. The plethysmograph volume signal vs flow or airway pressure relationships were examined visually immediately after the acquisition. Those manoeuvres showing obvious signal distortion – mostly suggestive of glottis closure or swallowing – were excluded. The drift-corrected plethysmograph signal (Peslin et al., 1987) was subjected to linear regression versus V' to compute sRaw, or vs airway pressure to compute TGV. The goodness of fit of each regression line was characterized by a correlation coefficient, usually better than 0.80 for sRaw and 0.97 for TGV. The latter was finally adjusted for the volume difference from the end expiratory position during occlusion so as to determine FRC which was used to compute the airway resistance (Raw).

At least three technically acceptable acquisitions were retained. All recordings were stored on disk for later systematic check by the research engineer. From the FRC and vital capacity, total lung capacity and residual volume were computed. For clarity, this part of the data has been omitted from the current paper. Mean values of sRaw, Raw, and FRC were calculated and tabulated for each individual.

2.4. Statistical analysis

Data were summarized in Excel files and statistical analysis was performed using SAS statistical software 9.3, SAS Institute Inc., NC, USA.

2.4.1. Bivariate analyses

Gender distribution was examined using the Chi square test, and difference between group means was determined using the Wilcoxon test. Relationships between Raw or sRaw and age, body weight, standing, and sitting height were analysed using Pearson's correlation coefficients.

2.4.2. Multivariate analyses

Variables significant at the 0.05 level were subsequently used in multiple linear regression analysis of the factors associated with Raw or sRaw.

3. Results

Ninety five subjects in HMU (60 males, 35 females) and 101 in HELFD (41 males, 60 females) fulfiled inclusion criteria. The sex ratio was significantly different, with a larger proportion of males being recruited in Hanoi ($p = 0.002$) and the data are therefore presented while stratified for gender. Biometrical characteristics are summarized in Table 1. Weight, standing or sitting height, TGV and FRC were significantly lower in Vietnamese than Caucasians and in females than in males ($p < 0.0001$). The gender-related difference was similar in both ethnic groups. FRC was found significantly lower than TGV ($p < 0.0001$) in both Vietnamese (2.86 ± 0.74 L vs 3.36 ± 0.76 L) and Caucasians (3.26 ± 0.75 L vs 3.54 ± 0.74 L) and the difference was larger in Vietnamese ($p < 0.01$).

The panting frequency was found slightly but significantly larger in the Vietnamese than Caucasians ($p = 0.008$) and in females than in males ($p < 0.05$, Table 1). Raw was also significantly larger in the Vietnamese ($p = 0.0003$) and in females ($p < 0.0001$), with comparable effects of gender in both ethnic groups (Table 1). Significant correlations were disclosed between Raw and standing or sitting height, weight, FRC but not with age or panting frequency. The multiple linear regression analysis indicated that FRC was in fact the only parameter significantly and independently related to Raw. The relationship between Raw and FRC presented in Fig. 1 indeed indicates that the data points for Vietnamese or French males and females were roughly distributed along the same hyperbola.

As expected from prior relationships, sRaw was not found to be different between males and females nor between Vietnamese