The airflow resistance sensing threshold during tidal breathing rises in old age in patients with asthma

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Abstract

Background: in a previous study, we showed that the ability to detect a rise in airflow resistance at rest was reduced in some non-asthmatic subjects in old age.
Objective: to determine whether airflow resistance detection is attenuated in elderly subjects with asthma.
Methods: we studied 60 adult subjects with stable asthma (age range 20–88). Progressive external airflow resistance loading was used to measure the inspiratory load detection threshold (LDT) during tidal breathing at rest.
Results: the mean inspiratory LDT was 5.57 (4.33 SD) kPa.s/l in the 20–64 age group (n = 32) and 15.6 (10.1 SD) kPa.s/l in those aged 65 and above (n = 28) (P < 0.0001). The inspiratory LDT was significantly correlated with age (r = 0.5246, P < 0.00008), mainly due to the effect of higher LDTs in about half of the subjects above the age of 65 years. Expiratory LDT values and correlations were very similar to inspiratory values.
Conclusions: the threshold for detecting external resistive loads during tidal breathing rises in old age in some, but not all, asthmatic patients as was observed in non-asthmatic subjects. The findings have implications for treatment guidelines because some elderly subjects are likely to have reduced awareness of worsening airflow obstruction, and consequently delay their use of rescue treatments.

Keywords: asthma, old age, respiratory load sensing, elderly

Introduction

In a previous study [1], we showed that the ability to detect a rise in airflow resistance during tidal breathing at rest is reduced in some non-asthmatic subjects in old age, particularly above the age of 65 years. It is likely that this change is due to the tendency for proprioceptive acuity to deteriorate in old age, more in some individuals than others [2–7], and is likely to be a consequence of ageing rather than any specific pathology of the respiratory system. These observations are consistent with other research showing a reduction in the sensation of breathlessness in older people during exercise or under active bronchoconstriction [8, 9]. This phenomenon could potentially delay the timely use of rescue self-medication in patients with reversible airflow obstruction in the early stages of an exacerbation. Further, if confirmed in patients with reversible airflow obstruction, the findings could have implications for steps 1 and 2 of the national guidelines for asthma, which recommend rescue bronchodilator self-medication in response to a subjective sensation of worsening resistance to airflow [10]. We therefore conducted a further study to determine whether the airflow resistive load detection threshold (LDT) at rest is higher in elderly subjects with asthma than in younger asthmatic patients.

Methods

Study design and subject selection
We conducted a prospective open cross-sectional study. Subjects with asthma aged 18 years or more were invited to
consent to participate. General practice asthma registers were used to identify suitable subjects who were then initially contacted by letter. Names were randomly selected from the registers until there were at least five subjects in each 10-year age band, and a total of 60, who met the study criteria. The inclusion criteria were: age above 18 years, never-smoked or trivial smoking only, abbreviated mental test (AMT) [11] above 7, willing to consent to take part in the study, a diagnosis of asthma made by a hospital consultant or general practitioner in accordance with the British Thoracic Society (BTS) guidance [10], no exacerbation or change of treatment for at least the preceding 3 months, receiving treatment at steps 1, 2 or 3 of the BTS asthma treatment guideline [10], forced expiratory volume in 1 s (FEV1) > 70% of predicted (checked immediately prior to measuring LDT). The exclusion criteria were: smoker or ex-smoker, AMT less than eight, known to have a respiratory condition other than asthma, taking any medication that can alter respiratory sensory function (such as opioids or benzodiazepines), any known or apparent central or peripheral nervous system condition that might alter respiratory sensory function (such as stroke or peripheral neuropathy), diabetes mellitus, any condition that precluded performing spirometry (such as recent eye surgery).

Sixty subjects (37 females) were finally recruited (age range 20–88 years). All met the study criteria and gave informed written consent to participate. None had an AMTS score below 9/10. They had been receiving treatment for a mean of 4.2 years (range 1.8–28.0). Forty-eight were taking regular inhaled corticosteroids and rescue bronchodilators, 10 used rescue bronchodilators only and 2 were taking regular combined corticosteroids and long-acting bronchodilator therapy with rescue bronchodilators. There was no apparent difference in the severity of asthma between the age groups.

Method for measuring the LDT

We constructed an apparatus using standard respiratory physiology equipment (Harvard). It consisted of a flanged mouthpiece connected to a one-way low resistance valve that was in turn connected to an airflow resistor by a 90-cm low resistance tube. The resistor could be positioned to either the inspiratory or expiratory direction of the valve. A disposable microbiological filter (Vitalograph) was placed between the mouthpiece and valve. The technical specifications of the apparatus, and its calibration and within-subject variability have been published in detail in a previous paper [1].

LDT measurements were made in a quiet room with sources of distraction minimised. The researcher explained the test. The subject was seated comfortably and breathed through the LDT apparatus wearing a nose clip and a pulse oximetry finger probe (Criticare Systems). The need to breathe naturally and tidally was reinforced. The resistance sensation was not demonstrated to the subject because we had found in preliminary studies that such a manoeuvre tended to disrupt tidal breathing and did not improve the reproducibility of LDT measurements. A settling period of about 1 min was allowed and the respiratory rate was recorded after which the resistor was closed, silently and out of sight, in half millimetre increments every four or five breath cycles until the subject indicated by raising a hand that they had reached the point at which they could first feel definite resistance to breathing. The subject then disconnected and rested for about 2 min. The final aperture setting was recorded and later compared with the calibration curve to determine the measurement. Three measurements were taken in the inspiratory and expiratory modes in each subject, in random order. The means of the three readings were taken as the recorded inspiratory and expiratory LDTs, respectively. Day-to-day corrections for actual temperature, humidity and atmospheric pressure were not made because they were found to be too small to be of significance in this context.

Spirometry

Spirometry was performed on each subject using a Microlab 3300 portable spirometer. The ERS/ATS performance and interpretation standards [12] for forced spirometry were applied and recordings were made of the peak expiratory flow rate (PEF), forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC). Subjects unable to have these indices measured to the required standard were not included in the data analysis. Height and age were recorded.

Statistical methods

Parametric data were compared using the two-tailed t-test. Correlation coefficients were calculated by the Spearman rank correlation method using online software.

Results

All 60 subjects were able to complete the study. PEF, FEV1 and FVC measurements, expressed as a mean (range) percentage of the predicted for age, height and gender were 85 (77–111), 88 (75–115) and 86 (75–112), respectively. None had a clinical history suggestive of chronic obstructive airways disease (COPD) and none had spirometry values that met GOLD [13] or NICE [14] definitions for COPD. All had a capillary oxygen saturation of 97% or more and none had a fall in oxygen saturation when having their LDTs measured.

The mean inspiratory LDT was 5.57 (4.33 SD) kPa.s/l in the 20–64 age group (n = 32, 21 females) and 15.60 (10.10 SD) kPa.s/l in those aged 65 and above (n = 28, 16 females) (P < 0.0001). The expiratory LDT values were 5.31 (3.99 SD) and 16.06 (9.76 SD), respectively (P < 0.0001). There was no significant difference between inspiratory and expiratory LDTs within the age groups.
The airflow resistance sensing threshold

Inspiratory LDT was significantly correlated with age ($r = 0.5246, P < 0.0008$), mainly due to the effect of higher LDTs in about half of the subjects above the age of 65 years. Figure 1 shows that the between-subject inspiratory LDT readings in the young and middle-aged subjects fell into a relatively narrow range, whereas those of the older subjects were spread wider. The distribution of expiratory LDT readings was very similar. A comparison of inspiratory and expiratory LDTs showed that there was a high degree of concordance between those indices in individuals, to the extent that the line of regression lies close to the line of axial identity, indicating a lack of tidal phase bias towards either index.

There was no significant correlation between inspiratory LDT and age-corrected FVC or respiratory rate. The resting respiratory rate at the start of the LDT procedure ranged from 12 to 22/min between subjects, and varied less than 2/min within subjects during the LDT procedure. There was no correlation between age or LDTs and starting or maximum respiratory rate.

Discussion

The study showed that elderly subjects with asthma often have a reduced ability to detect an external resistance to airflow during tidal breathing at rest. This finding is very similar to that which we found in non-asthmatic subjects [1], and therefore appears to be due to age-related changes rather than a consequence of asthma. Ageing changes leading to a reduction in the sensitivity and acuity of chest wall and diaphragmatic proprioception are the most likely explanation for the findings [2–7].

The clinical implications of our findings are threefold. Firstly, national guidelines [10] for the use of inhaled therapy for asthma that include the use of rescue bronchodilators when the patient feels an increase in chest tightness, or other dyspnoeic sensations, might not be suitable in old age because a substantial proportion of patients could be further into an attack before taking action. We studied patients breathing tidally at rest, which is arguably the physiological starting point for most elderly patients on most occasions when an exacerbation of their asthma occurs. Secondly, it can be contended that elderly asthmatic patients with known proprioceptive impairment might be particularly susceptible to late detection of a rise in airflow resistance. At present there is no empirical evidence to support that supposition, which will to be the topic of further research by our group. Finally, the reduced ability of an elderly person to feel a rise in airflow resistance is part of the general degradation of the clinical information available for diagnostic purposes, alongside the consequences of other factors such as hypoxia and dehydration. Therefore, the degree of reported breathlessness, if any, which is at least in part dependent on sensing the change in airflow resistance cannot be relied upon when assessing an elderly patient with asthma.

Key points

- The threshold for detection of an external resistive airflow load during tidal breathing at rest rises in old age in subjects with asthma.
- The pattern of this is the same as that observed in non-asthmatic subjects.
- This is a possible reason for the clinical observation that older patients often seem less aware of a deterioration in their asthma.
- It can be argued that guidelines for the use of self-administered rescue inhaled bronchodilator therapy should take into account the reduced awareness of rising airflow resistance in elderly patients.

Conflicts of interest

None declared.

Ethical approval

Dorset REC. Written consent was obtained.

References

Developing predictive models of excellent and devastating outcome after stroke

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Abstract

Background: models to predict functional status post-stroke have utility in balancing groups in randomised trials, for outcome comparison between stroke centres and may assist in outcome prediction. This study aimed to develop models of both excellent [modified Rankin score (mRS) 0–1] and devastating outcomes (mRS of 5–6).

Methods: patients admitted with ischaemic or haemorrhagic stroke in 2001–02 to the Halifax Infirmary, Canada, were enrolled. Sixteen clinical variables from the first neurological assessment and six radiological variables from the acute CT scan were used to model the outcome at 6 months.

Results: five hundred and thirty-eight stroke patients were enrolled. Thirty per cent had an excellent outcome and 30% had a devastating outcome. Three models of the excellent outcome were developed [area under the receiver operator curve (AUC) 0.866–0.882] including the variables age, pre-stroke functional status, stroke severity, ability to lift both arms, walk independently, normal verbal Glasgow Coma Scale and leukoaraiosis. Predictive models of the devastating outcome (AUC of 0.859–0.874) included additional variables living alone pre-stroke and total anterior circulation stroke. The simplest models of both outcomes were externally validated (AUC of 0.856–0.885).

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