IE50 measured by Structured Light Plethysmography (SLP) can differentiate between children with and without asthma, and can detect response to a bronchodilator

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PneumaCare NEXT GENERATION LUNG FUNCTION ASSESSMENT

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ABSTRACT

SLP is a novel technique which measures breathing patterns by measuring chest and abdominal wall movements during tidal breathing (1). In this study we assessed the use of SLP in determining differences in tidal breathing patterns between children with asthma and normal children, and we quantified the changes of clinically relevant breathing parameters following intervention with bronchodilator.

Children visiting the outpatient clinic with a diagnosis of asthma and reduced lung function (with FEV1< 80% predicted) were recruited, (n=30; age range 7-16 years). All such patients routinely have spirometry repeated after 400mcg of inhaled salbutamol to assess airway obstruction reversibility. 5 minutes of tidal breathing was recorded using SLP (Thora-3Di, PneumaCare Ltd) before and after this treatment. A matched group of children of similar age without asthma or diagnosis of respiratory illness were recruited (n=41) to generate comparative data for normal subjects.

SLP could be used in children with asthma to quantify clinically relevant tidal breathing parameters that differentiate asthma from normal, $IE50_{SLP}$ and its variability were higher in children with asthma and were also sensitive to a bronchodilator response.

INTRODUCTION

Asthma, the single most common chronic disease during childhood starts very early in life in the majority of cases.

Asthma is not a curable disease, however an early and accurate diagnosis and monitoring is very important for breathing assessment.

- Conventional techniques to measure lung function, such as spirometry, are challenging in young children, as the child's full cooperation is required to perform the test (2).
- Structured light plethysmography (SLP) is a novel technique developed in Cambridge, UK to determine the parameters of tidal breathing in a non-invasive and zero-contact environment.

STUDY AIMS

- Assessment of the use of SLP in determining differences in tidal breathing patterns between children with asthma and normal children.
- quantification of the changes in clinically relevant breathing parameters following intervention with bronchodilator.

METHODOLOGY

- 30 children visiting the outpatient clinic with a diagnosis of asthma and reduced lung function (with FEV1< 80% predicted) were recruited (age range 7-16 years).
- All such patients routinely have spirometry repeated after 400mcg of inhaled salbutamol to assess airway obstruction reversibility.
- Five minutes of tidal breathing was recorded using SLP (Thora-3Di, PneumaCare Ltd) before and after the administration of Bronchodilator.
- A group of age matched healthy children with no history of respiratory diseases were recruited (n=41), this group underwent the assessment with SLP only once to generate comparative data for normal subjects.
- Clinically relevant tidal breathing parameters such as respiratory rate (RR), duty cycle (tI/tTot) were obtained from the movement-time signal (Figure 2A).
- Flow measured by SLP is defined as the rate of change of the movement signal , and is calculated as the first derivative of the movement-time signal (Figure 2B).
- The ratio of inspiratory to expiratory flow at 50% of tidal movement $IE50_{SLP}$ was obtained from Flow-movement loops $TIF50_{SLP}$ divided by $TEF50_{SLP}$ (Figure 2C).
- Median (prefix 'm') was used to provide a measure of parameter magnitude and 'v' to denote IQR (i.e. within subject variability).

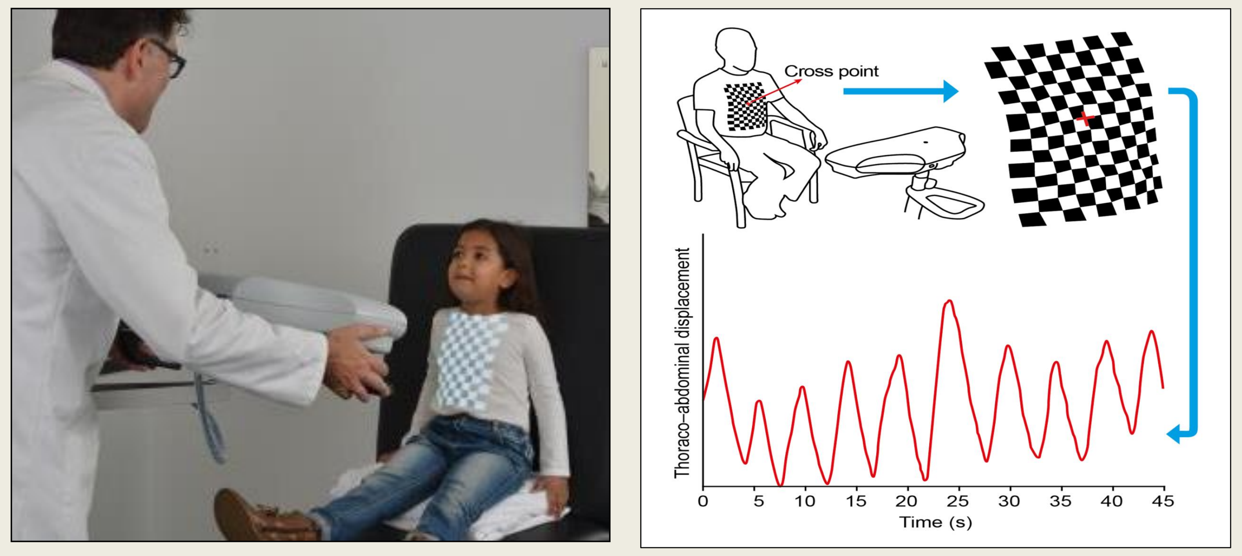

Figure 1: Structured Light projected onto the thoraco–abdominal (TA) wall of a participant seated approximately 1 meter from the device (Thora-3DiTM, PneumaCare, Cambridge, UK).

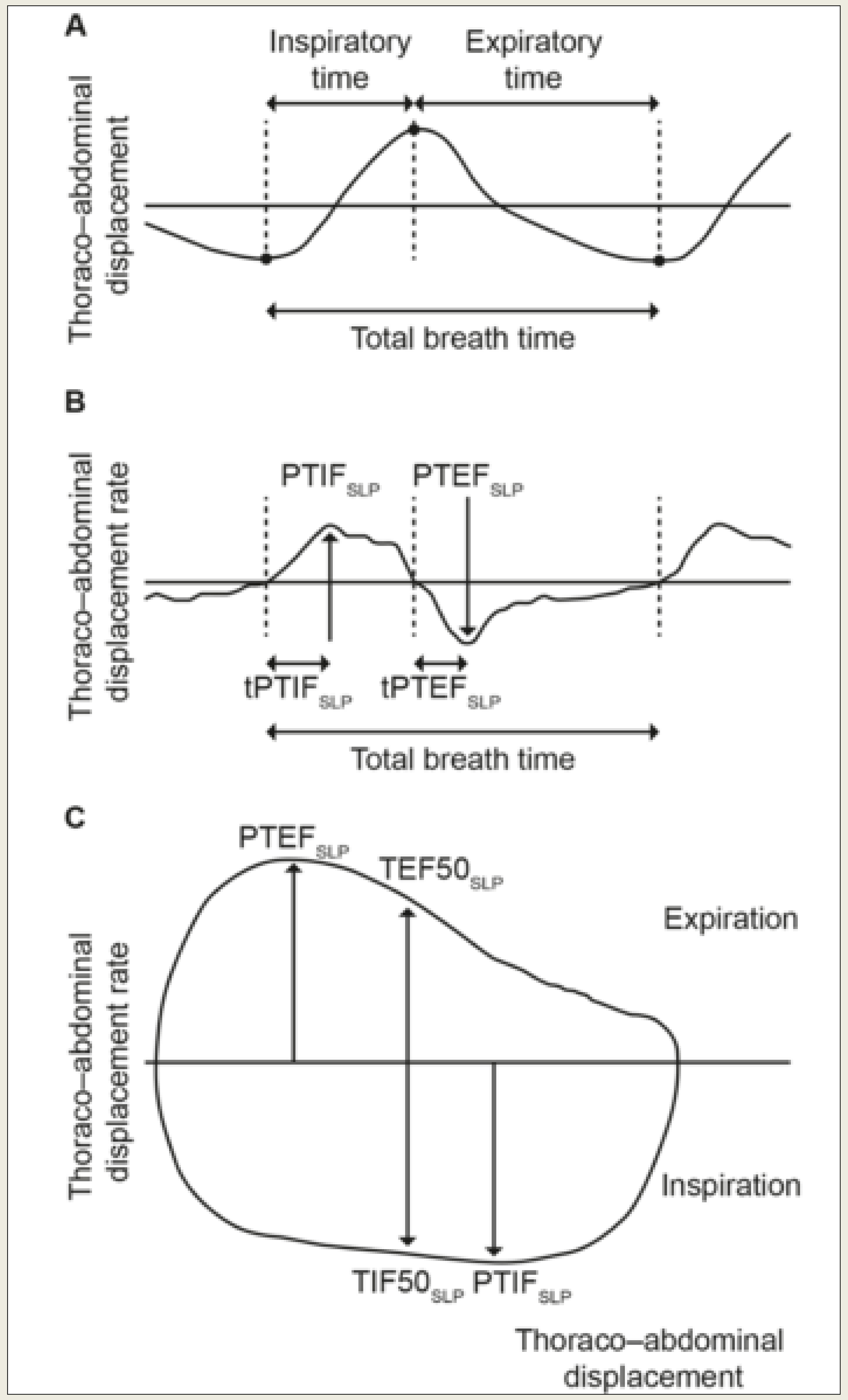

Figure 2: Structured light plethysmography tidal breathing traces and derived parameters. (A) Timing indices. (B) Thoraco–abdominal (TA) displacement rate-derived parameters; $PTIF_{SLP}$ (Peak tidal inspiratory Flow), $PTEF_{SLP}$ (Peak tidal expiratory flow), $tPTIF_{SLP}$ (time to peak tidal inspiratory Flow), $tPTEF_{SLP}$ (time to peak tidal expiratory Flow). (C) TA displacement rate with TA displacement-derived parameters.

RESULTS

An increase in FEV1 % predicted indicated a positive response to a bronchodilator (68.4 vs 81.2; p<0.0001) in the asthma group.

- $mIE50_{SLP}$ was significantly higher in asthmatic children (1.53 vs 1.22, P=<0.001) and decreased following bronchodilator intervention (1.53 to 1.45, P=0.01) however remained significantly higher than normal (1.45 vs 1.22, p<0.001) see Figure 3A.
- $vIE50_{SLP}$ was significantly higher in asthma (0.63 vs 0.47, P=<0.001) and decreased following bronchodilator intervention (0.63 vs 0.6, p=0.04)) but remained higher than normal (0.60 vs 0.47, p<0.01).

Several other parameters (mtI/tE, mtI/tTot and vtPTEF/tE) were lower in asthma however did not show a response to bronchodilator (p>0.05).

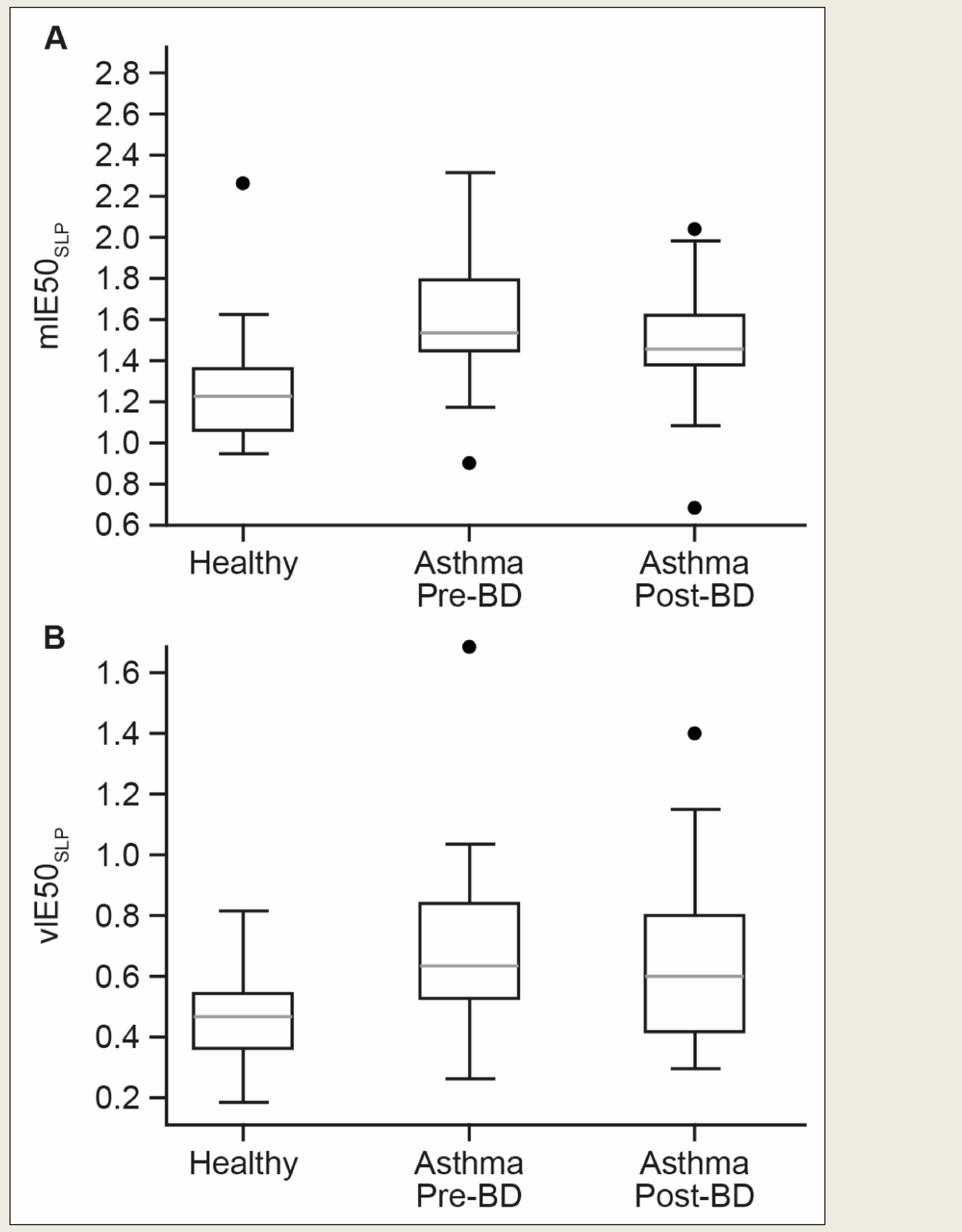

Figure 3: $mIE50_{SLP}$ (A) and $vIE50_{SLP}$ (B) in healthy children and in those with asthma (pre- and post-bronchodilator),. Each SLP parameter and its variability were compared between healthy children and those with asthma (pre-bronchodilator) using a Mann-Whitney-U test. The paired Wilcoxon signed-rank test was used to assess the effect of bronchodilator in children with asthma.

CONCLUSIONS

We have shown that SLP can be used in children with asthma to quantify clinically relevant tidal breathing parameters that differentiate asthma from normal. Most markedly, $mIE50_{SLP}$ was higher in children with asthma and was sensitive to a bronchodilator response.

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