Non-invasive, non-contact measurement of tidal breathing parameters in children aged 3-17 years using Structured Light Plethysmography (SLP)

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Background:

An accurate diagnosis and monitoring of a respiratory disease 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).

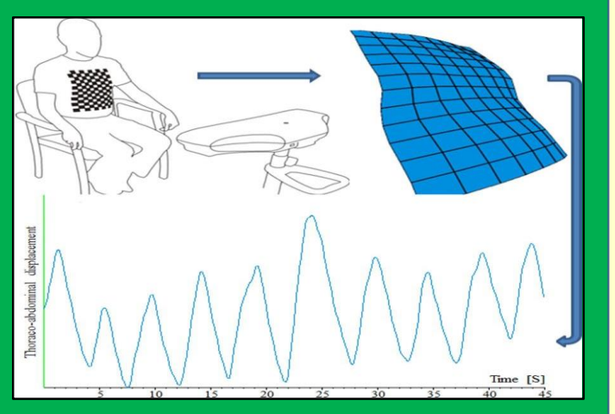
• Structured light plethysmography (SLP) is a novel technique developed at Cambridge to determine the parameters of tidal breathing in a non-invasive and zero-contact environment.

Study Aim:

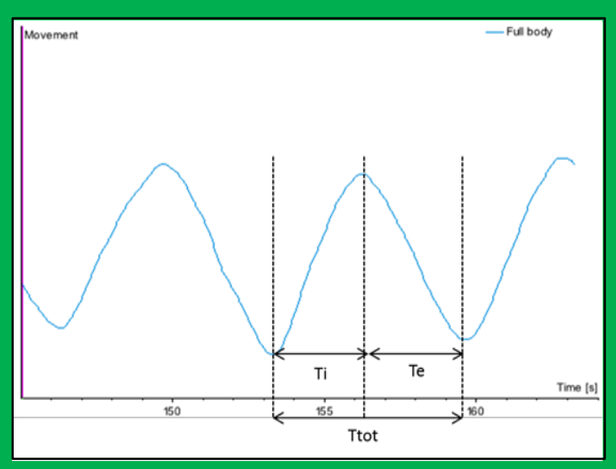
Investigating the use of SLP for measuring tidal breathing in children aged 3-17 years.

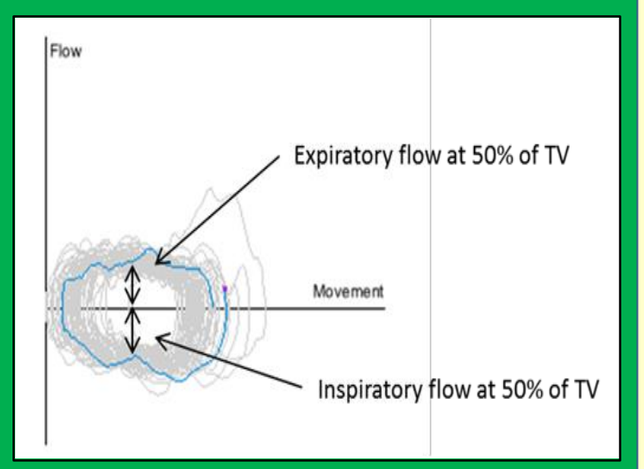
Methods:

- Structured light was projected onto the chest and abdomen of a child seated 1m from the device (Thora-3Di™, PneumaCare, Cambridge, UK)



- Fifty normal children (25 F, 25 M) ages 3 – 17 were recruited and their breathing was monitored for a period of 5 minutes.
- Clinically relevant breathing parameters such as respiratory rate (RR), duty cycle (Ti/Ttot) were obtained from the movement-time signal.
- Flow is defined as the rate of change of the movement signal , and is calculated as the first derivative of the movement-time signal.
- The ratio of inspiratory to expiratory flow at 50% of tidal movement IE50 $_{SLP}$ was obtained from Flow-movement loops.





- Relative contributions of rib-cage to total movement (RC2Tot) were determined.

Results:

Normative data were collected for 44 children for the age range 3 – 17 years. In six children, excessive movement of the child during data collection prevented reliable parameter estimation.

Age band	Height (m)	Weight (kg)	RR (min^{-1})	Ti/Ttot	IE50	RC2Tot (%)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
2 - 5	108.3 (8.9)	19.7 (4.1)	26.1 (6. 9)	0.73 (0.07)	1.83 (0.30)	40.4 (9.4)
6 - 9	120.4 (33.3)	28.1 (4.7)	26.2 (4.3)	0.45 (0.3)	1.29 (0.17)	42.3 (13.1)
10 - 13	148.2 (7.6)	42.8 (12.0)	19.0 (3.2)	0.44 (0.3)	1.32 (0.2)	44.4 (15.1)
14 - 17	167.6 (10.4)	61.4 (14.0)	18.8 (6.0)	0.42 (0.06)	1.55 (0.7)	50.5 (17.1)

Breathing parameters identified by SLP in non-asthmatic children

• A decrease in respiratory rate with increasing height was found.
• Variability in duty cycle decreased with increasing height (r=- 0.31, p=0.039).

Conclusion:

- We have demonstrated the feasibility of obtaining objective measures of tidal breathing using SLP in children without any specific expertise in pulmonary function testing.
- In addition to standard lung function parameters SLP provided information about regional changes in ventilation with age and allowed the quantification of relative contribution of thoracic and abdominal wall movements in breathing.

References:

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