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Thoracic excursion measurement in children with cystic fibrosis☆

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Abstract

Background: Measurement of thoracic excursion (TEM) during maximal ventilation is part of the physiotherapy assessment in children with cystic fibrosis (CF).
Objectives: The purpose of our study was to examine the reliability of TEM and its relation with pulmonary function.
Methods: Thoracic excursions were measured using a measuring tape. Thirty children participated in an intra-observer and inter-observer reliability study. Reliability was determined by calculating the typical error in repeated measurement, limits of agreement and correlation coefficients. Cross-sectional data from the annual check-ups were used to measure the relation between TEM and pulmonary function.
Results: In the intra-observer reliability study the typical error was 0.31 cm, the limits of agreement were ±0.86 cm. Pearson's r and ICC were 0.96 and 0.95, respectively. In the inter-observer reliability study these values were 0.56 cm, ±1.55 cm, 0.85 and 0.85, respectively. TEM correlated significantly with height (0.31, $P<0.001$), FVC (0.44, $P<0.001$), FEV_1 (0.41, $P<0.001$) and TLC (0.19, $P<0.05$), and there was a significant inverse correlation with RV%TLC (−0.45, $P<0.001$).
Conclusions: TEM is a reliable assessment tool. Thoracic excursion is significantly, although moderately correlated with pulmonary function.

Keywords: Cystic fibrosis; Child; Pulmonary function test; Physiotherapy

1. Introduction

Early recognition of pulmonary exacerbations and appropriate antibiotic treatment may slowdown the process of pulmonary decline in children with CF. Paediatric physiotherapists create conditions for optimising airway clearance, physical fitness, and daily functioning by teaching and supporting the child and his parents. Because of regular contact with the child, a paediatric physiotherapist should recognise early pulmonary deterioration. A standardised assessment by the paediatric physiotherapist is required in order to evaluate the pulmonary status. In the Netherlands, TEM is commonly used as an outcome parameter during in-hospital treatment or in the outpatient clinic [1]. It is a simple tool and takes little time. The rationale of TEM is that the range of motion of the thorax, including the thoracic vertebrae, sternum and ribs, serves the respiration. Movements of the thorax influence the content of the thorax cavity leading to alterations in lung volumes. On the other hand, decreased dynamic lung volumes due to chronic obstructive lung diseases and structural lung damage decrease the magnitude of thoracic range of motion. It is assumed that the maximal level of thoracic excursions may be an indirect measure of the pulmonary status in children with pulmonary disease [1]. Preliminary data supported this

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assumption [2]. However, the relation between TEM and pulmonary function has not been described so far. The aim of this study was to determine the reliability of TEM and its relation to pulmonary function and height.

2. Methods

2.1. Subjects

In the first part of the study, 30 children and adolescents with CF (M/F = 15/15, age 11.8 (5.9–18.0 years)) participated in an intra-observer reliability study. Thirty other children and adolescents with CF (M/F = 19/11, age 12.9 (7.4–18.9 years)) participated in an inter-observer reliability study.

In the second part of the study, cross-sectional data from 159 children and adolescents with CF (M/F = 85/74, age 12.3 (5.5–19.6 years)) were available and extracted from a database. These data consisted of pulmonary function and TEM parameters, obtained during the annual check-up at the Cystic Fibrosis Centre Utrecht. Informed consent was obtained from children and/or their parents.

2.2. Instruments

Thoracic excursions were measured using a measuring tape with centimetre markings (Hoechst Mass, Germany). Height was measured with a stadiometer (Holtain, Crymich, UK). Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV_1) were obtained from maximal expiratory flow volume curves (Jaeger Masterscreen) [3]. Residual Volume (RV), Total Lung Capacity (TLC), and RV%TLC were measured using body plethysmography (Jaeger Masterlab) [3].

2.3. Procedure

TEM was standardised: subjects were lying in supine. A measuring tape with centimetre markings was set around the chest at axillary level (Fig. 1). Subjects were asked to inhale and exhale calmly while at Functional Residual Capacity volume (FRC) thoracic circumference (in cm) was measured. The subjects were subsequently asked to inhale and exhale maximally, and thoracic circumference was measured at maximal in- and expiration. The difference in thoracic circumference (in cm) between maximal inspiration and maximal expiration was recorded as thoracic excursion. The same procedure was repeated at xiphoid level. The subjects were previously instructed to relax the shoulder muscles, and to perform to the best of their abilities.

In the first part of the study, one observer (JC) performed two consecutive measurements for the intra-observer reliability study. A two-sided measuring tape was used of which one side was blinded with masking tape.

Fig. 1. Thoracic excursion measurement.

After the first measure (using the un-blinded side) the measuring tape was turned around. Lines were drawn on the blinded side to mark the levels of thoracic circumference on maximal inspiration and maximal expiration during the second measure. Then, the distances between the lines were determined (in cm), recorded and compared with results from the first measurement.

Furthermore, two observers (JC, FK) performed a single measurement independently, on another patient group and under equal conditions for the inter-observer reliability study. Results of both observers were compared.

2.4. Data analyses

Thoracic excursions were expressed as the mean of thoracic excursions from the axillary and xiphoid level. The intra-observer reliability of TEM was determined by calculating the ‘change in mean’ and the ‘typical (standard) error of measurement’ according to Hopkins [4], and the ‘limits of agreement’ (LoA) as described by Bland and Altman [5]. Moreover, the ‘correlation coefficient’ (Pearson’s r) and ‘Intra-Class Correlation coefficient’ (ICC) were calculated. The same analyses were performed for the inter-observer reliability study.

In the second part of the study, the relations between TEM and age, height and pulmonary function parameters were measured. Partial correlation technique was used to control for height since we assume that height and pulmonary status independently influence the TEM score. A p-value <0.05 was considered statistically significant. Data were analysed using the SPSS, version 11.5.

3. Results

3.1. Reliability

There was a negligible difference between the means of TEM in the intra-observer reliability study, and the typical error was 0.31 cm, i.e. 4.9% of the mean (Table 1). The