BRIEF REPORT

Comparison of two devices for assessment of the interrupter resistance in preschool children

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ABSTRACT

Respiratory interrupter resistance (Rint) proved to be a useful lung function index in preschool children. In this brief report, we show the results obtained comparing two Rint devices: MicroRint (MicroMedical) and Pony (Cosmed). This comparison is very relevant in clinical practice because MicroRint, which was mostly used in the literature, is no longer available on the market, while no Rint reference values were reported using Pony. Briefly, 81 children [median age (range) 4.6 (2.8-6.0) yr] undertook Rint measurements with both devices, in a random order. We also evaluated the short-term repeatability of Pony in a different set of 25 children [median age (range) 4.8 (3.2-5.7) yr]. The mean (SD) of the difference Pony-MicroRint was small, albeit significant [0.046 (0.12) kPa.l^{-1}.s, p = 0.001]. The limits of agreement between the two devices were 0.286 to -0.194 kPa.l^{-1}.s. The short-term repeatability of Pony was 0.26 kPa.l^{-1}.s, very similar to the one previously published for MicroRint. In conclusion, we suggest that, in preschool children, normative data previously collected with MicroRint can be applied to measurements made with Pony, at least for clinical purposes, with acceptable error. However, these findings need to be confirmed in children with a greater range of ages and resistance values.

IMPACT STATEMENT

The device that was mostly used in the literature to calculate Rint reference values and repeatabilty is no longer available on the market. A formal comparison of that device with a similar device is expected to have a great impact on clinical practice.

INTRODUCTION

The interrupter technique, firstly described in 1927 (1), has been used in several laboratories and is a potentially useful tool in the evaluation of lung function in preschool children (2-5 years of age), in whom the use of conventional

These data were partially presented at the 2012 Annual Meeting of the American Thoracic Society, San Francisco, CA, USA (Lombardi E, Luzzi V, Fenu G, et al. Comparison of two devices for assessment of interrupter resistance in preschool children. Am J Respir Crit Care Med. 2012;185:A6148).

KEY WORDS

Interrupter technique; preschool children.

techniques is often very difficult: they are generally too old to be sedated and to perform standard tests used for infants, and too young to be able to correctly perform the voluntary maneuvers required for spirometry and other tests used in older children and adults (2). The assessment of lung function in this age group is important for clinical reasons and also to study the changes in respiratory mechanics due to the considerable growth of the respiratory system during childhood. Many studies have been published on the interrupter technique. In preschool children, it has been shown to be feasible and repeatable, to have a good correlation with "gold standard" techniques and be able to detect changes in airway caliber. The clinical interpretation of the interrupter resistance (Rint) has been made easier by the availability of reference values, repeatability coefficients, and bronchodilation cut-offs for preschool children (3-5).

Several studies on Rint measurements in children have been published using the MicroRint device (Micro Medical Ltd, Rochester, UK). Unfortunately, the company has stopped producing this device. The Pony device (Cosmed, Rome, Italy) has technical characteristics similar to those of the MicroRint, but a formal comparison of the two devices has never been reported so far. Both machines were designed to follow the ATS/ERS recommendations published in 2007 (2).

A formal comparison between the two devices is of great importance. Should the difference between the two machines be greater than the technique variability itself, the application of current reference values to Pony would be wholly inappropriate.

The aim of this study was to establish whether Rint measurements obtained with the Pony device are similar to those obtained with MicroRint. Also, since the repeatability of the technique is important for the interpretation of the limits of agreement between the two machines, we aimed to evaluate the short-term repeatability of the Pony device and compare it with the already published short-term repeatability for MicroRint (3, 4).

METHODS

This study was performed in children aged 3-6 years referred with a history of either cough or wheeze recruited during routine outpatient attendance in our Pediatric Pulmonary Unit at the Meyer Children's Hospital in Florence, Italy. The study was approved by the Ethics Committee of our institution. Before children were enrolled in the study, parents received an informative sheet about the research project and signed an informed consent form.

A formal comparison between the two devices (MicroRint, Micro Medical Ltd, Rochester, UK; Pony, Cosmed, Rome, Italy) was made by measuring Rint with both machines, in random order, about 10 minutes apart. Both machines comply with the ATS/ERS recommendations on pulmonary function testing in preschool children (2). All tests were performed by the same operator (VL) to minimise operator-induced variability. Procedure and measurement conditions followed the ATS/ERS recommendations (2). Briefly, children were asked to wear a nose clip and breathe quietly through a mouthpiece and bacterial filter (for each machine, the filter recommended by the manufacturer was used). All measurements were carried out with the children standing with the neck slightly extended; cheeks and pharynx were supported during the measurements. With both devices, the shutter closed automatically during tidal breathing after peaking expiratory flow and stayed closed for 100 ms. Mouth pressure was estimated by linear back extrapolation of the post-occlusion signal from 70 and 30 ms after closure to 0 ms. Rint was calculated by dividing mouth pressure by flow right before the occlusion. At least 10 interruptions were performed with each device to obtain at least 5 acceptable traces. Interruptions were discarded if the mouth pressure trace was flat or showed a decrease after the initial peak following the occlusion or if the child was breathing irregularly during the test (2). MicroRint allowed the operator to see the pressure-time curves at the end of the whole measurement, while Pony showed the pressure-time trace after each interruption. For both devices, each measurement was calculated as the median of the expiratory Rint values from at least 5 technically acceptable interruptions.

Short-term repeatability for Pony was assessed in a different group of preschool children by performing 2 separate measurements (meas1 and meas2) about 10 minutes apart using the same procedure as above. All tests were performed by the same operator (VL) to minimise the operator variability.

The Stata statistical package was used for the analysis (StataCorp LP, College Station, TX, USA, version 12.1). The equation previously published by our group [expiratory Rint = 2.126878 - (0.012538 × height in cm) kPa.l^{-1}.s] was used to calculate the predicted Rint values (3). Residual standard deviation (RSD) = 0.2038 kPa.l^{-1}.s (2, 3) was used to calculate Z-score values for Rint using the equation: (Rint measured - Rint predicted)/RSD. The normality distribution of variables was checked and the Student's t-test was used for the comparison of means. The difference between the two measurements was calculated as ΔRint = Pony - MicroRint for the comparison between the two devices and as ΔRint = meas2 - meas1 for short-term repeatability of Pony. The Bland-Altman test (plot of ΔRint versus mean Rint values) was used to evaluate if the difference between the two measurements was correlated with Rint baseline values (6). The limits of agreement between the measurements obtained with the two devices were calculated as +2 SD of ΔRint (6, 7). The coefficient of repeatability (CR) for Pony was also calculated as 2 SD of the mean Rint difference. A type-1 error <0.05 was considered to be statistically significant.

RESULTS

Eighty-one children [53 male (65.4%), median age (range) 4.56 (2.76-5.95) yr, mean height (SD) 107.8 (7.1) cm] underwent baseline Rint measurements with both devices. Mean Rint (SD) was 0.89 (0.26) and 0.94 (0.25) kPa.l^{-1}.s for MicroRint and Pony, respectively (p = 0.001), corresponding to a mean (SD) Z-score of 0.58 (1.21) for MicroRint and 0.80 (1.23) for Pony. The mean (SD) of the differences between the pairs was 0.046 (0.12) kPa.l^{-1}.s. The limits of agreement were 0.286 to -0.194 kPa.l^{-1}.s (**Figure 1**). When abnormal lung function was defined as having a Z-score >1.97, nine children (11%) had abnormal lung function with both Pony and MicroRint, while only one child had abnormal lung function with Pony and normal lung function with MicroRint.

The short-term repeatability of Pony was assessed in 25 children [15 male (60%), median age (range) 4.85 (3.19-5.70) yr, mean height (SD) 107.7 (5.7) cm]. Mean (SD) meas1 was 0.943 (0.27) kPa.l^{-1}.s and mean (SD) meas2 was 0.939 (0.27) kPa.l^{-1}.s, respectively (p = 0.889). The mean (SD) difference between the two measurements was -0.004 (0.13) kPa.l^{-1}.s and CR was 0.26 kPa.l^{-1}.s (**Figure 2**).

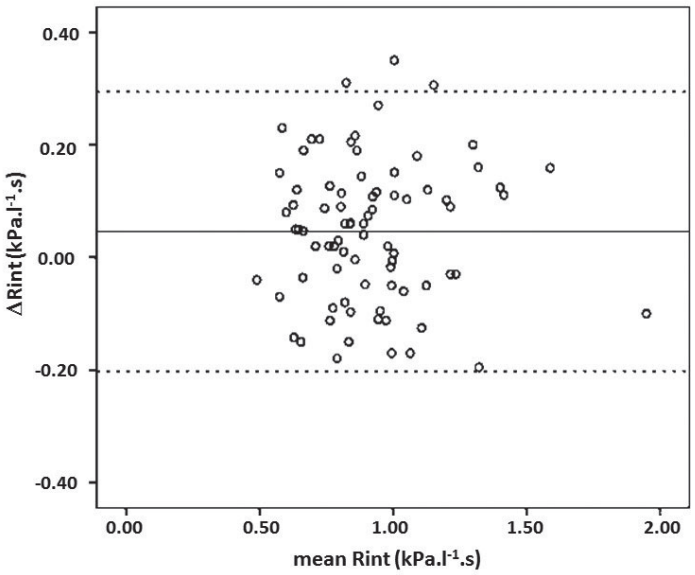

Figure 1. *Bland-Altman plot for the formal comparison between Pony and MicroRint (n = 81 children). The midline represents the mean of the difference between the 2 measurements (Pony-MicroRint); the dotted lines represent the limits of agreement between the two techniques (+2 SD of the mean difference).*

DISCUSSION

Many studies have been published on the interrupter technique which, in preschool children, has been shown to be feasible and repeatable, have a good correlation with "gold standard" techniques, and be able to detect changes in airway caliber (8). The interrupter technique was able to detect impaired lung function in a cohort of children born prematurely (9) and to measure dose-response to salbutamol in wheezy preschool children (10). Also, in a population-based prospective cohort study, Rint was found to be higher at age 6 in those with low levels of 25-hydroxyvitamin D at birth (11).

The MicroRint device was mostly used in the literature but is no longer available on the market. The Pony device has technical characteristics similar to the MicroRint, but no formal comparison of the two devices is available in the literature so far.

In the present study, we found a small but statistically significant difference between Rint measured with the two different machines. However, the group mean difference was small and unlikely to be clinically relevant. Also, the limits of agreement between the two machines were similar to the previously published short-term repeatability for MicroRint (0.24 kPa.l^{-1}.s) (3) and to the short-term repeatability for Pony measured in this study (0.26 kPa.l^{-1}.s). The fact that nine children had abnormal lung function with both Pony and MicroRint, while only one child had abnormal lung function with Pony but normal lung function with MicroRint, confirms that the clinical conclusions would be similar using the two machines.

The systematic difference in group mean Rint was not due to any systematic bias in study design: the order of the measurement with each machine was randomized and measurements were performed by the same operator to decrease the potential variability of the test. Both machines were set to follow the European Respiratory Society (ERS) and the American Thoracic Society (ATS) recommendations on lung function measurements in preschool children (2). The software in both machines allows the user to change the settings in the options menu; therefore, it is important that the settings be checked regularly. Inadvertent use of different settings is likely to lead to erroneous results.

In conclusion, Pony Rint values were systematically higher than those obtained with MicroRint. However, the difference between the results obtained with the two devices was clinically small, and the limits of agreement between the two machines were similar to their short-term repeatability. We suggest that, in preschool children, normative data previously collected with MicroRint can be applied to measurements made with Pony for clinical purposes with acceptable error. However, these findings need to

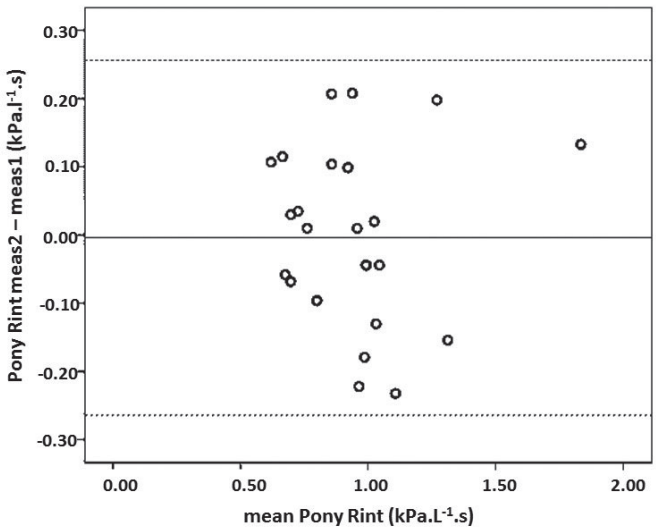

Figure 2. *Bland-Altman plot for the short-term repeatability of Pony (n = 25 children). The solid line represents the mean difference between the 2 measurements (meas2-meas1); dotted lines represent +2 SD of the mean difference.*

be confirmed in children with a greater range of ages, respiratory disorders, lung volumes, and resistance values.

COMPLIANCE WITH ETHICAL STANDARDS

Conflicts of interests

Claudia Calogero and Valentina Luzzi declared no conflict of interests; Grazia Fenu declared potential conflict of interests with the following companies: Boeringher-Ingelheim, Novartis, Restech, Sanofi, AstraZeneca, Chiesi, GSK, Novartis; Peter D. Sly reported no conflict of interests. Enrico Lombardi declared potential conflict of interests with the following companies: AbbVie, Angelini, Boehringer, Chiesi, Cosmed, GSK, Novartis, Restech, Sanofi.

Financial support

N/A.

Authorship

Claudia Calogero, Grazia Fenu (CC and GF contributed equally to this work and should be considered joint first Authors), Valentina Luzzi, Peter D. Sly, Enrico Lombardi.

Author contributions

CC and GF contributed to data acquisition, data analysis, and drafting the work; VL contributed to data acquisition and data analysis; PDS and EL contributed to the conception and design of the work, data analysis and interpretation, and critical review of the work for intellectual content.

Ethical approval

Human studies and subjects

The study protocol was approved by the Local Ethics Committee, in accordance with the ethical standards established in the Declaration of Helsinky 1946. Informed consent was obtained from the parents of all participants before enrollment in the study.

Animal studies

N/A.

Data sharing and data accessibility

The data underlying this article can be shared just before a reasonable request to the Corresponding Author and prior the authorization of the Local Ethics Committee.

Publication ethics

Plagiarism

Any overlaps with other articles are appropriately cited.

Data falsification and fabrication

All the data correspond to the real.

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