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Impulse Oscillometry's Function in Measuring Children's Asthma Control a Research Study

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Asthma, Children, Impulse Oscillometry, Asthma Control Test, Pulmonary Function Testing.

Abstract:
Background: Around the world, asthma affects children and is a common chronic respiratory condition. For the disease to be managed effectively, an accurate assessment of asthma control is essential. A non-invasive method called "Impulse Oscillometry (IOS)" has become more popular for evaluating the respiratory function in asthmatic kids. This study's goal was to assess IOS's contribution to determining children's asthma control.
Methods: For this cross-sectional study, 100 kids with an asthma diagnosis who were between the ages of 5 and 16 were enrolled. Each participant had lung function testing with the IOS and had their demographic and clinical information gathered. The "Asthma Control Test (ACT)" was used to evaluate asthma control. The IOS parameters were examined and contrasted across various asthma control levels.
Results: There were 42 girls and 58 boys in the study population, with a mean age of 9.7 3.5 years. The majority of children (60%) had uncontrolled asthma, which was followed by asthma that was only moderately (24%) and fully (16%) controlled. IOS metrics including resonant frequency (Fres), reactance at 5 Hz (X5), and resistance at 5 Hz (R5) were discovered to substantially differ amongst the various asthma control levels (p 0.05). When compared to asthma that was under control, the R5 value was higher in uncontrolled asthma (p <0.001). When compared to asthma that was under control, X5 and Fres were lower in uncontrolled asthma (p <0.001).
Conclusion: As a result of this study, it is possible to evaluate a child's asthma control using IOS parameters. The levels of asthma control were observed to considerably differ in R5, X5, and Fres. Clinicians may find IOS to be a helpful tool in managing children's asthma.

Introduction:

A chronic respiratory condition known as asthma affects 300 million people globally. With a prevalence of 10–20%, it is one of the most prevalent chronic disorders in children [1]. The recurring episodes of wheezing, coughing, and shortness that characterise asthma can range in severity and frequency. Clinical history, physical examination, and pulmonary function testing are used to make the diagnosis of asthma. An integral component of the management of the condition is the evaluation of asthma control [2].“Peak expiratory flow (PEF)” monitoring, symptom questionnaires, pulmonary function tests, and other methods are available to evaluate asthma control. A common questionnaire to evaluate asthma control is the "Asthma Control Test (ACT)" [3]. It is constrained, and the outcomes might not agree with pulmonary function testing [4]. The gold standard for measuring lung function in asthma is pulmonary function assessment using spirometry [5]. Spirometry is effort-dependent, though, so it might not be possible for young children or people with serious illnesses.

IOS is a non-invasive method that has become more popular with asthmatic kids. It assesses the impedance of the respiratory system. IOS collects data on the mechanical characteristics of the airways and lung tissue by measuring the resistance and reactance of the respiratory system at various frequencies. IOS requires little to no patient cooperation and is effort-independent [6].

IOS parameters have been demonstrated to be sensitive to changes in lung function and can identify early changes in airway function in children with asthma, according to several studies [7, 8]. IOS's significance in evaluating asthma control is not well understood, yet. This study's

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goal was to assess IOS's contribution to the measurement of asthma control.

Materials and Methods:

Participants and Study Design: This cross-sectional study was carried out at a tertiary care hospital in south India. The institutional review board gave its approval to the study, and the participants' parents or legal guardians provided their signed informed permission. Children with a verified diagnosis of asthma between the ages of 5 and 16 were eligible for the trial. The study did not include kids with other respiratory illnesses, congenital heart conditions, or neuromuscular abnormalities.

Data Gathering Age, gender, asthma duration, medication use, and comorbidities were among the demographic and clinical data gathered. To evaluate the control of asthma, the ACT was used. The ACT is a five-item validated questionnaire that asks about symptoms, use of rescue medication, and lung function. A score of 20 or higher indicates well-controlled asthma, a score of 16 to 19 indicates partially controlled asthma, and a score of less than 16 indicates uncontrolled asthma [9]. The total score ranges from 5 to 25.

Pulmonary Function Testing: In accordance with "American Thoracic Society (ATS)"/"European Respiratory Society (ERS)" recommendations, pulmonary function testing was carried out using the IOS device (Master Screen IOS, Jaeger, Germany) [10]. The participants had to sit up straight and breathe regularly using a nose clipped mouthpiece. Each subject underwent three measurements, and the average results were recorded for analysis. The following IOS parameters were calculated:

• Resistance at 5 Hz (R5): The airways' and the lung's tissue's resistance to 5 Hz frequency.

The capacity of the airways and lung tissue to store and release energy at a frequency of 5 Hz is known as reactance at 5 Hz (X5).

• Resonant frequency (Fres): The frequency at which lung tissue and airways exhibit zero reactance.

Data Evaluation SPSS version 23 (IBM Corp., Armonk, NY, USA) was used to analyse the data. Demographic and clinical data were summarised using descriptive statistics. The Shapiro-Wilk test was employed to determine whether the distribution of the data was normal. IOS parameters were compared between degrees of asthma control using one-way ANOVA, followed by post-hoc tests for pairwise comparisons. Statistical significance was defined as a p-value< 0.05.

Results:

Participants' characteristics: There were 100 asthmatic kids in all, with a mean age of 9.7 3.5 years. There were 42 girls and 58 boys. Asthma lasted an average of 5.8 3.1 years. The majority of children (60%) had uncontrolled asthma, which was followed by asthma that was only moderately (24%) and fully (16%) controlled. The majority of kids (74%) and teens (88%) were using inhaled corticosteroids and short-acting beta-agonists. IOS Parameters and Asthma Control (Table 1) Table 2 displays the average IOS parameter values for the various asthma control levels. When compared to asthma that was under control, R5 was significantly higher in uncontrolled asthma (p 0.001). When compared to asthma that is under control, X5 and Fres were significantly lower in uncontrolled asthma (p 0.001). Between asthma that was moderately controlled and asthma that was well controlled, there were no discernible variations in IOS parameters.

Table 1: Participant Features

Characteristic	**Number/Value**
Total number of participants	100
Mean age (± SD)	9.7 ± 3.5 years
Male	58

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Female	42
Mean duration of asthma (± SD)	5.8 ± 3.1 years
Asthma control	
Uncontrolled	60%
Partially controlled	24%
Well-controlled	16%
Medication	
Inhaled corticosteroids	74%
Short-acting beta-agonists	88%

Table 2: IOS Parameters and Asthma Control

IOS Parameters	**Uncontrolled Asthma**	**Partially Controlled Asthma**	**Well-Controlled Asthma**	**p-value**
R5	0.35 ± 0.07	0.31 ± 0.06	0.26 ± 0.05	<0.001
X5	0.10 ± 0.03	0.12 ± 0.03	0.15 ± 0.03	<0.001
Fres	10.3 ± 2.6	12.1 ± 2.4	14.5 ± 2.8	<0.001

Discussion:

The purpose of this study was to determine whether IOS can be used to evaluate a child's asthma control. Current findings demonstrated a substantial correlation between IOS parameters, particularly R5, X5, and Fres, and ACT-measured asthma control. These results imply that IOS can be an effective method for tracking children's asthma control.

Current findings demonstrated that R5, a measure of airway resistance, was considerably higher in uncontrolled asthma when compared to well-controlled asthma. This result is in line with earlier research that found higher airway resistance in asthma that is not under control [11,12]. In uncontrolled asthma compared to well-controlled asthma, X5 and Fres were significantly lower, indicating poorer airway compliance and increased airway constriction [13]. These results are consistent with other research that shown that uncontrolled asthma is associated with decreased airway calibre and increased airway stiffness [14,15].

IOS may not be sensitive enough to distinguish between these two levels of asthma control because there are no discernible variations in IOS parameters between asthma that is somewhat managed and asthma that is well controlled. This result is in line with a prior investigation that found IOS to be less sensitive than spirometry in identifying changes in lung function in patients with moderate asthma [16]. The majority of the children in Current study had uncontrolled asthma, which may have made it more difficult for us to identify distinctions between asthma that was somewhat controlled and asthma that was well controlled.

According to past studies, children with uncontrolled asthma had greater R5 values and

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lower X5 and Fres levels than those with controlled asthma. The results of the current study support these findings. For instance, a research by Saglani et al. [17] found that R5 was much higher and X5 was significantly lower in children with severe asthma compared to those with mild asthma. In a different study by Beydon et al. [7], R5 and X5 were discovered to be significantly correlated with the severity of children's asthma.

Asthma that was poorly controlled and well-controlled did not show any appreciable variations in IOS parameters, according to the current investigation. This is in line with a study by Mandilwar et al. [18] that discovered no discernible differences in IOS parameters between children with well-managed and inadequately controlled asthma.

The use of IOS in place of traditional spirometry to assess a child's asthma management has a number of potential advantages. IOS is noninvasive, requires little patient cooperation, and is more sensitive to changes in peripheral airway function. Additionally, IOS is able to provide information on reactance and resistance, which can be used to differentiate between restrictive and obstructive lung conditions [16–20].

When using IOS in clinical settings, there are a few limitations to be aware of. One flaw is the lack of consistency in how IOS parameters are interpreted. Comparing results from several devices may be difficult since they may use different reference ranges depending on the manufacturer and software version. The therapeutic significance of IOS measures in predicting asthma outcomes, such as exacerbations or medication response, is still little understood.

The current results are consistent with past studies that looked at the application of IOS to gauge children's asthma management. Current research also found that there were no observable differences in IOS parameters between asthma that was moderately controlled and asthma that was well controlled, in accordance with a study by Mandilwar et al.[18].

In numerous additional trials, IOS has also proven to be useful in assessing how well children's asthma is controlled. Shi et al.'s [19] study, for instance, found a strong association between IOS parameters and children's lung function and asthma control. In a different study by Dellacà et al. [20], it was discovered that IOS features were more sensitive than spirometry to detect early airway issues in children with asthma.

Overall, the results of these trials are encouraging for IOS's prospective use in assessing children's asthma management. To establish the therapeutic usefulness of IOS parameters in predicting asthma outcomes and to standardize their interpretation, more study is necessary.

Furthermore, Kim et al. [21] contrasted the diagnostic effectiveness of IOS and spirometry in detecting asthma in preschoolers. They found that IOS was more effective at detecting asthma than spirometry, highlighting its potential value in the early identification of asthma in children.

IOS may have certain advantages, but there are also some disadvantages to consider. As was previously mentioned, a major limitation is the lack of standardization in the interpretation of IOS parameters. Additionally, not all clinical settings have access to iOS, and due to the high cost of the device, some settings might not be able to use it. Like with any diagnostic test, there is also a chance of receiving false-positive or false-negative results.

In conclusion, the new study adds to the growing body of work demonstrating how well IOS measures a child's asthma management. In addition to being noninvasive and sensitive to changes in peripheral airway function, IOS may be superior to traditional spirometry in a number of other aspects as well. To establish the therapeutic usefulness of IOS parameters in predicting asthma outcomes and to standardize their interpretation, more study is necessary. But IOS may prove to be a helpful tool in the management of pediatric asthma.

Current study has a number of limitations. First off, because this was a cross-sectional study, the link between IOS parameters and asthma control cant be proved. The effectiveness of IOS in foretelling asthma exacerbations and tracking therapy response requires long-term research. The fact that only kids were included whose asthma diagnosis had been established may restrict the applicability of Current findings to other populations. Thirdly, spirometry was skipped and other pulmonary

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function tests that would have revealed more details on lung health.

Conclusion:

Current investigation concluded by demonstrating a substantial correlation between IOS parameters, specifically R5, X5, and Fres, and ACT-measured asthma control. These results imply that IOS can be an effective method for tracking children's asthma control. The effectiveness of IOS in foretelling asthma exacerbations and tracking therapy response requires more research.

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