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# THE IMPORTANCE OF MODIFIED BRONCHOPHONOGRAPHY IN THE DIAGNOSIS OF RECURRENT BRONCHOOBSTRUCTIVE SYNDROME IN CHILDREN

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**Abstract. Purpose of the study:** to establish the diagnostic and prognostic significance of modified bronchophonography in bronchobstructive syndrome in children. Material and methods of research. The paper presents the results of examinations of children with bronchoobstructive syndrome. The patients were divided into 3 groups of 60 patients: Group I - patients with acute obstructive bronchitis (AOB), acute bronchiolitis (ABL), Group II - children with recurrent obstructive bronchitis (ROB) and bronchial asthma (BA), Group III - patients with acute bronchitis without bronchial obstruction (BA). **Results of the study and discussion.** Analysis of modified bronchophonography indices in groups I-II showed that on admission, E:I index>1.6 indicating bronchial obstruction of the II degree (P<0.001). On the 2nd day of observation, E:I index significantly decreased in patients with ROB, BA and was significantly lower in comparison with indices of patients with OOB, OBL (P<0,05). On the 3rd day of observation and at discharge, the indices were relatively equal, no significant difference was observed (P>0.2; P>0.1). When constructing the ROC-curve and analysing the curve coordinates, it was found that in determining the risk of ROB and AD in children, the diagnostic significance of the E:I index≥1.78, with a sensitivity of 71.7% and specificity of 61.1%. **Conclusions.** The values of E:I index≥1.78 are predictors of the risk of ROS and BA development, the diagnostic significance of which is confirmed by high sensitivity and specificity, which can be recommended for detecting the risk of recurrent course of BOS in children.

**Key words:** bronchoobstructive syndrome, modified bronchophonography, children.

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**Relevance.**

The diagnosis of lung diseases heavily relies on acoustic methods for examining the respiratory system. However, a significant drawback lies in the subjectivity and absence of universally accepted standards for evaluating auscultatory data[1,2].

Airway obstruction stands as a crucial clinical characteristic in pediatric respiratory diseases[3,4], diagnosed through the study of lung function. Yet, this examination poses challenges in young children[5].

Respiratory acoustics represents a scientific field primarily focused on developing objective acoustic techniques to diagnose lung diseases. This development is rooted in the theory of sound propagation and generation within the lungs[6].

The evaluation of external respiratory function is a vital method for assessing and monitoring the bronchopulmonary system in children. However, in young children, it is significantly hindered by the difficulty in establishing productive contact with the patient. Consequently, efforts have been made to propose new investigation methods that do not require active participation from the patient[7,8]. Among the commonly used methods for assessing external respiratory function are spirometry and peak flow measurement[1,4].

The objective analysis of lung acoustics has been facilitated by the advent of computerized techniques for recording and processing respiratory sounds[9]. This method has demonstrated notable advantages over traditional auscultation, significantly enhancing the diagnostic capabilities for various lung diseases, notably bronchoobstructive syndrome in pediatric patients[10,11].

Bronchophonography, a technique employed to assess respiratory patterns by graphically representing phonorespirograms derived from respiratory noise spectrograms, holds promise in this domain[4]. Its capacity to register acoustic manifestations adds value to the differential diagnosis of respiratory ailments in children, particularly in discerning bronchobstructive syndrome, a critical concern in early childhood.

The prevalence and recurrent nature of bronchial obstruction syndrome in preschool children, often accompanying acute respiratory infections, continue to engender significant scientific interest due to diagnostic complexities[12,13].

Assessing external respiratory function in children below five years old is

constrained by their inability to execute forced maneuvers. Consequently, the increasing adoption of computer bronchophonography in pediatric practice reflects its utility in this population[2,14].

**Purpose of the study:** to determine the diagnostic and prognostic relevance of modified bronchophonography in children affected by bronchobstructive syndrome..

**Material and methods of research.**

The study presents examination results of children hospitalized for various respiratory conditions: acute bronchitis, acute and recurrent obstructive bronchitis, acute bronchiolitis, and bronchial asthma complicated by Bronchial Obstruction Syndrome (BOS). These investigations were conducted during inpatient care at the Pulmonology and Pediatric Intensive Care Units of the Samarkand Regional Children's Multidisciplinary Medical Center from 2020 to 2023.

Patients were categorized into three groups: Group I comprised patients with acute obstructive bronchitis (AOB) and acute bronchiolitis (ABL), Group II consisted of children with recurrent obstructive bronchitis (ROB) and bronchial asthma (BA), while Group III involved patients with acute bronchitis without bronchial obstruction (BA).

Assessment of bronchial obstruction severity in children utilized the modified bronchophonography method[15] through the calculation of the Expiration-to-Inspiration (E:I) index. This technique involves a respiratory noise recording system and software for data analysis on a personal computer. The E:I index was determined using the formula: E:I index = exhalation (ms)/inhalation (ms). Importantly, this modified bronchophonography method was applied across all age groups and patient conditions.

The degree of respiratory dysfunction in Bronchoobstructive Syndrome (BOS) was evaluated using the Respiratory Distress Assessment Instrument (RDAI) scale developed by Lowell DI et al.[10]. Additionally, a saturation-scale estimation was calculated using the formula:

SSO = (95 - SpO2) + RDAI, where SpO2 represents the patient's saturation index.

Statistical analysis of the collected data was conducted using the «SPSS Statistics 26.0.0» package for Windows by SPSS Inc. and Microsoft Office Excel 2019.

**Results of the study and discussion.**

The analysis of modified bronchophonography parameters in Groups I-II (Table 1) revealed that upon admission, an E:I index >1.6 indicated a second-degree bronchial obstruction (P<0.001). By the 2nd day of observation, there was a significant decrease in the E:I index among patients with ROB and BA, showing notably lower values compared to patients with OOB and OBL (P<0.05). However, by the 3rd day of observation and upon discharge, the indices were relatively similar, showing no significant differences (P>0.2; P>0.1).

**Table-1**

**E:I index as a function of follow-up time in patients of groups I-III**

| № Observation Time | | Group I | | Group II | | Group III | | P1 | P2 | P3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | M | m | M | M | M | m | | | |
| 1 | Admission | 1,69 | 0,03 | 1,92 | 0,04 | 1,08 | 0,01 | <0,001 | <0,001 | <0,001 |
| 2 | 2nd day | 1,58 | 0,03 | 1,50 | 0,04 | 1,03 | 0,01 | <0,05 | <0,001 | <0,001 |
| 3 | 3rd day | 1,39 | 0,04 | 1,45 | 0,05 | 1,05 | 0,01 | >0,2 | <0,001 | <0,001 |
| 4 | Discharge | 1,17 | 0,02 | 1,18 | 0,02 | 1,02 | 0,01 | >0,1 | <0,001 | <0,001 |

Note: P1, P2, P3 indicate the reliability of differences between Groups I and II, I and III, II and III, respectively.

The analysis of modified bronchophonography in patients from Groups I and III revealed significantly higher E:I index values in patients with OPD and OBL compared to those with OP, both upon admission and during follow-up (P<0.001). Simultaneously, patients in Group III with OP but without bronchial obstruction exhibited E:I index values within the normal range, confirming the absence of bronchial patency disorders.

A similar trend in modified bronchophonography parameters was observed in patients from Groups II and III. Patients with ROB and AD consistently displayed significantly higher E:I index values compared to those with ED across all stages of dynamic observation, confirming statistical significance (P<0.001).

The saturation-scale assessment, reflecting the severity of respiratory disorders and blood oxygen saturation, was conducted upon admission and throughout the disease progression in patients.

The dynamic indices in patients from Groups I-II (Table 2) indicated higher SSO data upon admission in Group II compared to Group I (P<0.05), suggesting a more pronounced degree of respiratory disorders in patients with ROB and BA. However, these values equalized between the studied groups on the 2nd and 3rd days (P>0.5).

**Table-2**

**SSO index depending on follow-up time in patients of groups I-III**

| № | Observation Time | Group I | | Group II | | Group III | | P1 | P2 | P3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | M | m | M | M | M | m | | | |
| 1 | Admission | 10,44 | 0,37 | 11,89 | 0,44 | 2,49 | 0,19 | <0,05 | <0,001 | <0,001 |
| 2 | 2nd day | 9,04 | 0,37 | 8,85 | 0,42 | 2,13 | 0,15 | >0,5 | <0,001 | <0,001 |
| 3 | 3rd day | 7,44 | 0,33 | 7,43 | 0,39 | 1,48 | 0,17 | >0,5 | <0,001 | <0,001 |
| 4 | Discharge | 3,79 | 0,19 | 4,68 | 0,31 | 0,91 | 0,0 | <0,05 | <0,001 | <0,001 |

Note: P1, P2, P3 denote the reliability of differences in indicators between Groups I and II, I and III, II and III, respectively.

Upon hospital discharge, patients in Group II maintained a relatively high SSO score (P<0.05).

The examination of SSE in patients from Groups I and III revealed a fourfold higher SSE upon admission in Group I compared to Group III (P<0.001). This discrepancy indicated pronounced respiratory disorders in patients with APS and OBL compared to those with OB. This trend persisted throughout the dynamic follow-up (P<0.001).

A similar disparity in SSE was observed between patients in Groups II and III. Upon admission, SSE was higher in Group II compared to Group III (P<0.01), signifying a comparatively heightened degree of respiratory distress in patients with ROB and AD, a distinction that persisted in subsequent days (P<0.001).

By constructing the ROC curve and analyzing the curve coordinates (Table 3), it was determined that an E:I index value ≥1.78 bears diagnostic significance in identifying the risk of ROB and AD in children, exhibiting a sensitivity of 71.7% and specificity of 61.1%.

**Table-3**

**Diagnostic value of E:I index grades in children with AD and ROB**

| Curvilinear coordinates | | |
|---|---|---|
| E:I index | Sensitivity | 1 - Specificity |
| 1,7240 | 0,605 | 0,235 |
| 1,7340 | 0,619 | 0,252 |
| 1,7440 | 0,677 | 0,269 |
| 1,7540 | 0,685 | 0,319 |
| 1,7640 | 0,685 | 0,352 |
| 1,7740 | 0,719 | 0,385 |
| 1,7850 | 0,725 | 0,419 |

Conclusively, the present study underscores the significance of the E:I index as a pivotal marker in assessing the risk of developing ROB and AD.

Abstract: The analysis of respiratory system functional indices among patients in Groups I-III, utilizing modified bronchophonography and saturation-scale assessment, highlights the importance of investigating the E:I index to delineate the course of bronchial obstruction in children and predict subsequent BOS episodes.

The recurrent pattern of BOS manifests with a considerable prolongation of exhalation compared not only to ROB (P<0.001) but also to acute BOS in children (P<0.001). This observation confirms a notable impairment of bronchial patency in patients with ROB and BA, as indicated by the E:I index.

Conclusions: E:I index values ≥1.78 serve as predictive indicators for ROS and BA development, supported by their diagnostic significance characterized by high sensitivity and specificity. These findings suggest the E:I index as a valuable tool for identifying the risk of recurrent BOS in children.

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