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Original article ■

Bronchoscopy and Bronchoalveolar Lavage in Children with Lower Airway Infection and Most Common Pathologic Microorganisms Isolated

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SUMMARY

The study represents a review of most common pathologic microorganisms with persistent lung infiltrates in the bronchoalveolar lavage (BAL) of paediatric patients.

The aim of the paper was to present the results of bronchoscopy and bronchoalveolar lavage in children with persistent lung infiltrates and most common pathologic microorganisms isolated in bronchoalveolar lavage.

This is a prospective and retrospective study. Information on the paediatric findings and BAL results of bronchoscopy were obtained from the hospital records. The records of fifty patients were analyzed. All patients had persistent lung infiltrates (lower airway infection). BAL was performed in the middle lobe and lingula by bronchoscope (Olympus 3,5 mm) and sent for microbiological analysis. There was no serious desaturation during bronchoscopy. Bronchoscopy was performed under general anesthesia (sedation, propofol, midazolam, morphium).

The most common pathologic microorganisms identified in BAL were: Streptococcus α haemoliticus (16%), Pseudomonas aeruginosa (12%) followed by Candida albicans (10%) and Klebsiella pneumoniae (8%).

Our study results have shown that bronchoscopy with BAL is recommended for isolating bacteria as causes of lung infection and is particularly suitable for proving pneumonias caused by microorganisms.

Key words: **flexible bronchoscopy in children, BAL in children**

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INTRODUCTION

Over the past twenty years, flexible bronchoscopy (FB) with bronchoalveolar lavage (BAL) has been progressively used in pediatric clinics and has been disseminated to a wide array of fields. BAL is well established as an extremely important procedure to obtain biological material from the lungs and has been widely used for diagnostic, therapeutic and research purposes. BAL is usually performed using a flexible bronchoscope, the diameter of which can range from 2,8-4,9 mm. The procedure is performed under general anesthesia.

Fiberoptic bronchoscopy and BAL are safe and well-tolerated procedures for the isolation of pathologic microorganisms from the lower respiratory infection, visual assessment of secretion, redness, edema and irritability of the mucosa (1, 2).

The BAL procedure is performed by instilling isotonic solution through the suction channel of the flexible fiberoptic bronchoscope with a volume that varies according to the weight of the child (1-3 ml/kg/weight) and can be repeated into three equal aliquots (3).

Chronic pneumonia is defined as a disease of slow progress followed by respiratory symptoms and radiological changes that remain for at least one month (4). The cause of pneumonia has great importance. That is why it is very important to detect the etiological agent of pneumonia in clinical practice. Bronchoalveolar lavage can be very helpful in establishing the correct diagnosis (5). Hospital-acquired pneumonia is any inflammation in the lower section of the respiratory tract that occurred within 48 hours on respirator. Ventilatory pneumonias develop complications in 8-28% of the patients. Mortality with ventilatory pneumonias varies from 24 to 50% and may achieve 76% if the infection has been caused by dangerous pathogenous bacteria. Pediatric flexible bronchoscopy is frequently indicated in these cases aiming to elucidate the diagnosis (6).

AIM

The aim of the present study was to evaluate the clinical role of bronchoscopic and bronchoalveolar lavage in the diagnosis of lung infiltrates.

METHOD

The age of the examined children of both genders ranged from one month to 16 years. All patients were hospitalized in Pediatric Clinic in Sarajevo, Bosnia and Hercegovina. The preparation of the children for bronchoscopy with BAL includes physical examination of the child upon admission, auscultatory lungs findings, general pediatric examinations, pediatric cardiologist findings and the basic laboratory findings, radiological lung findings, frontal and lateral if necessary, depending on the localization of pulmonary parenchyma changes, lungs MSCT. The BAL procedure is performed by instilling the isotonic solution (t 37°C) through the suction channel of the flexible fiberoptic bronchoscope with a volume that varies according to the weight of the child (1-3 ml /kg/weight) and can be repeated into three equal aliquots (3).

BAL was performed using 1 ml/kg of normal saline with the flexible bronchoscope (Olympus 3,5 mm) wedged in a segmental or subsegmental bronchus of the lobe that showed most of the abnormalities on chest radiograph. Many factors interfere in the sensitivity of BAL, such as the amount of liquid instilled, the aspiration pressure, the interval between collection and analysis, and the laboratory techniques performed, all of them directly reflecting the results. All these things should be regularly followed (collection protocol) (7, 8).

In 50 children with lung infiltrates who were intubated, BAL samples were also evaluated.

Children-patients: a prospective and retrospective review of all paediatric patients who underwent flexible bronchoscopy with bronchoalveolar lavage between 2005 and 2011 was undertaken, and the samples were taken from the right middle lobe plus the lingula or the part of the lungs most affected. A single lobe BAL is insufficient in assessing children with Cystic Fibrosis (C.F.) for lower airway infection. Even when BAL specimens are taken from two lobes, a number of infections may be missed. The European Respiratory Society modified the recommendations for children with cystic fibrosis suggesting two BAL specimens/right middle lobe and the lingula/ or the most affected lobe (9).

The bacteriological analyses were carried out in the Clinical Center Sarajevo, Microbiological laboratory. The methods used were Gram staining, culturing on blood and MCV agar. Following a 24-hour incubation, the preparation was observed microscopically and the microbiological cause was identified. This was a prospective and retrospective study recruiting pediatric patients who underwent flexible bronchoscopy and bronchoalveolar lavage. Children were followed from the hospital records. In our study, BAL analysis was used for the detection of microorganisms in the lung infiltrates.

The diagnostic yield for examined acid fast bacilli (AFB) on smear from BAL was better than that from GA (gastric aspiration) in children with probable pulmonary TB (pulmonary tuberculosis) (10).

Descriptive statistical methods were applied in this case (mean value, standard deviation and percentage share), while the data should be analyzed through relevant tests.

1. Z-test of the hypothesis for proposition
2. T-test of the hypothesis for mean value.

RESULTS

The patients had community-acquired pneumonia (n=19,38%), nosocomial pneumonia in ventilated patients (n=16,32%), cystic fibrosis (n=4,8%), neuromuscular diseases (n=4,8%) tuberculosis (n=4,8%) and polytrauma (n=3, 6%).

Fifty records were reviewed over a 5-year period. Sixty percents were male pediatric patients (n=30). Fifty-eight percents of the patients were aged five years and younger (n=29). Two of 12 mechanically ventilated children treated with antibiotics for presumed infectious pneumonia had undetectable concentrations of bacteria in their lower respiratory tract, while ten others had microorganisms present. The main indications for flexible bronchoscopy and BAL were abnormalities on the chest X-ray (lung infiltrate, pneumonia). In fifty children with bronchoscopy and BAL, the inflammation of the tracheobronchial tree (mycosal erythema and secretions and mucus plug) was confirmed. Distribution of changes in lung parenchymal diseases of children is shown in Figure 1.

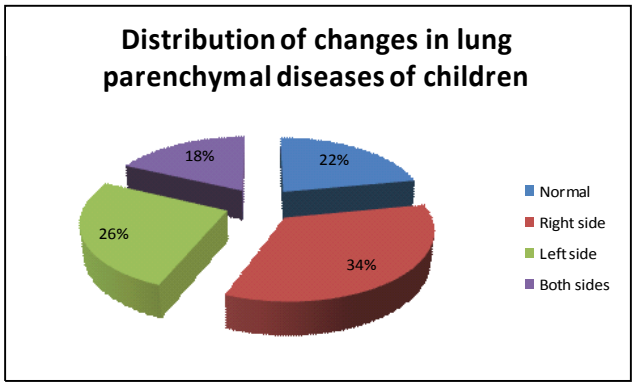

Figure 1. *Distribution of changes in lung parenchymal diseases of children*

Table 1 shows that out of the bacteria tested in BAL, the most frequent in the pediatric patients were Streptococcus α haemoliticus (n=8-16%), then Pseudomonas aeruginosa n=6-12%, followed by Candida albicans (n=5-10%) and Klebsiella pneumoniae (n=4-8%).

Table 1. *Bacteriological findings of bronchoalveolar lavage of the tested group*

Bacteriological findings	**No**	**%**
Normal	10	20
Enterobacter Cloaceae	1	2
Candida albicans	5	10
Proteus mirabilis	2	4
Enterococcus fecalis	2	4
Streptococcus α haemoliticus	8	16
Pseudomonas aeruginosa	6	12
Seratia Marcecens	2	4
Klebsiela pneumoniae	4	8
MTBC	1	2
Acinetobacter Calcoaceticus	3	6
Stenotrophomonas maltophilia	4	8
Escherichia colli	1	2
Staphylococcus epidermidis	1	2
Total	50	100,0
α=	0,01	H0: r<40%
Z=	4,041	H1: r>40%
P=	0,0000266	

The bacteriological analysis of the pediatric patients' lavage showed that infection was highly present. In this case, the Z-test of the hypothesis for the proportions was applied ($Z=4,041$ $\alpha=0,01$). One may claim with 99 % probability that in any given sample of pediatric parents more than 40 of them will have an infection (bacteria, indicators) (Table 1).

Bronchoalveolar lavage in children is a procedure allowing diagnosis to be set based on the results of the obtained sample.

No serious complications were observed in our study.

Seven children had episodes of oxyhaemoglobin desaturation that were reversal with temporary removal of the bronchoscope and continuous oxygen supplementation.

Adverse events are usually transient and well-tolerated. We should always consider a pre-existing lower respiratory infection associated with the post- BAL fever.

DISCUSSION

The most representative age group was up to five years of age. Fifty-eight percents of the patients were under the age of five, as other authors (11-13) have reported in previous studies recruiting children and adults. The annual incidence of pneumonia in children younger than five years of age was such that pneumonia was reported in each 34-40 cases per 1.000 residents of Europe and North America. The unresolved pneumoniae at this age group up to five years leads to a large percentage of death outcomes. Bronchoscopy with BAL gives importance to resolving pneumonia problem. A cytological analysis of the BAL is dominated by bacteria and neutrophils (31 children). The most represented are the bacteria isolated in BAL. Microbiological BAL diagnostics has confirmed the cause in 50 to 85 % of cases. The study showed the success of the application of flexible bronchoscopy with BAL in children with lung infiltrates. A total of 50 children who were subjected to flexible bronchoscopy with BAL were analyzed. BAL allows for a final diagnosis based on the isolated cause, which is of huge importance, because respiratory infections in general population, and especially in children, are still a significant cause of morbidity and mortality. This is why a timely diagnostics of pulmonary diseases resolves and reduces the risk of developing complications and deteriorations of the basic condition of a diseased child. These inflammatory cells have primary function - phagocytosis and the elimination of invasive pathogens, and play a key role in the pulmonary inflammatory process. Usefulness of the analysis of BAL is the main factor for the diagnosis of lung disease. Clinical history, physical examination and a careful evaluation of the available laboratory tests and imaging studies should also be interpreted.

Our proposal is to prefer BAL (Broncho-alveolar lavage) and bronchoscopy in early identification of inflammation in lungs infiltrates in ill children.

These findings provide essential information to guide therapeutic strategies and better understanding. BAL is used for the detection of microorganisms, monitoring the inflammatory response and for the evaluation of therapeutic strategies (14).

CONCLUSION

This study provides the first data on BAL in children with lung infiltrates from this area of Eastern Europe. Before performing a flexible bronchoscopy and BAL, it is necessary to have a systemic approach, which includes a careful history and main laboratory findings including nose and throat swabs, cardiology findings, chest X-ray, physical examinations, computed tomography of the chest.

BAL is recommended for isolating bacteria as a cause of lung infection and is particularly suitable for proving pneumonias caused by microorganisms.

Clinical parameters and local inflammation of the affected lobe are associated with positive bronchoalveolar lavage findings. BAL samples were taken from the right middle lobe in 95% of the children, while 5% of the samples were taken from the lingula, in line with the ERS guidelines (2) (Chart 1).

In our study, the bacteria causing pneumonia isolated from BAL performed in 50 children were Streptococcus alpha haemoliticus (16%), then Pseudomonas aeruginosa (12%) followed by Candida albicans (10%) and Klebsiella pneumoniae (8%).

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BRONHOSKOPIJA I BRONHOALVEOLARNA LAVAŽA KOD DECE SA INFEKCIJOM DONJIH DISAJNIH PUTEVA I NAJČEŠĆE IZOLOVANIM PATOGENIM MIKROORGANIZMIMA

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Sažetak

Ova studija predstavlja pregled najčešćih patoloških mikroorganizama koji su uzročnici plućnih infiltrata, izolovanih u bronhoalveolarnom lavatu (BAL) pedijatrijskih bolesnika.

Cilj rada bio je da prikaže rezultate bronhoskopije i BAL-a kod dece sa perzistentnim plućnim infiltratima i izolovane patološke mikroorganizme kod BAL-a.

Studija je prospektivna i retrospektivna. Analizirani su mikrobiološki nalazi u BAL-u kod 50 hospitalizovane dece. Sva ispitivana deca imala su perzistentne plućne infiltrate (infekcije donjih disajnih puteva). BAL je rađen u srednjem lobusu ili linguli sa bronhoskopom 3,5mm (Olympus). Bronhoskopija je rađena u opštoj anesteziji (sedacija propofol, midazolam, morfijum). Uzorak je dat na mikrobiološki pregled (biogram i antibiogram, bojenje po Gramu).

Nije bilo ozbiljnijeg pada saturacije tokom izvođenja bronhoskopije. Najčešće izolovani mikrobiološki patogeni u BAL-u su: Streptococcus α haemoliticus (16%), Pseudomonas aeruginosa (12%), Candida albicans i Klebsiella pneumoniae (8%).

Naši rezultati su pokazali da je bronhoskopija sa BAL-om metoda izbora za izolovanje bakterija koje su uzročnici plućnih infekcija donjih delova respiratornog trakta kod dece.

Ključne reči: **fleksibilna bronhoskopija kod dece, BAL kod dece**