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Original Article PEDIATRICS

Pediatric flexible bronchoscopy: A tertiary single center experience

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ABSTRACT

OBJECTIVE: Flexible bronchoscopy (FB) is an important tool for evaluating pediatric patients with respiratory issues. This study aims to investigate the clinical features of children who underwent FB.

METHODS: The study included 191 children who underwent FB between April 1, 2021 and December 31, 2022. Demographic and clinical data were retrospectively reviewed.

RESULTS: One hundred ninety-one children (45% girl) were enrolled to study. Median age was 25 months (min 1, max 214 months) and median duration of complaints was 4 (min 1, max 80) months. Among the patients, 61.7% of them had a chronic disease. The main indications were stridor (17.6%) and extubation failure (13.5%). Rate of patients in the ICU during FB was 27.5% and 15.5% of them were intubated. Airway secretions in the lower respiratory tract and isolated laryngomalacia were the most common abnormal FB results (30.1% and 9.8% respectively). The most common abnormal FB findings were in children with extubation failure (92.3%). Forty percent of patients with chronic cough had abnormal FB findings. Bronchoalveolar lavage (BAL) sampling was performed in 61.6% (n=119) of patients and *Haemophilus influenzae* was the most common pathogen in these patients (n=40).

CONCLUSION: FB is a valuable tool for investigating airway pathology and BAL sampling in children with respiratory problems.

Keywords: Bronchoalveolar lavage; bronchoscopy; stridor.

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Flexible bronchoscopy (FB) is a crucial and safe tool used to assess the anatomic and dynamic aspects of both upper and lower respiratory tracts [1]. Over the years, technological advancements have led to the production of FBs in various sizes, resulting in increased usage [2]. A multicenter survey in China that evaluated pediatric bronchoscopy procedures showed that the median number of FBs performed in a single center in one year was 158, and eight centers performed more than 1000 pediatric FBs. Indications of FB in the pediatric population are very common [3]. Recurrent lower respiratory tract infections (LRTI), stridor, persistent wheezing, chronic cough, bronchoalveolar lavage (BAL) sampling, and suspected foreign body aspiration (FBA) are some of the indications for FB in the pediatric population [4–6]. While FB is primarily utilized for diagnosis due to its excellent imaging and dynamic video capabilities, it also serves as a treatment tool. Procedures like mucus plug removal, whole lung lavage, hemoptysis control, and widening of narrow airways can be performed with FB [7, 8]. Pediatric FB necessitates general anesthesia and can be conducted in bronchoscopy units, operating rooms, or at the patient's bedside. Bedside FB holds a distinct advantage as it eliminates the need for patient mobilization [9].

This study aims to show the results of FB in children in a tertiary center in Istanbul and to retrospectively evaluate the indications of FB, demographic and clinical features of patients, and the anatomic and microbiological results of FB.

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MATERIALS AND METHODS

This study was conducted at Umraniye Training and Research Hospital. The medical records of children who underwent FB between April 1, 2021, and December 31, 2022, were evaluated. A total of 191 pediatric patients (45% female) aged 1 to 214 months (median age: 25 months) were included. The sociodemographic and clinical features, FB indications, and results of FB were recorded from the medical records of patients. The study was conducted in compliance with the Declaration of Helsinki and was approved by the Umraniye Training and Research Hospital Ethics Committee (decision number: 172, date: 26.05.2021).

FB was performed by the same pediatric pulmonology specialist in either the operating room or ICU. Sedation and anesthesia were administered by an anesthesiologist, using midazolam for premedication and propofol for sedation and anesthesia. All operations utilized a 3.6 mm diameter Olympus bronchoscope. Lidocaine was employed as topical anesthesia for the vocal cords and carina. The nasal route was used for all patients. Oxygen supplementation was provided during the procedure. Children in the ICU received positive ventilation and oxygen support during FB. If necessary, BAL was conducted in the area affected by the disease or pathology. If needed, BAL was taken in the area that is involved in the disease or pathology. Growth above 10000 cfu/ml was considered microbiologically significant. For cases with diffuse disease or no identifiable pathological area, BAL sampling was obtained from the right middle lobe or lingula using 3 ml/kg of saline.

Airway malacia was diagnosed through visual observation during spontaneous breathing, defined as the collapse of at least 50% of the airway lumen. Subglottic stenosis was characterized by 50% or more luminal obstruction of the subglottic area.

Statistical Analysis

The SPSS Statistics 23.0 software (IBM SPSS Statistics, Chicago, IL, USA) was used for statistical analysis. Categorical variables were presented as percentages, while continuous variables were presented as mean (SD) for normally distributed data, and median (interquartile range [IQR]) for non-normally distributed data. Fisher's exact test was employed to compare categorical variables.

Highlight key points

- Flexible Bronchoscopy (FB) is an important tool for evaluating patients with respiratory problems.
- FB provides the anatomical evaluation of the airways as well as BAL sampling and secterion clearance.
- There are many FB indications such as recurrent lower respiratory tract infections (LRTI), stridor, persistent wheezing, chronic cough, bronchoalveolar lavage (BAL) sampling etc.
- FB can be safely performed in children with chronic repiratory problems in appropriate indications.

RESULTS

191 pediatric patients who underwent FB were enrolled, of whom 104 (55%) were boys and 87 (45%) were girls. The current median age was 25 months (minimum 1, maximum 214 months), and the median duration of complaints was 4 months (minimum 1, maximum 80 months). Of these patients, 119 (61.7%) had a chronic disease, with neurological disease being the most common (16.6%) followed by congenital heart diseases. Stridor was the most common indication for FB (17.6%), and 27.5% of patients were in the ICU during bronchoscopy, including seven patients in the neonatal intensive care unit (NICU). Thirty patients (56.6% of patients in the ICU) were intubated before bronchoscopy. These patients were intubated already because of their primary illness. The rate of patients who had an abnormal chest X-ray was 39.4%. The demographic, clinical, and radiological characteristics of patients and indications of FB are shown in Table 1.

Table 2 shows the results and recommendations after bronchoscopy. 33.2% of patients had upper respiratory tract problems, and 36.8% had lower respiratory tract problems. The most common result was isolated secretions. Laryngomalacia (LM) was the second most common airway problem (isolated LM: 9.8%). LM was also present together with other abnormal findings, such as secretions, bronchomalacia, tracheomalacia, etc. (total: 14.5%). Secretions were the most common problem in the lower respiratory tract (30.1%). The rate of both upper and lower respiratory tract problems was 14.5%. Clinical follow-up and continuation of current treatment were the most common recommendations after FB. The second was new medical treatment. 37 patients (19.2%) were referred for surgery. FB and microbiological results of patients according to indications of FB are shown in Table 3. The most common result of flexible bronchoscopy that was performed by the stridor indication was laryngomalacia (35.2%).

Table 1. Demographic, clinical and radiological charecteristics of patients and indications of FB

Age-median (month)	25 (Min 1, Max 214) IQR 8.5–86
Duration of compliants-median (month)	4 (Min 1, Max 80) IQR 2–12
Gender (girl), n (%)	87 (45)
Presence of chronic disease, n (%)	119 (61.7)
Neurlogical disease, n	16.6
Congenital hearth disease	9.3
Bronchopulmonary dysplasia	7.8
Immun deficiency	5.7
Metabolic disease	4.1
Rhomatological disease	2
Asthma	2
Diaphragmatic hernia	1.6
Scoliosis	1.6
Tracheoesophageal fistula	1.6
Neuromuscular disease	1
Others	8.2
FB indications, n	
Stridor	17.6
Extubation failure	13.5
Atelectasis	12.4
Recurrent LRTI	11.9
BAL sampling	8.8
Chronic cough resistant to treatment	7.8
Suspected foreign body aspiration	6.7
Hemoptysis	6.2
Persistant wheezing	5.7
Pre- dekanulation evaluation	5.2
Feeding problems	2.6
Recurrent croup	1.6
ICU during bronchoscopy	27.5
Respiratory support before FB, n	
Intubation	1.5
Non-invasive ventilation	9.8
Tracheostomy	7.8
Oxygen support	3.6
Non-support	63.2
Abnormal chest X-ray, n	39.4
Performed thorax CT, n	39.4

FB: Flexible bronchoscopy; LRTI: Lower respiratory tract infection; BAL: Bronchoalveolar lavage; ICU: Intensive care unit; CT: Computed tomography.

Table 2. FB results and recommandations after FB

	n	%
Normal	**64**	**33.2**
Upper respiratory tract problems	**30**	**15.5**
Isolated LM	9.8	
Subglottic stenosis	4.1	
Vaocal cord pathology	0.5	
Laryngocele	0.5	
Subglottic hemangioma	0.5	
Lower respiratory tract problems	**71**	**36.8**
Isolated Secretion	30.1	
Airway narrowing and secretion	4.1	
Granulation tissue and secretion	3.1	
Isolated tracheomalacia	2.6	
Isolated airway narrowing	2.6	
Isolated granulation tissue	2.6	
Foreign body	2.6	
Both upper and lower respiratory problems	**28**	**14.5**
Laryngotracheomalacia	4.6	
LM and secretions	4.6	
Laryngeotracheobroncomalacia	3.1	
LM and bronchomalacia	2.2	
Recommandations after FB		
Clinical follow-up or continue of current treatment	39.9	
Medical treatment	29.0	
Surgery	19.2	
Additional examination or consultation	10.4	
Decannulation	1.5	

FB: Flexible bronchoscopy; LM: Laryngomalacia.

Microbiological results were summarized in Table 4. 119 (61.6%) patients underwent BAL sampling, and among these patients, 40 (20.7%) had a positive microbiological result. The most common pathogen was *Haemophilus influenzae*.

Table 5 shows a comparison of normal and abnormal FB results. There was no statistically significant difference between the two groups in age and duration of complaints. Stridor and extubation failure as indications were significantly higher in the abnormal FB group than in the normal FB group ($p<0.05$). However, chronic cough and hemoptysis indications were significantly higher in the normal group than in the abnormal group ($p<0.05$). The rate of the presence of chronic disease was significantly higher in the abnormal group ($p<0.05$). Abnormal X-ray and chest CT findings were significantly higher in the abnormal group ($p<0.05$). When the rates of respiratory sup-

Table 3. FB and microbiological results of patients according to indications of FB

	Stridor	Extubation failure	Atelectasis	Recurrent LTRI	BAL sampling	Chronic cough
Number	34%	26%	24%	23%	17%	15%
Abnormal FB	85.2	92.3	79.1	65.2	64.7	40
Isolated Secretion	11.7	30.8	70.8	43.4	64.7	26.7
Isolated LM	35.2	7.7	8.3	8.6	0	0
Tracheomalacia	11.7	11.5	0	4.4	0	0
Bronchomalacia	5.8	7.7	0	0	0	0
Subglottic stenosis	5.8	26.9	0	0		0
Vaocal cord pathology	2.9	7.7	0	4.4	0	0
Airway narrowing	8.8	0	0	4.4	0	13.3
Granulation tissue	2.9	0	0	0	0	0
Microbiological results						
Positive	8.8	0	37.5		35.2	13.3

FB: Flexible bronchoscopy; LM: Laryngomalacia; BAL: Bronchoalveolar lavage; LTRI: Lower respiratory tract infetion.

Table 4. Microbiological results of patients' BAL samples

	%
BAL sampled	n=119 (61.6)
Negative	40.9
Positive	20.7
Haemophilus influenzae	3.1
Candida albicans	2.5
Klebsiella pneumoniae	2.1
Serratia marcescens	2.1
Psuedomanas aeruginosa	1.5
Moraxella catarrhalis	1
Escherichia coli	1
Stenotrophomanas maltophilia	1
Stapylococcus aureus	1
Streptococcus pneumonia	1
Staphylococcus epidermidis	0.5
Aspergillus fumigatus	0.5
Others	3.1

BAL: Bronchoalveolar lavage.

port before FB were evaluated, it was seen that non-support and intubation were significantly different between the normal and abnormal groups ($p<0.05$). However, there was no statistically significant difference in tracheostomy and oxygen support.

DISCUSSION

FB is an important diagnostic and therapeutic tool commonly used in pediatric pulmonary disorders. Recently, the use of FB has increased rapidly. FB allows anatomic and dynamic observation in patients with respiratory problems. This study evaluated 191 FB results in a tertiary center. FB indications, clinical features of patients during the procedure, and FB results were assessed in the current study.

Among patients in our study, 61.7% of them had a chronic disease. The most common chronic disease was neurological disease. Another study from Turkiye found that immune deficiencies were the most common chronic disease [10]. Rate of patients with immune deficiency in our study was 5.7%. The second most common chronic disease was congenital heart disease.

Performing pediatric FB has increased recently, there are a lot of indications for FB in the pediatric population [11]. In our study, the most common indication was stridor, second was extubation failure. A survey study from China found that the most common indication was atelectasis/lobar pneumonia [3]. Another retrospective study from Greece reported that stridor was the most common indication as in our study [12]. A large population study that was designed by Ferraoe et al. [13] showed that the most frequent indication was recurrent respiratory infection. The reason for frequency of different indications among studies was thought to be related to the clinical features of the centers.

Table 5. Comparison of normal and abnorma bronchoscopic results

	Normal (62)	Abnormal (131)	p*
Age (mean) (month)	62.5±59.1	50.6±44.2	0.198
Duration of compliants (mean) (month)	8.3±7.3	10.5±9.2	0.33
Indications			
Chronic cough	14.5	4.5	**<0.05**
Stridor	5 (8	22.1	**<0.05**
Recurrent LRTI	12.9	11.4	0.771
Atelectasis	8	14.5	0.206
BAL sampling	9.6	8.3	0.06
Extubation failure	3.2	18.3	**<0.05**
Persistant wheezing	6.4	5.3	0.757
Hemoptysis	12.9	3.0	**<0.05**
Suspected foreign body aspiration	11.2	4.5	0.082
Presence of chronic disease	41.9	70.9	**<0.05**
Abnormal chest X-ray	46.7	65.6	**<0.05**
Abnormal chest CT	33.8	29.7	**<0.05**
Positive BAL result	14.5	23.6	0.094
Respiratory support before FB			
Non-support	83.8	53.4	**<0.05**
Intubation	3.2	21.3	**<0.05**
Tracheostomy	4.8	9.1	0.295
Oxygen support	4.8	83.9	0.374

*: Chi-square test, LRTI: Lower respiratory tract infetion; CT: Computed tomography; BAL: Bronchoalveolar lavage; FB: Flexible bronchoscopy.

The rate of patients in ICU during FB was 27.5% in our study. Among these patients, 7 children were in Neonatal Intensive Care Unit (NICU). More than half of these patients were intubated during the operation (56.6%). A study that evaluated pediatric FB at ICU in Turkiye reported similar intubation rate as our study (48.5%) [14]. Another study from China that investigated pediatric FB results at NICU showed that rate of intubated patients was 55.1% [15].

The most seen abnormality of our FBs was secretions in lower airways. Laryngomalacia (isolated or in combination with other abnormalities) was the second most frequent FB result in our study. A retrospective study from Greece showed that the most frequent result was laryngomalacia [12]. Another study from our country also reported that secretions in lower airways were the most seen in FB results in their cohort as in our current study [10]. Also FB results according to indications subgroups were evaluated in our study. The most seen FB result in patients with stridor was laryngomalacia. Erdem et al. [16] reported that the most frequent result in infants who underwent FB with stridor indication was laryngomalacia. Chronic cough is also one of the indications for pediatric FB [6]. Ferrao et al. [13] found that malacia diseases were the most common finding in patients with chronic cough. In our study, there is no laryngomalacia result in a patient with chronic cough. Isolated secretions in the lower respiratory tract are most seen in children with chronic cough.

BAL microbiological results were investigated in the current study. Among 119 patients who underwent BAL sampling, 40 patients had a positive result. The most common pathogen was *Haemophilus influenzae*. Most of other studies also reported results as our study [10, 13, 17, 18].

In this study, patients with normal and pathologic FB results were compared for indications and other clinical features. Stridor, chronic cough, hemoptysis, and BAL sampling as indications were significantly higher in patients with pathologic FB results than in patients with normal FB results. Another study that evaluated the diagnostic yield of FB in children reported that stridor indication was a higher diagnostic yield [12].

The current study had some limitations. Firstly, the study was a retrospective study; second, there were no viral BAL results in the study; lastly, BAL secretions score and malacia classification were not done.

Conclusion

Flexible bronchoscopy is a crucial diagnostic tool in pediatric respiratory diseases. Indications for pediatric age group are very wide FB such as stridor, atelectasis, recurrent LTRI, etc. Since FB provides both the visualization of airway anatomy and BAL sampling, it is a very useful tool for children with respiratory problems.

Ethics Committee Approval: The University of Health Sciences, Umraniye Training and Research Hospital, Clinical Research Ethics Comittee granted approval for this study (date: 26.05.2021, number: 172).

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REFERENCES

1. Yonker LM, Fracchia MS. Flexible bronchoscopy. In: Hartnick CJ, Hansen MC, Gallagher TQ editors. Pediatric Airway Surgery. Basel: Karger; 2012. pp. 12-8. [CrossRef]
2. Donato L, Mai Hong Tran T, Ghori UK, Musani AI. Pediatric interventional pulmonology. Clin Chest Med 2018;39:229-38. [CrossRef]
3. Lin J, Tao X, Xia W, Liu J, Zhong L, Sun X, et al. A multicenter survey of pediatric flexible bronchoscopy in western China. Transl Pediatr 2021;10:83-91. [CrossRef]
4. Terkawi RS, Altirkawi KA, Terkawi AS, Mukhtar G, Al-Shamrani A. Flexible bronchoscopy in children: utility and complications. Int J Pediatr Adolesc Med 2016;3:18-27. [CrossRef]
5. Soyer T. The role bronchoscopy in the diagnosis of airway disease in children. J Thorac Dis 2016;8:3420-6. [CrossRef]
6. Piccione J, Hysinger EB, Vicencio AG. Pediatric advanced diagnostic and interventional bronchoscopy. Semin Pediatr Surg 2021;30:151065. [CrossRef]
7. Singh V, Singhal KK. The tools of the trade - uses of flexible bronchoscopy. Indian J Pediatr 2015;82:932-7. [CrossRef]
8. Charya AV, Holden VK, Pickering EM. Management of life-threatening hemoptysis in the ICU. J Thorac Dis 2021;13:5139-58. [CrossRef]
9. Ergan B, Nava S. The use of bronchoscopy in critically ill patients: considerations and complications. Expert Rev Respir Med 2018;12:651-63. [CrossRef]
10. Ergenekon AP, Sahin E, Yilmaz Yegit C, Yanaz M, Gulieva A, Kalyoncu M, et al. Flexible bronchoscopy in children: the Marmara University Division of Pediatric Pulmonology experience. [Article in Turkish]. J Child 2022;22:99-104. [CrossRef]
11. Schramm D, Yu Y, Wiemers A, Vossen C, Snijders D, Krivec U, et al. Pediatric flexible and rigid bronchoscopy in European centers - availability and current practice. Pediatr Pulmonol 2017;52:1502-8. [CrossRef]
12. Kirvassilis F, Gidaris D, Ventouri M, Zampouri A, Mylona M, Keramidiotis A, et al. Flexible fiberoptic bronchoscopy in Greek children. Hippokratia 2011;15:312-5.
13. Ferraro VA, Baraldi E, Stabinger D, Zamunaro A, Zanconato S, Carraro S. Pediatric flexible bronchoscopy: a single-center report. Pediatr Pulmonol 2021;56:2634-41. [CrossRef]
14. Atag E, Unal F, Yazan H, Girit S, Uyan ZS, Ergenekon AP, et al. Pediatric flexible bronchoscopy in the intensive care unit: a multicenter study. Pediatr Pulmonol 2021;56:2925-31. [CrossRef]
15. Ke LQ, Shi MJ, Zhang FZ, Wu HJ, Wu L, Tang LF. The clinical application of flexible bronchoscopy in a neonatal intensive care unit. Front Pediatr 2022;10:946579. [CrossRef]
16. Erdem E, Gokdemir Y, Unal F, Ersu R, Karadag B, Karakoc F. Flexible bronchoscopy as a valuable tool in the evaluation of infants with stridor. Eur Arch Otorhinolaryngol 2013;270:21-5. [CrossRef]
17. Asseri AA, Khattab N, Ezmigna D, Awadalla NJ, Daines C, Morgan W. Diagnostic accuracy of nasopharyngeal swab cultures in children less than five years with chronic wet cough. Children (Basel) 2021;8:1161. [CrossRef]
18. De Schutter I, De Wachter E, Crokaert F, Verhaegen J, Soetens O, Piérard D, et al. Microbiology of bronchoalveolar lavage fluid in children with acute nonresponding or recurrent community-acquired pneumonia: identification of nontypeable Haemophilus influenzae as a major pathogen. Clin Infect Dis 2011;52:1437-44. [CrossRef]