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ARAŞTIRMA / RESEARCH

Evaluation of long-term lung capacity using spirometry in patients who underwent bronchoscopy due to foreign body aspiration

Yabancı cisim aspirasyonu nedeniyle bronkoskopi yapılan hastaların uzun dönem akciğer kapasitelerinin spirometri ile değerlendirilmesi

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Abstract

Purpose: The purpose of the present study was to evaluate the long-term lung status using spirometry in patients who underwent rigid bronchoscopy in acute period due to foreign body aspiration.

Materials and Methods: Records of 142 children who underwent bronchoscopy due to foreign body aspiration between March 2013 and April 2018 were retrospectively reviewed. The data of 20 patients who cooperated with the spirometry process were included in this study (Group 1). Twenty patients who were admitted to the routine pediatric surgeon polyclinic without any lung problem and pain complaints were included in the study as a control group (Group 2). Forced expiratory flow rate (FEV1), forced vital capacity (FVC), FEV1/FVC, and forced expiratory flow at 25-75% of forced vital capacity (FEF 25–75) parameters were recorded in the first second.

Results: Based on the statistical analysis results, there was no significant effect of age, sex, and BMI on FEV1, FVC, and FEF 25–75 values. The effect of bronchoscopy procedure on the same values, the difference between FEV1 and FVC values was statistically significant, whereas the difference between FEV1/FVC and FEF 25–75 values was not statistically significant for Groups 1 and 2.

Conclusion: There was no long-term negative effect on lung capacities assessed using spirometry in our patients who received early-diagnosis and intervention within 24 h.

Keywords: Foreign body aspiration, bronchoscopy, spirometry, children

Öz

Amaç: Bu çalışmada yabancı cisim aspirasyonu nedeniyle akut dönemde rigid bronkoskopi ile yabancı cisim çıkarılan hastaların uzun dönem akciğer durumlarının spirometri ile değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Mart 2013 – Nisan 2018 tarihleri arasında yabancı cisim aspirasyonu için bronkoskopi yapılan 142 çocuğa ait kayıtlar retrospektif olarak incelendi. Spirometri işlemine kooperasyon kurabilen 20 hastanın verileri çalışmaya dahil edildi (Grup 1). Rutin çocuk cerrahisi polikliniği'ne başvuran akciğer problemi ve ağrı şikayeti olmayan beş yaştan büyük 20 hasta kontrol grubu olarak çalışmaya dahil edildi (Grup 2). Değerlendirme için; 1. Saniyedeki zorlu ekspiratuar akım hızı (FEV1), zorlu vital kapasite (FVC), FEV1/FVC ve zorlu ekspirasyon ortası akım hızı (FEF 25-75) parametreleri kaydedildi.

Bulgular: FEV1, FVC ve FEF 25-75 gibi değerlerin üzerinde yaş, BMI ve cinsiyetin anlamlı bir etkisi olmadığı görüldü. Aynı değerler üzerinde bronkoskopi işleminin etkisi incelendiğinde Grup 1 ve Grup 2 için FEV1 ve FVC değerleri arasındaki fark istatistiksel olarak anlamı, FEV1/FVC ve FEF 25-75 arasındaki fark ise anlamlı değildi.

Sonuç: Erken dönemde tespit edilen ve 24 saatten önce müdahale edilen hastalarımızın spirometre ile değerlendirilen akciğer kapasitelerinde uzun dönem olumsuz bir etkilenme tespit edilememiştir.

Anahtar kelimeler: Yabancı cisim aspirasyonu, bronkoskopi, spirometri, çocuklar

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INTRODUCTION

Foreign body aspiration (FBA) is an avoidable serious clinical problem that is responsible for numerous mortalities and morbidities, particularly in children aged <3 years[1-3].Many different foreign bodies, such as organic materials (peanuts, nuts, etc.) and, most frequently, plastic or metal toy pieces, pins, can be aspirated [2, 3].Although foreign bodies are usually aspirated into the right main bronchus, they can be found in any region, including terminal bronchioles on both sides [1, 2].Acute airway obstruction with clinical manifestations of suffocation and coughing after aspiration is alleviated as the foreign body drifts distally[4]. Rigid bronchoscopy is a safe and effective means for the diagnosis and removal of a foreign body[4]. Spirometry is a physiological test that measures the proportion of varying lung volumes during forced breathing maneuvers and is used to diagnose, manage, and monitor various respiratory diseases [5, 6]. The purpose of the present study was to evaluate the long-term lung status using spirometry in patients who underwent rigid bronchoscopy in acute period due to FBA.

MATERIALS AND METHODS

After obtaining the approval of Ethics Committee (2018/79), records of 142 children who underwent bronchoscopy due to FBA between March 2013 and April 2018 were retrospectively reviewed. The patients, who were admitted to the pediatric emergency department and for whom a bronchoscopy was scheduled under emergency conditions due to acute symptoms after foreign body aspiration, were included in the study. Bronchoscopy decision was made in the presence of one or more positive findings found in the medical history, physical examination, and anterior-posterior chest x-ray. Any of the following was accepted as a positive finding, including a history of choking associated with feeding; complaints of wheezing, coughing, acute dyspnea; parents' complaints that the child was "not breathing right", detection of wheezing in the physical examination, a low level of oxygen saturation (SpO2) (85-97%) in pulse oximetry; or visualisation of unilateral lung emphysema, air trapping or foreign body (if it is radio-opaque) in the anterior-posterior chest x-ray.

Forty-two patients aged > 5 years who were thought to be co-operative during the spirometry process were invited by telephone. The data of 20 patients who cooperated with the spirometry process were included in this study (Group 1). Patients with negative bronchoscopy result, children aged < 5 years, the patients who underwent bronchoscopy after 24 hours, with chronic diseases such as asthma and reactive airway disease, using prophylactic bronchodilators and those who could not cooperate during the spirometry process regardless of age were excluded from the study. Twenty patients aged > 5 years who were admitted to the routine pediatric surgeon polyclinic without any lung problem and pain complaints were included in the study as a control group (Group 2). Because personal information, such as height, weight, age, sex, and racial group, may affect spirometry measurements, data for both groups were separately recorded[7].

Bronchoscopy procedures in all patients included in the study had been performed under general anesthesia in the operating room using a pediatric bronchoscope (Karl Storz). All foreign bodies detected in the tracheobronchial system had been removed using a foreign body optical forceps (10378KF or 10378L, Karl Storz).

Pulmonary function test (PFT) technique

PFT was performed by the same staff, between 10 and 11 am, after patients had rested for at least 15 min, while they were in a sitting position. The procedure was explained in detail and then trial measurements were taken. Age, sex, height, and weight of the patients were measured and recorded in the device. Cosmed Omnia 1.6 (COSMED Quark PFT by OMNIA, Certificate No. SM94991) was used for the spirometry process. At least three acceptable tests were performed for each patient. Forced expiratory flow rate (FEV1), forced vital capacity (FVC), FEV1/FVC, and forced expiratory flow at 25-75% of forced vital capacity (FEF 25–75) parameters were recorded in the first second.

Statistical analysis

Statistical analyses were performed using the SPSS 18.0 package software. Normal distribution of the data was evaluated by the Shapiro–Wilks test, and the result was normal. The chi-square test was used for determining whether there were any differences in the distribution of age, sex and BMI between the study groups. The effect of age, sex, surgical procedure, and body mass index (BMI) on the FEV1, FVC, and FEF 25–75 values was analyzed by four-way ANOVA at a significance level of $p < 0.05$.

RESULTS

In the study, the patients were divided into two groups: Group 1 (those who underwent bronchoscopy) and Group 2 (control). The demographic data of Group 1 and 2 are summarized in (Table 1).

Table 1. Demographic data of group 1 and 2.

	Group 1		Group 2		
	Female	Male	Female	Male	P
Sex n(%)	7 (35)	13(65)	8 (40)	12(60)	0.519
Age (year) (mean)	7.3 (5-15)		7.8 (5-16)		0.76
BMI	17		14		0.29

Of the aspirated objects, 55% (n = 11) were in the right main bronchus, 35% (n = 7) in the left main bronchus, and 10% (n = 2) in the trachea. In terms of foreign bodies, 75% (n = 15) peanuts (1–4 pieces), 10% (n = 2) pumpkin seeds (single piece), 10% (n = 2) pins, and 5% (n = 1) sunflower seeds (single piece) were removed.

Table 2. Comparison of FEV1, FVC, FEV1/FVC, FEF 25–75 for Groups 1 and 2

	Group 1	**Grup 2**	**P values**
FEV1	91.8±19,8	84,5±14,6	0.007
FVC	93.2±16,1	86.2±21,1	0.009
FEV1/FVC	89.5±10,2	84.9±10,4	0.51
FEF 25-75	90±20	91±21	0.83

Based on the statistical analysis results, there was no significant difference between group 1 and group 2 in terms of sex (p=0,519), age (p=0,76) and BMI (p=0,29) distributions. Furthermore, there was no significant effect of age, sex, and BMI on FEV1, FVC, and FEF 25–75 ($p > 0.5$) values. When we examined the effect of bronchoscopy procedure on the same values, the difference between FEV1 ($p = 0,007$) and FVC ($p = 0,009$) values was statistically significant, whereas the difference between FEV1/FVC ($p = 0.51$) and FEF 25–75 ($p = 0.83$) values was not statistically significant for Groups 1 and 2. According to this, despite being normal, contrary to our expectation, the FEV1 and FVC values of the patients who underwent bronchoscopy were significantly higher than the FEV1 and FVC values of the control group. The mean ± SD values of FEV1, FVC, FEV1/FVC, FEF 25–75 and multiple comparison p values for Groups 1 and 2 are summarized in (Table 2).

DISCUSSION

The prevalence of tracheal-bronchial foreign bodies is higher in children than in adults owing to anatomical and physiological features, such as poor chewing capacity because of absence of molar teeth, immature swallowing coordination, and high respiratory rates[2].

During the time elapsed from aspiration to treatment, foreign bodies cause irritation in the bronchial mucosa, severe local inflammatory reaction and edema, cell infiltration, and, if there is excessive delay, formation of ulceration and granulation tissue and consequently serious airway obstruction[1,4]. The bronchoscopic procedure itself leads to postoperative complications, such as hemorrhage and increased edema after manipulation[3,4]. In addition, organic pieces that tend to break into small bits during bronchoscopy may not be noticed and may migrate to the distal air space. Undiagnosed, persistent foreign bodies lead to serious problems, such as pneumonia, atelectasis, and bronchiectasis, that can disrupt lung functions[1,4]. There were no delayed cases among our patients. All patients had been diagnosed within 4–24 h, and foreign bodies had been removed. Negative effects of undiagnosed, foreign bodies chronically affecting lung function are known; however, to the best of our knowledge, our study is the first to evaluate the effects of foreign bodies that were diagnosed and successfully removed in the acute period on long-term lung functions using spirometry.

It is particularly difficult to perform quality and reliable tests on pediatric patients because, compared to adults, they complete forced expiration process in a shorter time and have a smaller lung volume and a larger air passage in proportion to the lung volume[5,7].

There are a number of indications for spirometry in children, such as the identification of mechanical dysfunction in the respiratory system; identification of obstructive or restrictive patterns of the dysfunction; diagnosis and follow-up of symptoms and diseases such as chronic cough, persistent wheezing, asthma, and cystic fibrosis; evaluation of therapeutic interventions in diseases; and epidemiological and clinical investigations[6,7].

To perform a reliable spirometry test, children should

not have a learning difficulty; mental status disorder; or chest, abdomen, mouth, or facial pain. There were no such conditions in our patients. Some studies have reported that spirometry can be safely performed even in children aged 2–5 years with the help of adequate education and practice using a child-friendly approach, which may include the use of visual and verbal incentives prior to testing[5,7,8]. However, some argue that the accuracy of the results of spirometry is unclear in children aged <6 years[6,9]. In our study, children aged 4–5 years were not eligible for spirometry. Approximately half of our patients were aged 3–5 years, but they were excluded from this study because a reliable spirometry could not have been performed in them. Only patients aged >5 years were included in the study.

The parameters that are commonly used to interpret spirometry results are FEV1 (the volume of air exhaled in the first second of forced expiration), FVC (the sum of tidal volume, expiratory reserve volume, and inspiratory reserve volume; it is the maximum air volume that can be inhaled after a forced exhalation), FEF 25–75 (the average air flow from the point of 25% of FVC, which is the forced expiratory flow during the middle half of FVC, to the point of 75% of FVC during the forced expiration), and FEV1/FVC ratio[6,7,8,10].

FEV1/FVC and FEF 25–75 are more sensitive and specific indicators of airway obstruction[8]. In particular, FEF 25–75, a value of the central expiratory flow, was 60% lower than the predicted value, which suggests an obstructive cause[8,10]. However, in the present study, we found that FEF 25–75 and FEV1/FVC values were >80% in both groups and that there was no statistically significant difference between the two groups (Tables II).

Early diagnosis and treatment is very important and lifesaving in the case of FBA. There was no long-term negative effect on lung capacities assessed using spirometry in our patients who received early-diagnosis and intervention within 24 h. It would be useful to evaluate an adequate number of chronic cases of FBA with late diagnosis (>24 h) in this regard.

Yazar Katkıları: Çalışma konsepti/Tasarımı: AA, MEÇ, ND, ÇE, BA; Veri toplama: AA, ND, ÇE, MEÇ, BA; Veri analizi ve yorumlama: AA, MEÇ, ND, ÇE, BA; Yazı taslağı: AA, MEÇ, ND, BA, ÇE; İçeriğin eleştirel incelenmesi: AA, MEÇ, ND, BA, ÇE; Son onay ve sorumluluk: AA, ND, MEÇ, ÇE, BA; Teknik ve malzeme desteği: AA, ND, MEÇ, ÇE, BA; Süpervizyon: AA, BA, ND, ÇE, MEÇ; Fon sağlama (mevcut ise): yok.
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