

MMEF or FEV₁ in Estimating Bronchial Obstruction in Asthmatic Children

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In this study the maximal mid-expiratory flow (MMEF) was compared with forced expiratory volume in 1 sec (FEV₁) by a spirometric investigation of healthy children and children with slight bronchial obstruction. We found that the reproducibility of MMEF was good in both healthy and asthmatic children and that both methods had the same ability to detect abnormality before inhalation of a beta₂-receptor agonist. After such an inhalation the discriminatory power was greater for FEV₁ than for MMEF and we therefore prefer FEV₁ in estimating bronchial obstruction in children.

Key words: asthmatic children; forced expiratory volume in 1 sec (FEV₁); maximal mid-expiratory flow (MMEF); salbutamol inhalation.

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Early recognition of mild bronchial obstruction, even subclinical, is essential when treating children with asthma (2, 8, 10). To obtain this information, it is useful for the clinician to have some simple technical device. Many of these devices are based on the spirometric principle. When employing such a technique, forced expiratory volume in 1 sec (FEV₁) is one of the most frequently used parameters for revealing bronchial obstruction. Several authors claim that the maximal mid-expiratory flow (MMEF), i.e. the mean rate of air flow between 25 and 75% of the forced vital capacity (FVC) and calculated from the spirometric curve, is more sensitive than the FEV₁ measurement (2, 7, 8, 10), but this view is not supported by other authors (1, 9).

In previous studies (3, 4, 5) we evaluated the reliability and sensitivity of some "simple" spirometers using the FEV₁ parameter. The aim of this study was to compare the FEV₁ measurement with the MMEF parameter by an investigation of healthy children and asthmatic children with slight bronchial obstructions before and after inhalation of salbutamol.

METHODS

The healthy children were investigated with a Monaghan M403 pulmonary function analyzer, equipped with a recorder as previously described (4). The equipment was calibrated against the ATPS values of a Bernstein spirometer. The children were investigated in a sitting position. The highest value of three determinations was chosen. After spirometry the child inhaled a beta₂-receptor agonist (salbutamol) using a nebulizer of compressor type (Pari Inhaler Boy). The dose was 0.15 mg/kg body weight. Twenty minutes after the inhalation spirometry was repeated.

The asthmatic children were investigated with the same equipment and in addition with a Vitalograph with its original calibration. A Monaghan spirometer and a Vitalograph were distributed alternately to each child. The asthmatic children then also inhaled salbutamol and the investigations were repeated. MMEF was calculated from the Monaghan and the Vitalograph spirometric graphs with the calculation devices supplied by the manufacturers.

MATERIAL

From a randomized sample of *healthy* Swedish children, described previously (4), the spirometric results were used of those 49 children whose spirometric graphs were obtained with the Monaghan equipment before inhalation of salbutamol. In 42 of these children such graphs were also obtained and used after inhalation of salbutamol. The ages were 7 to 15 years (mean: 11.2 years).

From a randomized sample of *asthmatic* children described previously (5), the spirometric results were used of those 40 children whose spirometric results were obtained with the Monaghan equipment and the Vitalograph before and after salbutamol inhalation. The ages were 7–16 years (mean: 11.5 years). The children were tested when they were subjectively free from bronchial distress. They had no symptoms or signs of respiratory infections. No drugs were used 12 h before the investigation and none of the children were on steroids.

RESULTS AND COMMENTS

Before inhalation of salbutamol

The correlation of FEV₁ and MMEF to body height and the residual standard deviations (RSD) for the 49 healthy children before salbutamol inhalation are presented in Table 1. Like other authors we found the correlation of MMEF with body height was weaker than that of FEV₁ (6). The RSD is also considerably greater.

The FEV₁ and MMEF values obtained by Monaghan spirometry before salbutamol inhalation of the 40 asthmatic children in relation to the healthy children are given in Table 2. In spite of the greater variation of MMEF in healthy children there is no obvious difference between FEV₁ and MMEF in discriminating the asthmatic children.

After inhalation of salbutamol

As in our previous report (4) FEV₁ increases significantly in the healthy children after inhala-

Table 1

Monaghan spirometry in 49 healthy children. Relation to body height. The correlation coefficients (*r*) and the residual standard deviations (RSD) of forced expiratory volume in 1 sec (FEV₁) and maximal mid-expiratory flow (MMEF) are given

		FEV ₁	MMEF
<i>r</i>	boys	0.96	0.82
	girls	0.97	0.84
RSD %	boys	11.4	17.9
	girls	9.4	21.3

Table 2

Forced expiratory volume in 1 sec (FEV₁) and maximal mid-expiratory flow (MMEF) in 40 symptom-free asthmatic children are related to the reference values of 49 healthy children

No. of children with values	FEV ₁	MMEF
above M	10	6
between M and -2 RSD	22	27
below -2 RSD	8	7

Mean = M, residual standard deviation = RSD.

Table 3

Change in maximal mid-expiratory flow (MMEF) and forced expiratory volume in 1 sec (FEV₁) in Monaghan spirometry after salbutamol inhalation in 42 healthy children. Mean (M) and SD of the differences are given in percentages of the initial values

Height subgroup	No. of children	FEV ₁	MMEF
≤ 139 cm	M	4.7**	17.7**
<i>n</i> = 13	SD	4.0	11.5
140–159 cm	M	2.2**	12.1**
<i>n</i> = 14	SD	2.5	8.8
≥ 160 cm	M	4.0**	12.9**
<i>n</i> = 15	SD	2.2	6.1
Total	M	3.6**	14.1**
<i>n</i> = 42	SD	3.1	9.1

The significances were calculated according to Wilcoxon's test.

Table 4

Change of MMEF and FEV₁ in Monaghan spirometry after salbutamol inhalation in 40 asthmatic children. The number of asthmatic children with a change below (normal) or above (abnormal) the normal upper limit is given. Normal upper limit = $M + 2$ SD of the change in 42 healthy children (Table 3)

	FEV ₁	
	Normal	Abnormal
MMEF		
Normal	17	10
Abnormal	1	12

tion of salbutamol and the increase is significant also for the small number of healthy children in the three height subgroups (Table 3). Svenonius et al. (11) found no such increase in a similar number of healthy children but this is probably due to the approximately 10-fold higher dose of salbutamol used in our studies and/or to the fact that Svenonius et al. used an ordinary dose aerosol.

After salbutamol, MMEF increases approximately three times more than FEV₁ in the healthy children and the variation of the changes is also greater for MMEF. Hence, the upper normal limit of the increase is substantially greater for MMEF than for FEV₁. This probably explains the lesser discrimination ability of MMEF after salbutamol inhalation in the asthmatic children (Table 4).

Reproducibility of MMEF

A non-parametric permutation test comparing the Monaghan spirometer and the Vitalograph revealed no significant MMEF differences in the asthmatic children. The differences were (in percentages of the initial value): 0.0% (SEM = 1.9%) before inhalation of salbutamol and 1.7% (SEM = 1.2%) after inhalation.

Although the investigations were performed with two different kinds of spirometers the comparison showed surprisingly small differences, thus indicating a good reproducibility of MMEF.

CONCLUSIONS

1. MMEF can be estimated with good reproducibility.
2. MMEF and FEV₁ are almost equally effective for detecting abnormality in asthmatic children *before* inhalation of salbutamol.
3. MMEF is less effective than FEV₁ for detecting abnormality in asthmatic children *after* salbutamol inhalation.

In conformity with these results, we prefer to use FEV₁ rather than MMEF in estimating bronchial obstruction in children.

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