The Match Test Revisited

Blowing Out a Candle as a Screening Test for Airflow Obstruction

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The physician of the last century who asked a patient with respiratory disease to whistle or blow out a candle was crudely assessing the maximum respiratory velocities.[1] In 1959, using matches, Snider et al[2] described a semiquantitative version of this crude maneuver and noted that failure to extinguish a lighted match held 15 cm from the wide-open mouth indicated a forced expiratory volume in 1 second (FEV_1) of less than 1000 mL. Subsequently, others[3,4] reported a more extensive evaluation of this test. They obtained good correlation of match distance with FEV_1 and maximum breathing capacity (MBC) but not with FEV_1/FVC (forced vital capacity).

Although spirometry and peak expiratory flow (PEF) measurements are now the standards for pulmonary function testing, this study was undertaken to reevaluate the maneuver of extinguishing a flame for two reasons. First, indiscriminate use of screening tests requiring special apparatus should be discouraged in an era of health care cost containment; in addition, such apparatus may be unavailable in remote areas, and third world countries. Second, another rough assessment of airway function, forced expiratory time (FET), which also requires no special equipment, is available to clinicians to assess the degree of airway obstruction.[5,6]

The Snider match test and FET have never previously been directly compared as screening tests for airflow obstruction, and they might reflect different aspects of airway function. In a study reported here, maximum candle distance at which a subject extinguished the flame was compared with spirometric and peak flow values. Similarly, using the results of spirometry and PEF as quantitative standards, candle distance was compared to FET. An ordinary candle rather than a match was used, and the subject was allowed to purse the lips for a more reproducible maneuver.

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METHODS

Fifty-two outpatients (30 male and 22 female) with the clinical diagnosis of chronic obstructive pulmonary disease (COPD) or asthma, and 42 healthy medical staff members of Harborview Medical Center (21 male and 21 female) were the subjects for this study. Spirometry, peak flow, and candle blowing were performed in that order, in the sitting position, by each subject. Recording the duration of audible airflow, the FET was measured with a stopwatch with the stethoscope over the trachea during spirometric measurements. A Volumetric Spirometer VS400, a mini-Wright peak flow meter (Fraser Harlake, Orchard Park, NY), and an ordinary domestic wax candle (9 × 203 mm) were used for the study. All the tests were demonstrated to each subject, and all observations were made by the same investigator (B.T.).

The candle test was performed by holding the lighted candle perpendicular to a horizontal 180-cm wooden board, which in turn was placed on an adjustable bedside tray so that the flame height was that of the subject's mouth and one edge of the board just touched the chest of the subject (Figure 1). The candle was moved by 5-cm increments toward or away from the subject depending on whether the candle flame could be extinguished in three attempts. Subjects were given a resting period when they either felt tired or were observed to be tired. After a maximum inspiration, each subject attempted to blow the candle out with pursed lips. The furthest distance at which the candle was extinguished was recorded as candle distance. All the tests were performed in a room free of wind with the subject sitting comfortably in a chair.

Regression equations were determined for FVC, FEV_1, FEV_1/FVC%, PEF, and FET vs candle distance. The same was done for FET.

Figure 1. Subject extinguishing a lighted candle.

RESULTS

The relationships of candle distance and FET to FEV_1, FEV_1/FVC% and PEF in the 94 subjects are shown in Figures 2 and 3. The range of candle distance was 5 to 145 cm. Seven (13%) of the 52 patients blew out the candle at 15 cm or less, and 26 (50% of 52 patients) at 35 cm or less, while all healthy controls extinguished the candle at 40 cm or farther. Ninety-six percent of subjects with a candle distance of 35 cm or less had an FEV_1 of 1.5 L or less, while those with a candle distance of 15 cm or less had an FEV_1 of less than 1.0 L. Six patients did not complete all tests either because they felt too ill to continue or were not cooperative.

Regression equations for FVC, FEV_1, FEV_1/FVC%, PEF, and FET vs candle distance are shown in Table 1. Similar regressions for FET are shown in Table 2. Candle distance correlated best with FEV_1 and least well with FEV_1/FVC%, whereas FET correlated most highly with PEF but almost as well with FEV_1/FVC%.

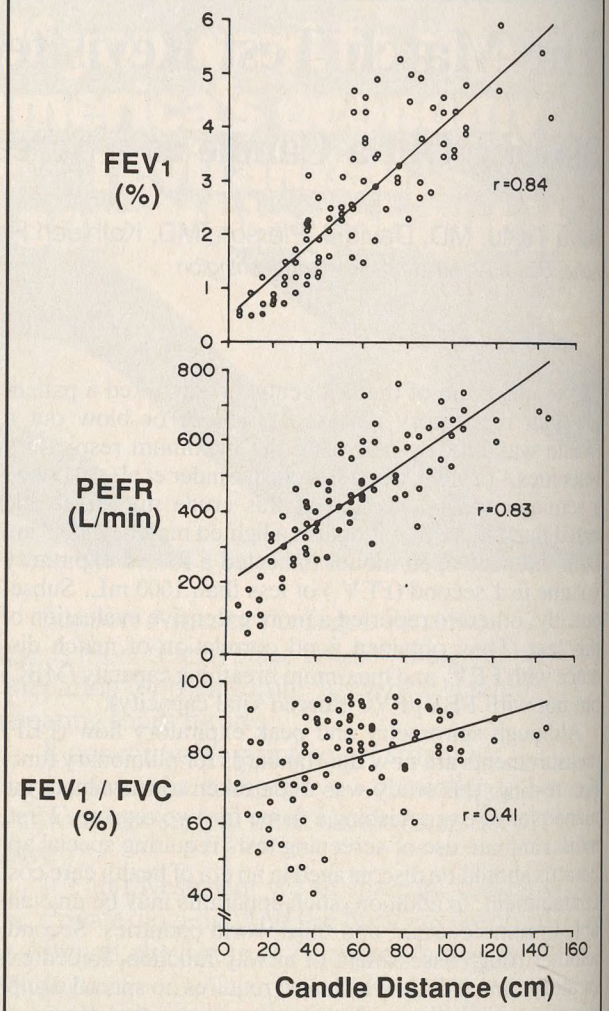

Figure 2. Correlation of candle distance with spirometry and peak expiratory flow rate (PEFR). FEV_1—forced expiratory volume in 1 second, FVC—forced vital capacity.

DISCUSSION

These findings, that candle distance reflects FVC, FEV, and PEF and that FET correlates better with FEV_1/FVC than does candle distance, corroborate some previous studies[2,4] but not others.[6,7] Snider et al,[2] Carilli and Henderson,[4] and Barry[8] found good correlation of FEV_1 and MBC with match distance, and accordingly the match test was recommended for preoperative assessment of pulmonary function. No comparison was made, however, between match distance and FEV_1/FVC%, the reference standard for airway obstruction. On the other hand, Lal et al[6] reported that FET had good correlation with FEV_1/FVC% and not with PEF, while Rosenblatt and Stein[7] noted a correlation of FEV_1 and MBC with FET. Like the study of Weg et al,[5] the current study was unable to reproduce the FET findings of Lal et al.[6] There was a poor correlation of FEV_1 with FET in both healthy control subjects and patients.

These results are consistent with the hypothesis that candle distance and FET measure different aspects of

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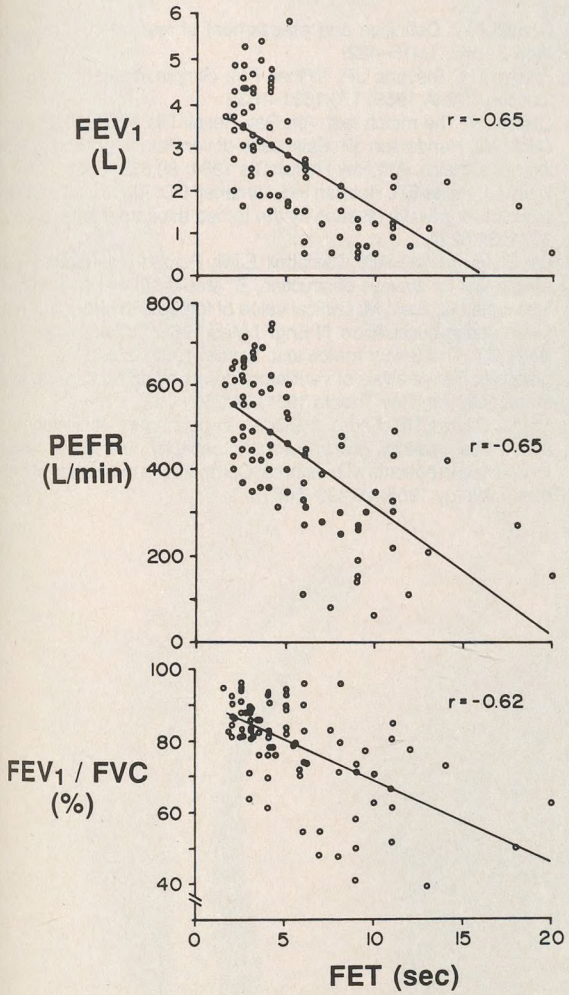

Figure 3. Correlation of forced expiratory time (FET) with spirometry and peak expiratory flow rate (PEFR). FEV_1—forced expiratory volume in 1 second, FVC—forced vital capacity.

pulmonary function. Candle distance reflects the sum total of respiratory forces generated by the lungs and thoracic cage. Accordingly, it could predict such absolute values as FVC, FEV_1, and PEF, and thus depends to a large extent on the size of the lungs. On the other hand, FET reflects the relative degree of airway obstruction irrespective of lung size, ie, it gives a better reflection of FEV_1/FVC. Even then, there are two shortcomings of FET. First, FET in the normal population is relatively constant,[9,10] suggesting the lack of linear relationship of FET with either FVC, FEV_1 or PEF. Second, because of

TABLE 1. CANDLE DISTANCE VS SPIROMETRY, PEF, AND FET

Regression Equations	R	*P* Value
FVC (sample size 92) y = 0.04039x + 0.9606	0.805	<.001
FEV_1 (sample size 92) y = 0.037659x + 0.4983	0.836	<.001
PEFR (sample size 90) y = 4.3379x + 195.5	0.825	<.001
FET (sample size 90) y = −0.071331x + 9.5991	−0.689	<.001
FEV_1/FVC% (sample size 92) y = 0.17735x + 69.222	0.413	<.001

PEF—peak expiratory flow, FET—forced expiratory time, FVC—forced vital capacity, FEV_1—forced expiratory volume in 1 second, PEFR—peak expiratory flow rate.

dyspnea, patients with severe COPD cannot maintain a prolonged expiration, and the maneuver may underestimate FET.

The Snider match test was a crude bedside assessment of ventilatory function. All the tests were performed with the mouth opened wide and a lighted match held at 15 cm. The rationale for the wide-open mouth was to simulate spirometric maneuvers. In practice, however, there are no standard mouthpieces or connecting tubes of spirometers. In addition to difficulty in gauging how wide the mouth should be in blowing out the match, the maneuver is awkward. Blowing a candle with pursed lips is easy and generates maximal airflow.

In conclusion, the candle test is a simple and inexpensive tool for assessing overall respiratory mechanics. This test may be particularly useful in remote areas and developing countries where resources are very limited. Candle distance did not correlate well with FET, but the latter could be utilized to advantage to assess the relative degree of airway obstruction.

TABLE 2. FORCED EXPIRATORY TIME (FET) VS SPIROMETRY AND PEF

Regression Equations	R	*P* Value
FVC y = −0.2405x + 4.6071	−0.554	<.001
FEV_1 y = −02525x + 4.0469	−0.647	<.001
FEV_1/FVC% y = 91.7943 − 2.3170x	−0.615	<.001
PEFR y = 607.97 − 29.809x	−0.654	<.001

PEF—peak expiratory flow, FVC—forced vital capacity, FEV_1—forced expiratory volume in 1 second, PEFR—peak expiratory flow rate.

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