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Forced Expiratory Time in Indian Children – Ability to Meet the Criterion

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ABSTRACT

The forced vital capacity (FVC) maneuver is central to a multitude of information about the functioning of the lungs. But for it serve this purpose proper performance of this complex maneuver is essential. Standards have been prescribed by various agencies to monitor the FVC maneuver, concentrating mainly on adults. Children in general find it difficult to satisfy these adult based standards, and especially the forced expiratory time (FET) criterion, which is a part of the end of test (EOT) criteria, is found to be most difficult to achieve. Technically acceptable FVC maneuvers obtained from 91 children yielded FET values which were analyzed and Pearson's correlation coefficients were derived with height, weight, age and body surface area (BSA). The children in the present study produced an average FET of 1.53s, and over the age, height and weight ranges FET exhibited a positive correlation. Hence adult based standards may not be achieved by children vis-à-vis FET, even though the curves obtained are technically acceptable as far as complete expiration is concerned.

Keywords: American Thoracic Society, children, European Respiratory Society, FVC pulmonary function tests

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INTRODUCTION

The FVC maneuver consists of inspiration to Total lung capacity (TLC) followed by forcible expiration to Residual volume (RV) [1]. This maneuver provides clinically relevant parameters like FVC, Forced expiratory volume in the first second (FEV_1), Peak expiratory flow (PEF) and Maximal mid expiratory flow (MMEF) [2]. The maneuver by itself can be divided into three distinct phases' namely maximal inspiration, forcible expiration and complete expiration [3]. Patient cooperation is highly essential in all these phases because inappropriate performance in any/all of these phases can result in fallacious values of various pulmonary function test (PFT) parameters [4]. In fact the largest single source of within subject variability is improper performance of the maneuver [5]. So efforts have been made to standardize the procedure from time to time by many agencies, with the American thoracic society (ATS) [6,7,8] and European agencies like European Community for Coal and Steel (ECCS) [9] and European respiratory society (ERS) [10] spearheading the process. To bring about a semblance of order in these recommendations a joint task force of ATS/ERS has also submitted its report [11]. Initially these recommendations did not consider different strategies for adult/children. An important sticking point was with the applicability of end of test criteria (EOT), especially the forced expiratory time criterion which assesses the "complete expiration" component of the FVC maneuver in children [12]. The aim of the present study was to determine the ability of Indian children to achieve this EOT criterion and also to correlate the FET with age, height, weight and BSA.

MATERIALS AND METHODS

The present study was conducted under the aegis of the institute's department of physiology, on 10-15 years old male school children drawn from local Government Schools. Ethical clearance was obtained from the institute's ethical committee before the start of the study. Written informed consent was obtained from the parents/guardian after the detailed procedure and purpose of the study was explained to them. All the children were naive to spirometry. They were subjected to detailed clinical examination to rule out the presence of any underlying diseases that could affect the results of pulmonary function tests. Healthy boys in the age group of 10-15 years, non-smokers, not suffering from any diseases that could affect the lung function and not involved in any physical activity (beyond the normal level) were included in the study. Those with history of upper/lower respiratory tract infections in the past 3 weeks, present/past history of cardiac disease, history of bronchial asthma, who were physically/mentally handicapped and smokers, were excluded from the purview of the study. In all 91 children met the inclusion criteria as well as were able to perform acceptable FVC maneuvers and the flow volume loops did not exhibit obstructive features. Height and weight were measured using accepted standard procedures. Age was calculated based on the date-of-birth provided in the school register.

The instrument used in this study was Spirolyser SPL-95 (France International Medical, Lyon). Calibration of the instrument with a 3L Syringe was done on a regular basis to maintain the reliability of the equipment. The procedures were done with the subject standing and with

the nose clip in place. All the procedures were done in the school itself in order to provide a familiar environment to the children. Each child was taught about the performance of FVC maneuver for about 5 minutes and then was allowed to do some practice blows. Sufficient rest was provided between the procedures. The subjects were asked to perform the FVC (forced vital capacity) maneuver and at the culmination of satisfactory test session, the disposable mouthpiece was discarded and new one was put in its place.

The values of the expiratory time obtained by FVC maneuvers were subjected to correlation analysis with height, weight, age and BSA. A two tailed significance test was applied to the correlation analysis results. Statistical analysis were done using software SPSS for MS Windows-release 11.0.

RESULTS

The distribution of children in different age groups and the average values/standard deviations (SD) of various anthropometric data are presented in (Table-1).

Table – 1 : Anthropometric data in different age groups (Mean ± SD)

Age group	Height (cms)	Weight (kgs)	BSA (sq.mt)	BMI
10.1 to 11.0 yrs (n=27)	108.3 ± 4.20	23.2 ± 3.07	0.82 ± 0.06	19.7 ± 1.58
11.1 to 12.0 yrs (n=12)	119.4 ± 2.64	31.1 ± 1.82	1.00 ± 0.03	21.8 ± 1.32
12.1 to 13.0 yrs (n=21)	129.9 ± 4.18	36.3 ± 1.71	1.13 ± 0.04	21.5 ± 1.35
13.1 to 14.0 yrs (n=13)	142.2 ± 3.10	41.2 ± 1.60	1.28 ± 0.04	20.4 ± 0.58
14.1 to 15.0 yrs (n=18)	153.6 ± 3.44	45.7 ± 6.90	1.41 ± 0.10	19.4 ± 2.76

The Mean's and SD's of forced expiratory time achieved by children in different age groups during the FVC maneuver are provided in (Table-2).

Table – 2 : Expiratory time in different age groups

Age group (years)	10.1-11.0 (n=27)	11.1-12.0 (n=12)	12.1-13.0 (n=21)	13.1-14.0 (n=13)	14.1-15.0 (n=18)
Ex.t (secs) Mean± SD	1.54± 0.55	1.34± 0.30	1.45 ±0.32	1.50± 0.37	1.76± 0.47

Finally the correlation coefficients of expiratory time with anthropometric parameters like height, weight, age and BSA are given in (Table-3).

Table – 3: Correlation analysis of expiratory time with anthropometric data

	Height	Weight	Age	BSA
Correlation coefficient	0.23	0.18	0.20	0.20
P value (2 tail)	0.028*	0.090	0.060	0.050

* significant

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There was a positive correlation of expiratory time with all these parameters but significance ($p<0.05$) was only exhibited for height.

DISCUSSION

Forced expiratory time is the duration taken for expelling the air from the lungs (i.e. up to the residual volume) preceded by a deep inspiration, during a FVC maneuver. In normal individuals a major part of this air (>70%) is expelled within the first second of the maneuver and the remaining air takes about a further 2 seconds or so to be expelled [13]. In a flow-volume curve a complete expiration is characterized by a gradual asymptotic approach of the curve to the volume axis [12]. An improper performance during various phases of the FVC maneuver is found to be responsible for erroneous values of various PFT parameters derived from it [14].

Because of these reasons efforts have been put by the ATS to set proper benchmarks to ascertain proper performance of the three parts of a FVC maneuver. The benchmarks for complete exhalation are referred to as the EOT criteria, of which the FET is one aspect. The 1987 ATS statement pertaining to FET was a generalized prescription of an exhalation time of at least 6s to indicate complete exhalation [7]. While in its 1994 update it added that a shorter exhalation time is acceptable in certain groups like children, young adults etc, but refrained from mentioning the actual values required [8]. A joint task force of ATS and ERS was constituted to simplify the standards of spirometry performance [15]. They have recommended a FET of ≥3s for children aged <10 years and ≥6s for those above this age [11]. In a clarification provided recently it has been suggested that this benchmark should actually be considered as just a guide [16].

In a study done by Arets HG et al[12] it was observed that only 15.6% of the children in the age group of 12-15 years were able to achieve a FET of >6s, while the FET that was achieved by 90% in this group was around 1.8s. Our study population had an average FET of 1.53s and also showed a positive correlation with height, age, weight and BSA. It has been shown that body size [16] and age [12,16] are important factors that determine the duration of exhalation times. Due to such low compliance of children to achieve adult based FET criteria, it has been suggested that the FET criteria be modified as 2s for children >8 yrs of age and 1 s for children <8 yrs of age, as long as there is a satisfactory approach of the flow-volume curve toward the volume axis [12]. Furthermore underestimation of FVC is not said to be clinically important in children [4], and the possibility of underestimation of FVC if any, can be essentially overcome by substituting VC obtained from a slow VC maneuver for FVC when determining the FEV_1 ratio [8].

CONCLUSION

Thus FET recommendations prescribed for adults are unlikely to be achieved in young children and this has been the case in our study also. A visual inspection of the flow volume curve may be adequate enough to confirm complete exhalation.

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REFERENCES

[1] Weinberger SE, Rosen IM. Disturbances of respiratory function. In: Fauci AS, Braunwald E, Kasper DL, Hauser SL, Longo DL, Jameson JL, *et al* editors. Harrison's principles of internal medicine, 17th edn. New York: McGraw-hill medical; 2008. p. 1586-92.
[2] Lebowitz MD, Knudson RJ, Robertson G, Burrows B. Chest 1982; 81: 566-70.
[3] Wanger J. Pulmonary function testing: a practical approach, 3rd edn. Sudbury, Mass: Jones and Bartlett learning; 2012. p. 1-68.
[4] Enright PL, Linn WS, Avol EL, Margolis HG, Gong H Jr, Peters JM. Chest 2000;118:665-71.
[5] Lung function testing: selection of reference values and interpretative strategies. American Thoracic Society. Am Rev Respir Dis 1991; 144: 1202-18.
[6] American Thoracic Society: ATS statement: Snowbird workshop on standardization of spirometry. Am Rev Respir Dis 1979; 119: 831-38.
[7] Standardization of spirometry-1987 update. Statement of the American Thoracic Society. Am Rev Respir Dis 1987; 136: 1285-98.
[8] Standardization of Spirometry, 1994 update. American Thoracic Society. Am J Respir Crit Care Med 1995; 152: 1107-36.
[9] Quanjer PH. Bull Eur Physiopathol Respir 1983; 19 (Suppl. 5):1-95.
[10] Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, Yernault J-C. Lung volumes and forced ventilatory flows. Eur Respir J Suppl 1993; 16: 5-40.
[11] Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Eur Respir J 2005; 26: 319-38.
[12] Arets HG, Brackel HJ, van der Ent CK. Eur Respir J 2001; 18: 655-60.
[13] Lal S, Ferguson AD, Campbell EJM. BMJ 1964; 1: 814-17.
[14] Enright PL. Respir Care 2003; 48; 773-6.
[15] Brusasco V, Crapo R, Viegi G. Eur Respir J 2005; 26: 1-2.
[16] Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A. Eur Respir J 2010; 36: 1496-8.