Transfer factor in smokers and non-smokers after smoking two cigarettes

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Summary

Impairments of lung functionality as long-term effects of cigarette smoking have been well established. To our knowledge, no study on acute recovery patterns in any important lung function index after smoking a very limited number of cigarettes has ever been reported. The present study reports recovery patterns of lung transfer factor (TF) and related parameters in smokers and non-smokers who smoked two Camel cigarettes.

Lung transfer factor and other indices were determined by the single breath-holding technique. From our results, the TF and related indices of healthy Malaysians are similar to previously published normals of comparable age. On smoking two cigarettes, male smokers began to recover from the 30th minute; male non-smokers had not begun recovery even by the 50th minute. Extrapolation of the recovery curves suggests that a "safer" interval between cigarettes for male smokers is about 114 minutes.

Key words: Lung transfer factor, single breath-holding technique, smoking two cigarettes, recovery patterns, "safer" smoking intervals.

Introduction

Lung transfer factor (TF) and other indices of lung functionality have long been shown to be lower in smokers than in non-smokers.[1,2,3,4,5] Localization and characterization of lesions caused by cigarette smoking have progressed from identifying hypertrophy of the medial muscle and intimal fibrosis of the bronchiolar arterioles to specifying bronchiolitis of the first and second-order respiratory bronchioles.[6,7,8,9] A decrease in the small airway muscle tone has also been reported.[10] But these are all long-term effects. Besides, they reach severe disease states in only a small proportion of smokers.[11] Based on these reports, it would be very difficult to persuade especially young adults against starting, let alone stopping, the smoking habit. To such people, the established links between smoking and emphysema, chronic airway obstruction and cancer sound all too distant to apply to them.

The smoking of a single cigarette has been shown to significantly increase metabolic rate by 3% for 30 minutes.[12] An increase in the 24 hour energy expenditure in smokers has also been recently reported.[13] Smoking has, in addition, been shown to decrease the circulating α-1-proteinase inhibitor which normally protects alveolar and other elastic membranes in the

respiratory bronchioles against elastase activity.[10,14,15] These are all quite acute changes which should be reflected in consistent changes, admittedly subtle, in some indices of lung functionality. A subject in whom such acute subtle changes occur should be able to recover.

The present study reports recovery patterns of transfer factor in male non-smokers and male smokers after the subjects each smoked just two cigarettes. To our knowledge no such studies have previously been reported. From the recovery curves, quantifiable effects of the smoking of even two cigarettes are apparent and optimal intervals for slightly "safer" cigarette smoking are suggested.

Materials and methods

Nine male smokers and ten male non-smokers particpated in this study. All subjects were between 20 and 41 years old. Each of the subjects was a normal healthy staff or student of our Faculty of Medicine. None of them had any cardio-pulmonary infection, episodes of difficult breathing or anemia during the six months preceding the study.

Anyone who had regularly smoked 15 or more cigarettes per day during the 12 months prior to the study was classified as a smoker. Non-smokers had never smoked cigarettes before the experiment. The informed consent of each subject was obtained prior to the experiment.

All tests were carried out between 0900 and 1200 hours (Malaysian time) in our smoke-free respiratory function laboratory maintained at 23°C and at a relative humidity of 55%. Smokers abstained from smoking during the 12 hours immediately preceding the experiment (usually from 2100 hours the night before). The Camel brand of cigarette was used for all tests. Smoking sessions for this study were carried out in an open corridor some 14 meters from the respiratory laboratory. It took about ten seconds for the subjects to walk unhurriedly back to the respiratory laboratory for post-smoking measurements.

The height, weight and age of each subject as well as whether they were smokers or not were punched into the 47804A pulmonary Calculator (Computer) System (Hewlett Packard, Andover, Massachussetts, USA) which was used to determine pulmonary indices.

The single breath-holding technique of Ogilvie et al.[16] with slight modifications was employed to determine TF values. Before each test, one of the authors demonstrated the manoeuvre to subjects. The latter then undertook at least three trials, breathing air, until their performances were judged satisfactory. The subjects were not connected to the computer system during the trials; the test began when they were connected. Each subject breathed in and out normally for about two minutes until an indicator light on the machine signalled that he should breathe in deeply. Following a maximal expiration each subject was instructed to deeply inhale and hold his breath for ten seconds. Then he forcibly exhaled into a rubber bag. The exact volume of inspired air consisting of a mixture of 10% helium, 0.2% carbon monoxide, 21% oxygen and 68.8% nitrogen as well as the duration of breath-holding were recorded by the computer calculator system. After 60 seconds, the computer automatically printed out the values for the TF, Total Lung Capacity (TLC), Vital Capacity (VC), Residual Volume (RV) and the computed Body Surface Area (BSA).

Three pre-smoking recordings of TF and other lung parameters were taken at seven minutes intervals for each subject. Each test lasted about three minutes. So, the recordings were actually at ten-minute intervals. The pre-smoking readings represented the subjects' normal values. During

the smoking sessions, subjects were encouraged to inhale as much smoke as possible, every 40 seconds. Usually ten such inhalations finished a single cigarette. The non-smokers (like the authors) often choked and coughed so badly after a couple of inhalations of smoke that they were allowed, thereafter, to take long deep draughts, hold the smoke for about two seconds in their buccal cavities and then exhale. But for this modified monoeuvre, it would have been very difficult to persuade most non-smokers to volunteer, and perhaps impossible for them to complete the experiment with two cigarettes.

Trial determination of TF done after smoking just one cigarette showed only a negligible decrease. On the other hand trials with three cigarettes at a stretch were found to be too stressful. The study therefore limited itself to observing the effect of smoking two cigarettes.

The significance of the difference between means was assessed by the student's t test.

Results

The values of height, weight, BSA, TF, VC, TLC, TF/BSA, and TF/TLC are presented in Table I. The normal TF of male smokers (27.93 ± 1.45 ml/min/mmHg) is significantly lower ($P < 0.05$) than that of the male non-smokers (31.89 ± 1.14 ml/min/mmHg) despite similarities in their age and body surface area. The TF standardised for body surface area (TF/BSA) is significantly lower ($P < 0.05$) than those of non-smokers. Similarly, the RV and TLC in smokers are lower ($P < 0.01$) than that in non-smokers.

The RV/TLC ratios range from 35% in smokers to 40% in non-smokers. Attempted correlations of TF, TLC, VC, RV or their transformed values with time showed that predictably only TF or TF/BSA significantly correlated (Figs. 1 and 2). Consequently, no recovery curves for other parameters were plotted.

The first indication of a recovery is arbitrarily defined here as the earliest point in the curve when the deviations from the pre-smoking (normal) TF level plateau out or show an upswing back towards the normal value. Using this criterion, smokers began to recover at the 30th minute. Male non-smokers did not seem to have started recovery even by the 50th minute. The recovery curves for TF/BSA followed generally the same pattern. Perhaps a quantitatively more instructive picture of the recovery pattern can be seen in Table II which shows the magnitude of impairment of TF caused by the smoking of two cigarettes. These figures are obtained from Figure 1 by sub-

Table I

Normal anthropometric and spirometric values of smokers and non-smokers

Groups	No. of subjects	Age (Years)	HT (CM)	BSA (M^2)	TF (ml/min/mmHg)	VC (L)	TLC (L)	RV (L)	RV/TLC %	TF/BSA	TF/TLC
Male Smokers (SM)	9	31.67 ±1.57	162.90 ±1.35	1.68 ±0.05	27.93 ±1.45	3.35 ±0.12	5.46 ±0.15	1.94 ±0.15	35.26 ±2.24	16.57 ±0.67	5.14 ±0.24
Male Non-smokers (NSM)	10	27.00 ±2.41	165.47 ±0.99	1.68 ±0.04	31.89 ±1.14	3.56 ±0.11	6.06 ±0.15	2.46 ±0.07	40.50 ±0.81	19.10 ±0.84	5.30 ±0.21
SM vs NSM	df (17)	N.S.	N.S.	N.S.	$P < 0.05$	N.S.	$P < 0.01$	$P < 0.01$	$P < 0.05$	$P < 0.05$	N.S.

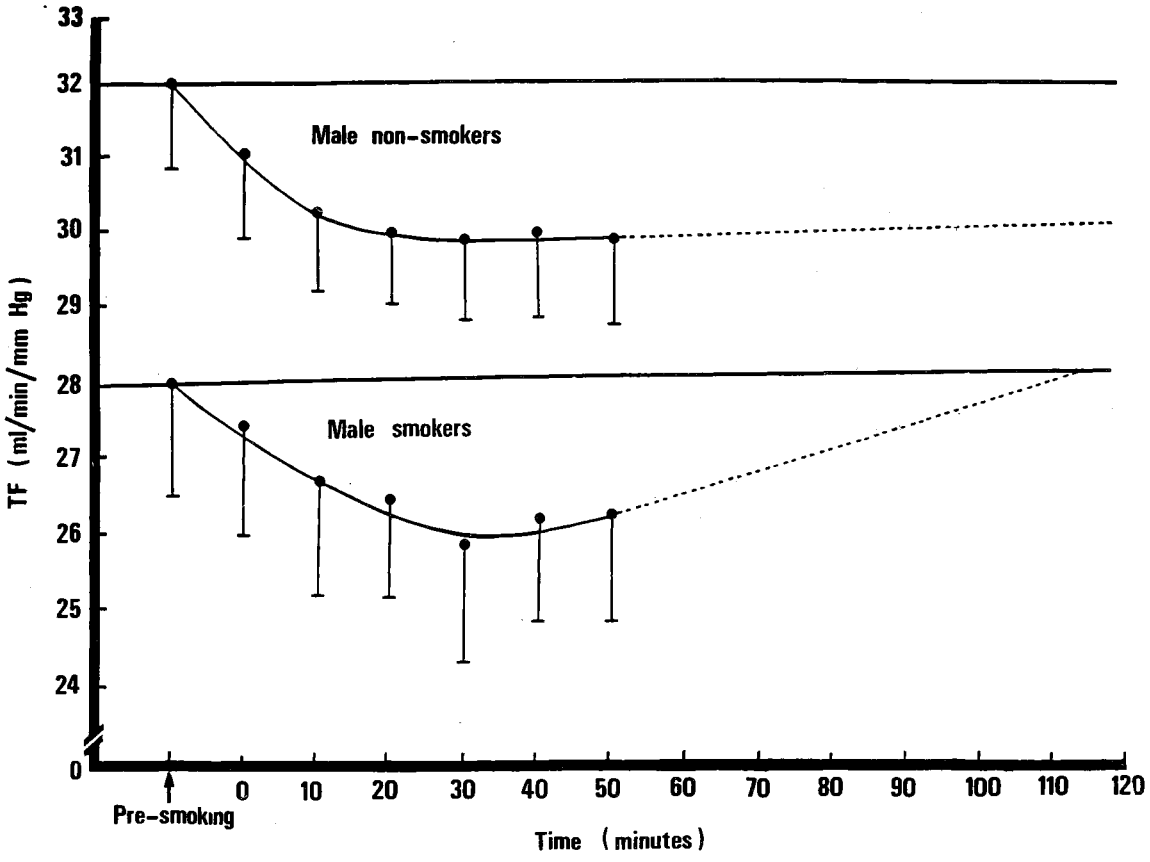

Fig. 1 Recovery curves showing mean serial values of TF following smoking.

tracting the TF at any given time from the pre-smoking TF of respective groups. Though the impairments are consistent, their magnitude is not enough to show any statistical difference between the two groups. A similar table could be constructed from Figure 2 for TF/BSA and would show essentially the same pattern of recovery with male smokers recovering faster than male non-smokers.

Discussion

Malaysian statures are generally smaller than European and North American ones. Consequently, it was tempting to surmise that Malaysian lung indices would be correspondingly smaller. Our data have not borne out this proposition. Even from the small sample of the healthy local population involved in this study, basic lung parameters such as VC, TLC, TF and TF/BSA were not statistically different from published values of either non-smokers or smokers. A decrease in the TF for smokers compared to non-smokers also confirms many previous reports.[1,2,3,4,5] Residual volumes of our male smokers were not only significantly lower than those of the male non-smokers ($P < 0.01$) but were generally higher than those previously reported.[1] This explains why the RV/TLC values for our smokers (35%) and non-smokers (40%) were much higher than published North American values which are 23 and 21% respectively.[2] But it is difficult to explain the observation of lower RV values in smokers than in the non-smokers with the data we have. Values of RV reported by Wilson et al.[1] for males who have been smoking

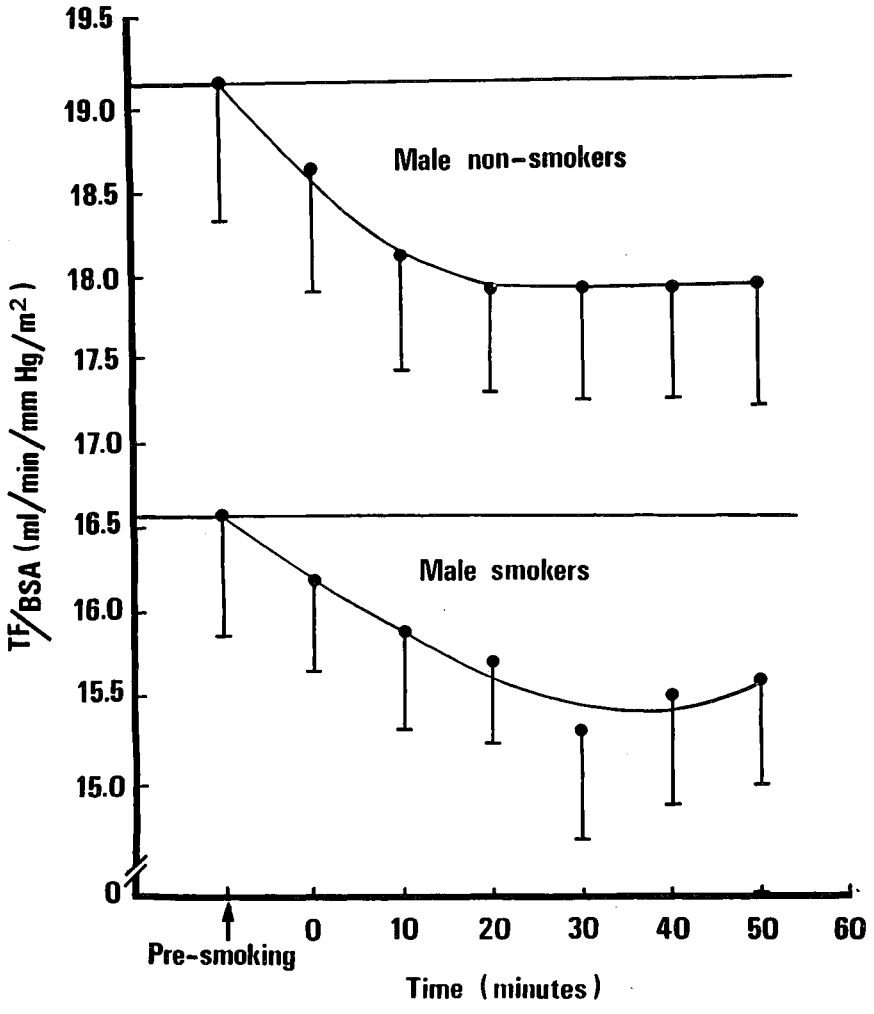

Fig. 2 Recovery curves showing mean serial values of TF/BSA following smoking.

Table II

Mean deviations from normal in lung transfer factor following the smoking of two cigarettes

Groups	Normal TF ml. min^{-}. $mmHg^{-}$ (X ± SEM)	Deviation from normal					
Male smokers (SM)	27.93 ± 1.45	−0.60	−1.10	−1.65	−1.90	−1.80	−1.60
Male non-smokers (NSM)	31.89 ± 1.14	−0.95	−1.75	−1.95	−2.00	−2.02	−2.05
Time (min)		0	10	20	30	40	50

20 cigarettes per day for 18 years were statistically no different from those of their male non-smokers. Our smokers had averaged about 15 cigarettes per day for about ten years. Comparisons on this with previous reports are thus probably untenable. However, parallel on-going studies in our laboratory may clarify this point.

Recovery curves for TF showed a consistent pattern. Smokers began to recover after 30 minutes. This was perhaps to be expected. For smokers, there was no novelty in smoking two cigarettes within ten minutes. Some smokers do occasionally smoke more than double this number of cigarettes in less than ten minutes. Their lungs would have fully adapted to the exposure while not becoming totally immune to impairments in some other indices of lung functionality. By extrapolating recovery curve, smokers would fully recover in about 114 minutes (Fig. 1).

For the non-smokers, the smoking session was quite a novelty. The deviations from normal TF (Table II and Fig. 1) were therefore greater at each time interval than those for the smoker. Non-smokers showed no signs of starting to recover even by the 50th minute. Hence it was not possible with our data to extrapolate when they would fully recover.

The exposure to only two sticks of cigarette produced impairments, albeit slight, from which male smokers needed up to 30 minutes to begin to recover, and non-smokers even longer. The cumulative damage done to lung functionality must, therefore, be terrifying in the continuous massive exposure to the smoke of "chain" smokers.

Undoubtedly, the best treatment for smoking remains complete cessation of the habit. Arising from this study, however, is a suggestion to those who are either unwilling or unable to stop smoking: they could facilitate the return of normal TF values by spacing their smoking about two hours apart.

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