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ACUTE EFFECTS OF DEEP BREATHING FOR A SHORT DURATION (2-10 MINUTES) ON PULMONARY FUNCTIONS IN HEALTHY YOUNG VOLUNTEERS

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Abstract : Breathing is the most vital function for maintenance of life. Slow and deep breathing is an integral part of Pranayama and it reduces dead space ventilation and renews air throughout the lungs. The reported beneficial effects of deep breathing as a part of either long term or short term practice of pranayama are well documented. However our knowledge about the effects of a few minutes' of deep breathing on human ventilatory parameters is poor. In the present study, we examined the relationship between exposure to short duration of deep breathing and performance on Pulmonary Function Tests before and after the deep breathing.

The study was conducted in a homogenous group of 12 volunteers containing 4 females and 8 males who were well trained in pulmonary function testing (PFT) before the start of the study. The volunteers performed deep breathing (DB) exercise for 2, 5 and 10 minutes at the rate of 6 breaths per minute under guidance, and the duration of DB exercise for that day was randomly selected for each group. PFT was done before and after the DB exercise.

There was a significant ($P<0.05$) increase in vital capacity (VC) after 2 and 5 minutes' DB exercise and a consistent improvement in tidal volume (TV) and minute ventilation (MV) after the DB exercise in all the three groups, though it wasn't statistically significant. There was a significant ($P<0.05$) increase in forced vital capacity (FVC) after 2 minutes' of DB exercise and a consistent increase in all the three groups in forced inspiratory vital capacity (FIVC) and peak inspiratory flow rate (PIFR), though this increase was not statistically significant. This shows that deep breathing exercise, even for a few minutes' duration is beneficial for the lung functions.

Key words : deep breathing acute effects pulmonary functions

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INTRODUCTION

Slow and especially deep breathing, as it is in Pranayama breathing exercise, is economical because it reduces dead space ventilation. It also renews air throughout the lungs in contrast with shallow breathing which renews air only at the base of the lungs. The reported beneficial effects of deep breathing as a part of either long term or short term practice of pranayama are an improvement in ventilatory functions (1), effect on grip strength (2) and also on heart rate variability (3). Its effects as a part of comprehensive yoga therapy intervention are well documented (4).

Even a few successive episodes of deep inhalations are known to influence the lung and airway dynamics (1). Deep inhalations either can increase or decrease the airway resistance depending on many variables (5). The role of deep breathing on release of surfactant and consequent change in pulmonary compliance and other lung functions has been extensively studied, both in cultured pulmonary epithelial cells (6) and in isolated and intact lungs of many different animals (7, 8, 9). But whether the same type of phenomenon occurs in intact human subjects and whether that can alter any of the parameters of pulmonary functions testing has not been studied in detail. All the available studies mainly discuss the effects of at least a short term practice extended over a period of a few days to weeks of pranayama rather than acute effects of pranayama. The present study was conducted to study the acute effects of a brief period of practice of deep breathing exercise for 2–10 minutes' duration on the pulmonary functions.

MATERIALS AND METHODS

Subjects

The study was conducted in a homogenous group of 12 volunteers, 4 females and 8 males. The demographic characters are as follows (Mean±SD): Age, 23.6±2.6 years, weight, 61.1±15.7 kg and height, 1.64±0.08 m. Informed written consent was obtained after explaining the procedure and the protocol. The subjects were divided into 3 groups, each containing 4 volunteers, by random allocation.

Methodology

All the subjects were very well trained in pulmonary function testing (PFT) before the start of the study and it was made sure that their performance on PFT was highly reproducible. Then the volunteers performed deep breathing (DB) exercise for 2, 5 and 10 minutes at the rate of 6 breaths per minute, guided by one of the investigators on three different days, at the same time, on all the days. The duration of DB exercise for that day was arbitrarily selected for each group.

PFT was done just before the start of the DB exercise. After the DB, each subject was given 5 minutes' rest and the PFT was again performed. The test was done on a computerized spirometer (Model – Spirobank G). The PFT was repeated at least twice both before and after the DB exercise and the best of the three values was chosen at each instance.

The PFT parameters recorded were tidal volume (TV), respiratory rate (RR), minute ventilation (MV), expiratory and inspiratory times (te and ti), flow rate during inspiration (TV/ti) and vital capacity (VC), which were all done with a slow maneuver.

In the forced test, the parameters recorded were forced expiratory vital capacity (FVC), forced expiratory volume in 1st second (FEV1), percentage of vital capacity expelled forcefully at the end of 1st second (FEV1%), peak expiratory flow rate (PEFR), mid expiratory flow rates (MEFR), forced inspiratory vital capacity (FIVC) and peak inspiratory flow rate (PIFR).

Statistical analysis

The data of all the subjects was pooled under the heading baseline, 2 minutes, 5 minutes and 10 minutes and compared using Friedman's ANOVA. A value of $P<0.05$ was considered significant. A post hoc analysis was done to identify which groups were significantly different when $P<0.05$.

RESULTS

All the volunteers completed the study. The results for the PFT parameters during slow maneuver are shown in table1 for 2, 5 and 10 minutes.

There was a consistent increase in TV, MV and VC after the DB exercise in all the three groups, and the change in VC was statistically significant after 2 and 5 minutes' DB exercise as analyzed by two way ANOVA though it was not so after 10 minutes'. These changes are graphically represented in Fig. 1.

There was a trend towards an increase in the duration of inspiration, but without much

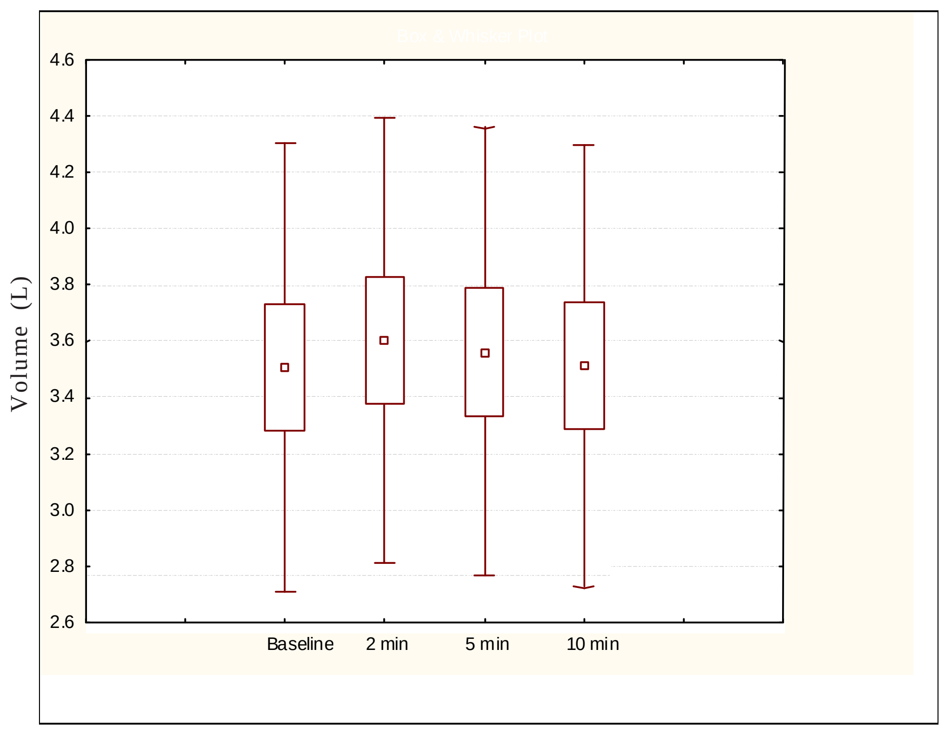

Fig. 1: Effect of deep breathing on vital capacity. The mean values are shown as small boxes, the Mean±SE values are shown as large boxes and the Mean±SD values are shown as error bars.

TABLE 1: Effects of different duration of DB exercise on parameters of Slow maneuver PFT.

	TV (L)	*RR (/min)*	*MV (L/min)*	*te (s)*	*ti (s)*	*TV/ti (L/s)*	*VC (L)*
Baseline	0.59±0.16	16.80±5.42	9.35±2.94	2.23±0.70	1.72±0.62	0.37±0.13	3.50±0.80
2 min	0.65±0.17	17.47±6.49	10.86±4.19	2.20±0.83	1.75±0.79	0.42±0.17	3.60±0.78*
5 min	0.65±0.21	17.18±6.66	10.56±4.05	2.23±0.80	1.78±0.74	0.41±0.17	3.56±0.79*
10 min	0.65±0.22	16.10±6.91	10.02±4.45	2.43±0.91	1.92±0.77	0.38±0.19	3.51±0.78

Results are shown Mean±SD. *P<0.05 as compared to baseline.

TABLE 2: Effects of different duration of DB exercise on parameters of Forced maneuver PFT.

	FVC (L)	*FEV1 (L)*	*FEV1% (%)*	*PEFR (L/s)*	*MEFR (L/s)*	*FIVC (L)*	*PIFR (L/s)*
Baseline	3.64±0.82	3.19±0.68	87.80±6.32	7.88±2.38	3.79±1.03	3.65±0.83	6.54±2.00
2 min	3.71±0.81*	3.22±0.72	86.93±7.38	7.73±2.55	3.82±1.19	3.76±0.82	6.59±2.07
5 min	3.65±0.80	3.19±0.66	88.05±6.20	7.79±2.51	3.83±0.97	3.71±0.83	6.62±2.11
10 min	3.66±0.85	3.17±0.75	86.91±6.60	7.76±2.60	3.70±1.18	3.71±0.83	6.77±2.22

Results are shown Mean±SD. *P<0.05 as compared to baseline.

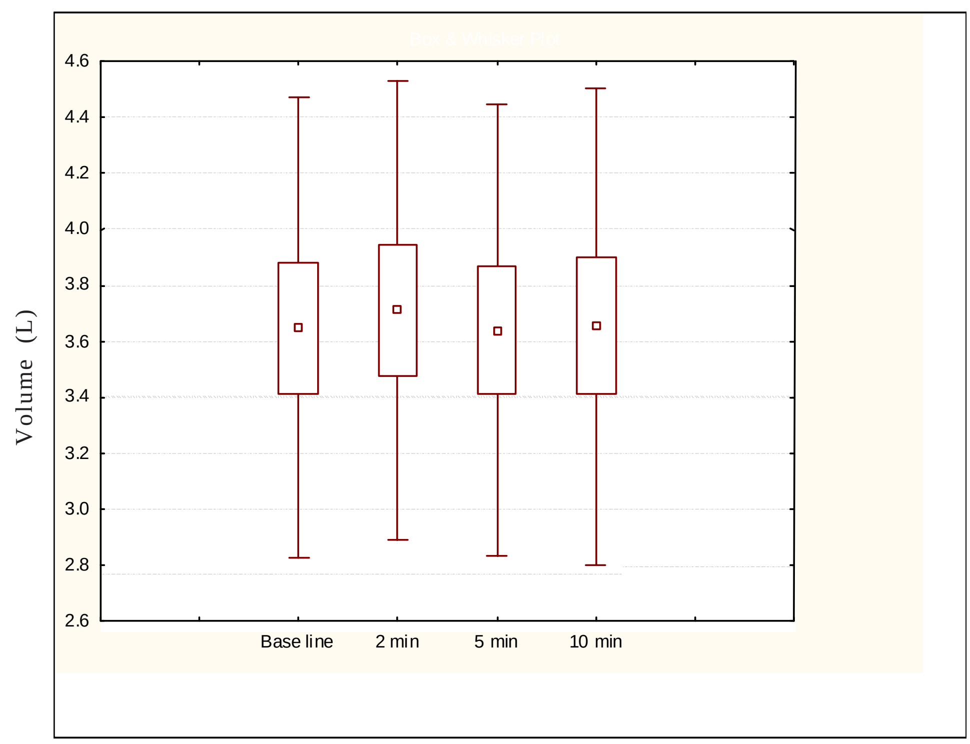

Fig. 2: Effect of deep breathing on forced vital capacity. The mean values are shown as small boxes, the Mean±SE values are shown as large boxes and the Mean±SD values are shown as error bars.

of a change in RR and expiratory time. Since there was also a trend towards an increase in tidal volume and consequent minute ventilation, this was possible because of an increase in inspiratory flow which showed increase in all the three groups, though all these changes did not reach the statistical significance levels.

The changes in PFT parameters of forced maneuvers are shown in Table II. As can be seen, there was a statistically significant increase in FVC after 2 minutes' of DB exercise, but not so after 5 and 10 minutes' of DB exercise, which is graphically represented in Fig. 2. There were consistent improvements in forced inspiratory parameters. The FIVC was consistently more after the DB in all the 3 groups, with a similar trend in PIF, though was not statistically significant. There was a trend towards a lower PEFR in all the 3 groups, without any consistent change in FEV1 and MEFR.

DISCUSSION

The alveoli of the lungs are the place for gas exchange and also an area where there is air – water interface. This interface causes surface tension and decreases the compliance, which in turn reduces the lung compliance. The normal surface tension is reduced to a great extent by the surfactant, which is a surface active agent secreted by type II pneumocytes. The release of surfactant is helped by deep inspirations and increases the compliance as shown in the increased compliance during the deflation phase of the pressure volume curve of a lung. This phenomenon has been well studied in isolated animal lungs, in-situ lungs and also in the cultured pulmonary epithelial cells with the possible mechanism of exocytosis (7, 8, 9). This could be a possible explanation for the beneficial effects seen in mechanically ventilated lungs of acute lung injury, where in variable tidal volumes were shown to improve alveolar stability and blood oxygenation, and decrease lung injury (10, 11).

The effects of deep inhalation in human being on lung and airway resistances has also been documented (5) so also are the beneficial effects of long term practice of pranayama, which involves slow and deep breathing (1, 2, 3, 4). But there are hardly any studies which have tried to explore the effects of few minutes' of deep breathing on human ventilatory parameters. Our study tries to see these changes.

Deep breathing, even of a few minutes' duration, as was done in this study, showed a significant improvement in VC, and a trend towards increased TV and MV, even though in some cases there was a reduction in RR, as could be seen after 10 minutes' DB, which shows that the increase in TV was more than compensating for the reduction in RR. The slow rate of breathing is not only economical in terms of energy spent on work of breathing, but reduces dead space ventilation by an increase in VC and hence improves alveolar ventilation. Hence the improved MV was mainly adding to alveolar ventilation which is a further advantage. The increased VC which was statistically significant even when the DB was of short duration, indicates that a long term practice might improve it further, as has already been documented in the literature. The slowing of breath seen after 10 minutes of DB can also help in reducing the sympathetic activity and increasing the parasympathetic activity, which also has been demonstrated for pranayama (12).

The beneficial effects seen in FVC and the trend seen in other forced inspiratory parameters like FIVC and PIF, indicate that there could be a change in the compliance of the lungs. The fact that airways get compressed during forced expiration might have negated the beneficial effects of deep breathing on lung compliance and this might be a reason for the type of results in this study, which does not show any significant improvement in forced expiratory parameters like FEV1, PEFR and MEFR. But during inspiration, whether forced or not, the airway resistance decreases and hence does not oppose the air movement. Our study shows a significant increase in the FVC, even after just 2 minutes' of DB exercise and also a trend towards an increase in FIVC and PIF. This could be due to a possible increase in surfactant levels, released because of deep inhalations. Even 2 minutes' of DB might be good enough to bring about a significant release of surfactant, which will increase the lung compliance, even during the inspiratory phase of the lung. That could be an explanation for the significant increase seen in FVC after 2 minutes' of DB with the trend of improving PIF and FIVC seen after 2, 5 and 10 minutes' DB.

In conclusion, deep breathing, even for a few minutes' duration seems to be beneficial for the lung functions. Further studies are needed to confirm the possible mechanism(s) responsible for such an effect.

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