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Role of *Pranayama* breathing exercises in rehabilitation of coronary artery disease patients— A pilot study

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Coronary artery disease (CAD) is the most common form of heart disease which gets precipitated by increasing stress, dietary habits and urban sedentary lifestyle. Pulmonary functions are found to be influenced in congestive heart failure, left ventricular dysfunction and after cardiac surgery. *Pranayama* breathing exercises & yogic postures play an impressive role in strengthening of respiratory muscles which improve cardio-respiratory efficiency. The effect of *Pranayama* breathing exercises on pulmonary function tests (PFTs) of CAD patients was observed. PFTs of 20 diagnosed stable patients of CAD were recorded. They were then taught *Pranayama* breathing exercises which they practiced at home twice a day. Their PFTs were repeated after 2 weeks and compared to their basal PFTs. Anthropometric parameters were recorded and a standardized questionnaire related to cardio-respiratory health was also worked out. Statistically significant improvements were seen in FEV1%, PEFR, FEF25-75 and MVV after a brief period of breathing exercises. FEV1, FVC and PIFR also showed a trend towards improvement. *Pranayama* breathing exercises were found to improve lung functions in CAD patients and can be used as a complimentary therapy for their rehabilitation.

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Cardiovascular disease is a major cause of death globally. Coronary Artery Disease (CAD) is the most common form of heart disease. This is caused by the buildup of cholesterol in the inner layers of the arteries. As a result of that, the blood flow slows down and the cardiac muscles do not get enough supply of blood particularly during exercise and exertion when the demand is high[1]. Most people with CAD often experience angina (pain, pressure, or burning in the chest, arm, or neck). The pain indicates that the heart muscle lacks blood supply. Emotional stress both from within the individual as well as from the environmental sources play an important role in predisposition, precipitation & perpetuation of CAD[2,3]. It also contributes significantly to unusual and acute events of CAD. Sedentary life style and change in dietary habits are also associated with higher incidence of obesity, development of restrictive lung function & cardiovascular morbidity. The lungs are linked in series with the cardiac pump, and they are not only influenced by mechanical alterations in pump function but also by neurohumoral modulators and cytokines involved in the pathogenesis of various heart diseases[4,5]. It has also been proposed that increased levels of circulating cytokines (such as tumor necrosis factor-[alpha] and interleukin-6) in CAD patients may induce changes in lung parenchyma[6]. High left atrial pressures may also induce chronic remodeling of the pulmonary vasculature and its wall thickening. There may also be an enhanced degree of airway reactivity[7].

Various studies have described pulmonary function-related changes in patients with chronic left ventricular dysfunction & heart failure. These studies have varying conclusions ranging from essentially normal values, to primarily restrictive changes, to combined restrictive and obstructive changes[8-11]. Most of them reported mild restrictive changes and reduced lung compliance even in stable condition[12,13]. Pulmonary complication occurring after cardiac surgery is also a major cause of postoperative morbidity. Patient undergoing coronary artery bypass surgery (CABG) often develop atelectasis and severe reduction in lung volumes & oxygenation in early

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postoperative period. Reduced lung functions and impaired gas exchange remain even after several months of CABG[14]. Buffalo health study revealed FEV1 as an independent predictor of overall long term survival rate and could be used as a tool in general health assessment[15]. Low grade systemic inflammation is also associated with atherosclerosis, reduced FEV1 might be an important risk factor for cardiovascular morbidity and mortality[16]. An effort towards improving FEV1 can also improve cardiovascular outcomes in CAD patients. *Yogic* breathing exercises leads to broncho-dilatation by correcting the abnormal breathing patterns and by reducing the muscle tone of respiratory muscles. Due to improved breathing patterns, respiratory bronchioles may be widened and perfusion of a large number of alveoli can be carried out efficiently[17]. Several researchers have reported that *yogic* lifestyle intervention decreases the stenosis of coronary artery, decreases the anginal episodes, retards atherosclerosis, decreases sympathetic activity leading to less stress and improves the exercise capacity[18-21]. However, so far no study showing the effect of *Pranayama* breathing exercises on pulmonary function tests in CAD patients has been reported. So, attempt was made to study the effect of *Pranayama* breathing exercises on PFTs of CAD patients.

Methodology

Twenty clinically and angiographically documented patients of CAD from Guru Teg Bahadur Hospital were selected for the study. All the patients were male and their CAD was stable for the past 2-6 yrs. They all belonged to the age group 35-55 yrs (mean age 48±6.57). They served their own control in the study. Exclusion criteria included: subjects having any attack of angina or MI in the recent past (within 6 months); subjects having any previous history of asthma, COPD, tuberculosis or diabetes mellitus; and subjects having any history of smoking as smoking may be a confounding factor affecting both lung functions and cardio-vascular functions. Informed consent was taken and a standardized questionnaire related to cardio-respiratory health was worked out. Family history of CAD, hypertension, asthma or any other disease was also noted down. Height, weight and body surface area were also noted and their basal pulmonary functions were recorded. The procedure of PFTs was properly explained to all the subjects. Parameters of the PFTs recorded were: forced expiratory volume in 1 sec (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, peak expiratory flow rate (PEFR), forced mid expiratory flow (FEF25-75), peak inspiratory flow rate (PIFR) and maximum voluntary ventilation (MVV). All the parameters were taken three times and the best reading was noted down.

After recording the basal PFTs, all CAD patients were taught P*ranayama* breathing exercises- *Anulomvilom* and *Kapalabhati*. They were advised to practice them (10 min each) twice a day– morning and evening. They were instructed to perform these breathing exercises empty stomach at home and to focus the attention on their breath during that period. All of them continued the medication as prescribed during the study period. After 2 weeks of breathing exercises their pulmonary function tests were repeated and compared with their basal PFTs. For *Anulomvilom* the subject sits down in *Padmasana* or *Siddhasana* and closes his right nostril with right hand's thumb and inhale through left nostril deeply and slowly. When the lungs are full slowly exhale through the right nostril closing the left with right hand's index finger. Then keeping left nostril closed, inhale through the right nostril and ultimately exhale the breathe through the left nostril. This constitutes one cycle of *Anulom-vilom. Kapalabhati* is a cleansing practice of breathing, where subject was advised to breathe forcefully and at the same time use only abdominal breathing, not chest breathing. In *Kapalabhati,* the exhalation is more forceful, rapid and strong while inhalation is passive. Lungs are used as a pump, creating so much pressure that along with the air all waste is removed from the air passages through the nostrils. PFT parameters before and after *Pranayama* breathing exercises in CAD patients were analyzed by using *Student's paired T test.* P value was derived from two-tailed analysis and less than 0.05 was accepted as indicating significant difference between the compared values.

Results and discussion

The anthropometric parameters of the CAD patients are given (Table 1). The subjects under study served their own control so these anthropometric parameters did not vary. They continued the same medication during the study period. The pulmonary function tests before and after two weeks of *Pranayama* breathing exercises were assessed. FEV1%, PEFR, FEF25-75% and MVV are found to be significantly improved after 2 weeks of *Pranayama* breathing exercises. FEV1, FVC and

PIFR also showed a trend towards improvement although not significant (Table 2). Following the practice of *Pranayama* breathing exercises, significant improvements were seen in FEV1%, PEFR, FEF25-75% and MVV. This indicates that there is some degree of broncho-dilatation, which is leading to better oxygenation of the alveoli. Endurance power of the lungs also improved as shown by improvement in maximum voluntary ventilation. FEV1, FVC and PIFR also showed a trend towards improvement but non-significant which may be because of the short period of the study. Longer duration of *Pranayama* may improve these parameters too. *Yoga* lifestyle intervention has been reported by various researchers to retard progression and increases regression of coronary atherosclerosis in patients with severe coronary artery disease[17-20]. Very few reports are there which document that breathing exercises prevent pulmonary complications developing after the cardiac surgery[22,23]. No study was observed depicting the effect of *Pranayama* breathing exercises on lung functions in stable patients of CAD. Although there are reports depicting the role of *Pranayama* on PFTs in asthmatic patients[24].

A change in lifestyle (which consists of dietary modification, physical exercises, stress relaxation techniques and no smoking) is reported to be beneficial to patients with CAD[2,3,18-20]. Decrease in average percent diameter stenosis of coronary artery, improvement in exercise capacity & reduction in the number of anginal episodes/week have been reported after *yogic* lifestyle intervention[19,20]. The results indicated a reduction in the sympathetic reactivity, no change in parasympathetic activity and significant improvement of pulmonary function. It also helps to reduce stress and anxiety which aggravate the severity of CAD and thus can lead to elimination of the modifiable risk factors for CAD. *Yogic* exercises also improved the lipid profile and antioxidant status of the CAD patients[25]. Practice of *Kapalabhati* shifts the sympathovagal balance towards sympathetic activation and *Anulom-vilom* towards decreased activation of both the components[26]. Increase in parasympathetic activity and reduced sympathetic activity in slow breathing group is reported, whereas no change is reported in fast breathing group[27]. Oxygen utilization by the muscles also found to be increased after breathing exercises which suggest an improvement in aerobic muscle power[28,29]. Moreover, better and synergistic results are reported by combining a calming and a stimulating type of pranayama[30]. One calming (*anulom-vilom*) and one stimulating (*kapalabhati*) exercise was combined to achieve the optimal results on pulmonary function tests in CAD patients.

Improvement in PFTs in the study could be because of reduction of sympathetic reactivity attained with *Pranayama* training. This may allow bronchiodilatation by correcting the abnormal breathing patterns and reducing the muscle tone of inspiratory and expiratory muscles. Due to improved breathing patterns, respiratory bronchioles may be widened and perfusion of a large number of alveoli can be carried out efficiently. In response to variations in breathing patterns a number of central and autonomic nervous system mechanisms as well as mechanical (heart) and haemodynamic adjustments are also triggered, thereby causing both tonic and phasic change in cardiovascular functioning[31]. Hence, it can be said that *Pranayama* breathing may prevent serious cardio-respiratory complications by emphasizing optimal physical and mental conditioning. It also helps in tranquilizing the mind and as a result patients feel

Table 1—Anthropometric parameters of CAD patients

Parameters	Mean ± SD
Age (Years)	48 ± 6.57
Weight (Kg)	82 ± 9.81
Height (cm)	168 ± 6.09
BMI (Kg/m^2)	27.52 ± 7.13

Table 2—PFT parameters before and after *Pranayama* breathing exercises

Subjects	Number of subjects	Pulmonary Function Tests						
		FVC (L)	FEV1(L)	FEV1/FVC (%)	PEFR (L/sec)	FEF 25-75% (L/sec)	PIFR (L/min)	MVV (L/min)
Before *Pranayama*	20	2.10± 0.65	1.58± 0.67	76.46± 16.34	3.14± 1.26	2.58± 1.87	2.21± 0.58	54.08± 15.86
After *Pranayama*	20	2.23± 0.72	1.86± 0.69	82.78± 13.96	4.16± 1.64	3.18± 1.12	2.43± 0.64	66.15± 14.56
Sig (2-tailed)		.221	.205	.031*	.05*	.005*	.184	.029*

*P ≤ 0.05

relaxed and stress free. Short term *Pranayama* breathing exercises were found to be so beneficial in improving the lung functions of CAD patients. It can be inferred that pulmonary functions can be improved and complications can be prevented by encouraging CAD patients to practice *Pranayama* breathing exercises regularly. Results of the study can be correlated to a large group of patients and for a longer duration of *Pranayama* exercises.

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