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Effect of Pranayama Training on Cardiovascular Parameters

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Research Article

Abstract: **Objectives-** To study the effect of pranayama training on cardiovascular parameters. **Design-** Longitudinal study. **Settings/Location-** Government Dental College, Aurangabad. **Subjects-** 60 Normal healthy females and males volunteers in the age group of 30 to 50 years ready to give consent. Subjects were divided randomly into two groups of 30 individuals act as subjects and control. Trial was registered under WHO and CTRI trial registry systems. CTRI registration no. is CTRI/2012/03/002512 and WHO registry no. is UTN- U1111-1129-2155. **Interventions-** Pranayama training camp will be conducted 45 minutes daily for 1 month. The exercises include slow and fast breathing exercises like 'nadishuddhi', 'mukh-bhastrika', 'pranav' and 'savitripranayama'. **Outcome Measures-** Cardiovascular efficiency will be tested by using parameters like

1. Systolic blood pressure
2. Diastolic blood pressure
3. Heart rate and Systolic time intervals involving pre-ejection period (PEP), left ventricular ejection time (LVET), total mechanical systole (QS_2) & PEP/LVET ratio.

Results- Pranayama training for 1 month resulted in significant decrease in systolic blood pressure (<0.0001) & LVET (<0.0001) whereas QS2 (<0.0001) and PEP (<0.0001) were increased significantly.PEP/LVET ratio which is a sensitive index of cardiac performance was significantly increased after the training. **Conclusion-** Our study shows that pranayama training improves ventricular performance by increasing parasympathetic activity.

Key words: Pranayama, Systolic time intervals, Parasympathetic activity.

Running Head: Pranayama and systolic time intervals

Introduction

The science of pranayam (a yogic breathing technique) deals with the knowledge, control and enrichment of this vital force. The mind and body are intricately interrelated. Slow, deep and uniform pranayam breathing produces psychosomatic relaxation especially when it is associated with meditative awareness. During pranayam, one can follow the breath as it flows in and out. One can also visualize cosmic pran flowing into the body and mind with each inspiration enlightening the whole being. According to yogic texts, the practice of pranayam results in inner peace and joy, broadening of vision and development of positive emotions like unselfish love. Pranayam is described as a means to achieving divinity and perfection. (1)

The modern age is the age of stress and stress-induced disorders pose a great challenge to the present society. Pranayama literally means control of prana. *Prana,* in Indian philosophy, refers to all forms of energy in the universe. Life force is one part of this energy. Life force in an individual is symbolized by breathing. That is why pranayama is generally considered to mean regulated breathing. (2) There is evidence that pranayam training produces deep psychosomatic relaxation (3, 4) and improvement of cardio-respiratory efficiency. (5)

Systolic time intervals (STIs) are useful, reproducible and non-invasive measures of left ventricular function.(6,7) It is interesting to note that the term "non-invasive" was first used in connection with the STIs which are the earliest quantitative non-invasive tests used for the determination of cardiac function.(6)

STI measurements consist of the following:

QS2. This period is measured from onset of Q wave in electrocardiograph (ECG) to the first high frequency aortic component of the second heart sound. It includes electromechanical lag (EML), isovolumetric contraction time (IVCT), PEP and LVET. It is primarily used to measure PEP when the LVET values are known.

PEP (QS2 - LVET*)*. Extends from depolarization of LV to the start of ejection and includes the time for depolarization. It is closely related to the haemodynamic status of the heart and is a better measure of the contractility of the heart. Normal values range from 80 to 105 milli seconds (mean 100 ±13 milli seconds).

LVET. It is the time interval from the upstroke of the carotid pulse wave (indicates rise in aortic pressure) to its incisura (indicates aortic valve closure). It represents the isotonic phase of left ventricular systole and is inversely related to heart rate. It has high correlation with stroke volume (SV) and cardiac output (CO) and is inversely related to rate of left ventricular ejection. Decrease in SV shortens LVET. QS2 and LVET have an inverse but linear relationship with heart rate, whereas PEP is affected only slightly.

PEP/LVET ratio. Most of the individual STI's are influenced by factors like HR, SV, CO, sex, age, physical condition and other factors. Hence, attempt has been made to derive a sensitive index having high correlation with corresponding hemodynamic indices and direct measurement of contractility. It uses uncorrected values of PEP and LVET. The normal values are 0.345 ± 0.036.Ratio increases to almost 0.6 in patients with heart failure. This ratio is maximum in patients with heart failure and is the most reliable and sensitive index of cardiac performance. (8)

It was proven that savitri pranayam (slow, rhythmic and deep breathing with a ratio of 2:1:2:1 between inspiration, breath held in inspiration, expiration and breath held in expiration) produces a significant reduction in oxygen consumption and deep psychosomatic relaxation within 5 minutes. (3) Telles and Desiraju have demonstrated that a variant of pranayam breathing is associated with a 19% reduction in oxygen consumption.(9)

So the present study was carried out to determine the effect of pranayam training on ventricular function as assessed by Systolic time intervals.

Material and Method

The study was carried out in 60 staff members of Government Dental College, Aurangabad, of the age 30 to 50 years. After explaining the purpose and design of the study, persons ready to give voluntary consent were enrolled in the study. Subjects suffering from any cardiac or respiratory problems or having history of smoking were excluded. Subjects engaged in yoga practice in the past or doing any physical exercise were also excluded in the study. Subjects were divided randomly into two groups of 30 individuals as subjects and control. Trial was registered under WHO and CTRI trial registry systems. CTRI registration no. is CTRI/2012/03/002512 and WHO registry no. is UTN-U1111-1129-2155.

Pranayam training was conducted 45 minutes daily for 1 month in morning from 8am to 8.45am in subjects under direct supervision of a trained yoga teacher. The exercises include 'nadishuddhi', 'mukhbhastrika', 'pranav' and 'savitri' pranayams. Cardiovascular efficiency was tested by using following parameters

Blood pressure: Systolic and Diastolic blood pressure was measured by using electronic blood pressure apparatus (Omrom Company) to avoid subjective errors.

Systolic time intervals: systolic time intervals measured were pre-ejection period (PEP), left ventricular ejection time (LVET), total mechanical systole (QS2) & PEP/LVET ratio. All Systolic time intervals (STI's) were measured by using 16 channel polyrite machine (Medicaid, USA) before & after pranayama training.

STI's were measured through five consecutive cycles in each set of recording to the nearest 0.5 mm (5 msec) and averaging was done. The various time intervals, which were measured, have already been mentioned. Heart rate corrected indices of systolic time intervals; QS2-I, LVET-I and PEP-I were calculated by the regression equations obtained by Weissler, Harris & Schoenfeld (1968).(10)

QS2-I = QS2 + 2.1 x HR

LVET-I = LVET + 1.7 x HR

PEP-I = PEP + 0.4 x HR

The control group was not given any kind of pranayama. Similar parameters were studied in them at start and end of one month study.

Result:

The results observed for basal parameters were compared in table 1. There was no significant difference between the height, weight and age of both subject group and control group.

Table 1: Basal parameters among subjects and controls

Parameter	Control	Subjects	P-value
Age (years) (Mean ± SD)	43.86 ± 8.84	44.16 ± 7.39	0.8112 (NS)
Weight(Kg) (Mean ± SD)	50.53 ± 8.94	52.76 ± 7.55	0.6344 (NS)
Height (m) (Mean ± SD)	1.61 ± 0.06	1.65 ± 0.06	0.1839 (NS)
BMI (Mean ± SD)	19.49 ± 3.49	19.48 ± 3.11	0.9099 (NS)

Table 2 shows comparison in control and study group before and after pranayama. The results show no significant changes in any parameter in control group that was not given pranayama as an intervention. Study group shows significant fall in Heart rate, Systolic blood pressure and LVET-I. Diastolic blood pressure was also found to be decreased but the difference was not statistically significant. Systolic time intervals PEP-I, QS_2-I and ratio of PEP-I/LVET-I were significantly increased.

Table 2: parameters before and after pranayama in control and subject groups

Parameter	Subjects			Control		
	Before Pranayama (Mean ± SD	After Pranayama (Mean ± SD)	'P' value	Before Pranayama (Mean ± SD	After Pranayama (Mean ± SD)	'P' value
Heartrate(beats/min)	84.7 ± 4.83	76.97 ± 4.13***	<0.0001	83.4 ± 3.34	84.23 ± 3.16	0.6127
Systolic BP(mmHg)	122.2 ± 2.6	113.13 ± 9.1***	<0.0001	118.3 ± 3.2	119.2 ± 3.8	0.5796
Diastolic P(mmHg)	79.2 ± 8.11	78.67 ± 7.22	0.0579	80.5 ± 3.12	79.1 ± 3.51	0.5303
PEP-I	120.26 ± 8.03	155.67± 10.75***	<0.0001	126.25 ± 6.03	128.86 ± 5.96	0.3319
LVET-I	422.1 ± 6.68	406.4 ± 9.18***	<0.0001	420.51 ± 5.53	416.91 ± 7.03	0.2219
QS_2 –I	542.36 ± 7.72	562.06 ± 9.58***	<0.0001	545.03 ± 5.08	540.21 ± 6.95	0.1314
PEPI/LVET-I	0.285 ± 0.021	0.384 ± 0.032***	<0.0001	0.279 ± 0.080	0.281 ± 0.042	0.9695

Discussion

Despite recent developments in echocardiography for estimating LV systolic function, this prospective study demonstrates that STI measurements are precise, reproducible, and probably the simplest method to perform. Numerous studies demonstrated that external measurements of STI directly reflected the intra-cardiac events measured simultaneously from high-fidelity catheters in the LV and aorta.(11)

It has been reported that *pranayam* improves cardiorespiratory functions (3, 4, 5) and alters autonomic status (12, 13, 14). In our study, subjects performing pranayama training were matched with control for age, height, weight and BMI (Table 1). pranayama training of one month duration resulted in a significant reduction in basal HR. In contrast, there was no change in basal HR of control subjects (Table 2). Pranayama training produced significant decrease in systolic blood pressure and decrease in diastolic blood pressure though not significant. N.K. Subbalakshmi et.al. have reported similar results in 'nadi -Shodhana Pranayama'. The probable reason for significant decline in basal heart rate and systolic blood pressure in the pranayama practice could be largely due to better parasympathetic control over the heart. Diastolic blood pressure mainly varies with the degree of peripheral resistance and heart rate. The non-significant change in diastolic blood pressure observed in the present study suggests that pranayama might have no immediate effect on peripheral vascular resistance or if it has some role, then it is obscured by a slow heart rate.(15)

A decrease in sympathetic activity in pranayama group is also confirmed by a significant increase in QS_2 and QS_2I and a significant decrease in LVET and LVETI. In this connection it is interesting to note that Lewis et al have found a strong correlation between urinary catecholamine excretion and QS_2I as a dose-dependent shortening of QS_2I in response to intravenously administered positive ionotropic agents (16). The significant prolongation of PEP and PEPI in our *pranayam* group can be attributed to a diminished rate of left ventricular pressure rise (6). McConahay et al (17) have reported increase in LVET and a decrease in PEP following physical exercise and attributed this to increase in sympathetic activity. Since our finding in group I subjects following *pranayam* training are in the opposite direction of those of McConahay et al (17), we postulate that *pranayam* training produces decrease in sympathetic activity. PEP/LVET ratio, which is the single most useful STI measure of left ventricular performance (6) increased in both the groups but the increase was more significant in *pranayam* group (Table 2). It might be argued that this increase in PEP/LVET ratio indicates a compromise in myocardial function (7, 18). However, the, initial value, of PEP/LVET ratio was low in our subjects and it increased towards the normal range during the three months of study period. Spitaels et al (19) have reported that the normal values of PEP/LVET ratio in children is 0.313 ± 0.05 which is very similar to the value of our group I subjects following *pranayam* training. The increase in PEP, PEPI and PEP/LVET ratio in both the groups (Table 2) can be explained by the fact that PEP increases as the age advances from infancy to puberty (6, 19). However, as the increase in these values was more pronounced in the *pranayam* group, we suggest that *pranayam* training promotes normalisation of' STI values.

In conclusion, the present study shows that one month of *pranayam* training, modulates ventricular performance by altering the cardiac autonomic tone. The changes in ventricular performance are brought about by increased parasympathetic and decreased sympathetic activity. Further studies involving larger sample size and other indicators of cardiac performance may unravel the underlying mechanism(s) involved in this alteration.

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