Physiological Effect of Yogic Procedures on *Pranvahastrotas* (Respiratory System) in Healthy Individuals

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Abstract

The present research aimed at researching the physiological effect of yogic procedures in healthy subjects on *Pranavahastrotas*. The objective of the study was to test *Pranvahastrotas'* physiological functions by evaluating Herat Rate (HR), Respiration Rate (RR), Tidal Volume (TV), Inspiratory Reserved Volume (IRV), Expiratory Reserved Volume (ERV), Forced Vital Capacity (FVC), MVV (Maximum voluntary ventilation), Ratio-FEV1/FVC (Forced expiratory volume in one second). Total thirty healthy participants were selected by lottery method with prior written consent. After institutional Ethical committee clearance selected participants performed schedule of *Yogasanas* and *Pranayama* for 9o minutes daily for two months and they were again assessed for all the above parameters after completion of 60 days. After 60 days heart rate and respiration rate decreases to significant level whereas there is significant rise in IRV, ERV, FVC, MVV and FEV1. In conclusion, yogic exercises and *Pranayama* done regularly improve pulmonary function test, there helps in improving the health of *Pranvahastrotas*

Keywords: *Asan, Pranayam, Pranvahastrotas.*

Introduction

According to Chhandogyopanishad, one of the most ancient Upanishads, a human being may live without eyes, ears, legs, etc but cannot live without breathing and nourishment, for life derives from these two elements and depends entirely on them. This is the vital energy within them or vital force. *Pranvayu* (vital air) is responsible for breathing, regulating manas, sensory organs and activities such as circulation of blood, sneezing and belchingare vital functions for life. *Pranvayu* staying at *Murdha* (head region) and moving in neck and throat area conducting all these things is therefore called *Prana* life[1]. This *Pranvahastrotas*is vitiated by waste, repression of natural desires, indulgence in dry things, exercise during hunger and other *Strotasa* (systems) disability.[2]

Pranvahastrotas is among the body's most important structures. It is mainly responsible for providing oxygen and removing carbon dioxide. It facilitates speaking, too. Oxygen is the source of life and lack of supply of oxygen in the body may mean death. The oxygen that our respiratory system produces is used by the hundred billion cells that make up our body, in particular the Brain [3] The respiratory system include the nose, the nasal cavity, the pharynx, the larynx, the trachea, the bronchi and their smaller branches and the lungs which contain the terminal air sacs or alveoli. [4] The diseases developed due to impairment in the functions of *Pranvahastrtotas* may develop diseases like *Shwas*(asthma),kasa(cough) and also point out the problems of respiratory system.[5]

Asanas (physical postures) and *Pranayam* (respiratory exercises) are essential steps of *Ashtanga Yoga* (eightfold yoga), *Asanas*are the stable postures of the body, helps to improve and promote muscle health. *Pranayama* is a procedure of controlling mind by controlling the *Vayu* (air) in inspiration and expiration. These yogic procedures are not only having psychological benefits but they are having many physical benefits also[6,7] Lung volumes and capacities express the functional status of respiratory system in physiological as wellas pathological situations.[8]

All *Pranayama* forms include deep inspiration, with holding of air and deep expiration. Respiratory activity thus greatly affects the lung capacities and volumes.[9]

Pranayam can be described as to inhale, toretain and to exhale the additional quantity of *Pranvayu* or fresh air. As the additional quantity of air is inhaled and retained for an additional period in the lungs, its gets more time to exchanged by alveoli and the vital capacity of the lungs is increased. The amount of airthatisflushed in and out during aspiration is measured by spirometer.[10] Normal volumes and capacities are as follows.-

Tidal volume (T.V.): 500 mlper inspiration. 360 ml reaches the lungs while 140 ml remains in bronchi.

Inspiratory reserved volume (IRV): The air which can be forcibly inspired beyond the tidal air volume (2100- 3200ml)

Expiratory reserved volume (ERV): The amount of air that can be evacuated after tidal expiration. (1000-1200ml)

Respiratory capacities: The following features are covered in inhaled after normal expiration.

Inspiratory capacity (IC): Maximum amount of the air that can be inhaled after normal expiration.

Vital capacity (VC): Maximum amount of the changeable air that can be expired after normal inspiration. It includes tidal inspiratory reserve and expiratory air volumes. In healthy youths it is about 4800ml.

Functional residual capacity (FRC): Volume of the air remaining in the lungs after a normal tidal volume expiration.[11]

Methodology

Participants fulfilling inclusion criteria were selected for study. Thirty healthy subjects were enrolled in the study (n = 30). All participants were between 20–50 years of age and were recreationally physically active. After detailed oral and written information regarding all procedures and possible consequences, each subject signed a written consent prior to participation. The study was approved by the Institutional Ethics Committee of Datta Meghe Institute of Medical Sciences.

Selection of participants for the study: All the participants were selected by lottery method. The health of the participants was assessed by noting the present, past, family and personal history and also by thorough general and systemic examinations.

Inclusion criteria:

- Healthy individuals between the age group 20-50 years
- With normal lung function
- Donot smoke or take any medications
- Do not suffered from acute or chronic diseases

Exclusion criteria:

- Had acute injuries
- Did participants take part in any activities that could possibly influence respiration such as singing or playing a wind instrument on a regular basis
- Subjects who were trained in yoga.
- Subjects with history of any systemic illness.
- Subjects who were not able to perform respiratory function tests
- Subjects who smoked, consumed alcohol, or any drugs

Procedure: Before starting yogic procedures, on first day following respiratory parameters of all the subjects were recorded to assess the functions of *Pranavaha Strotas*.

- Herat Rate (HR)
- Respiration Rate (RR)
- Tidal Volume (TV)
- Inpiratory reserved volume (IRV)
- Expiratory reserved volume (ERV)
- Forced Vital Capacity (FVC)
- MVV (maximal voluntary ventilation)
- Ratio-FEV1/FVC (Forced expiratory volume in one second)

All the subjects were under uniform yoga training under the supervision of yoga expert for a period of 60 days for 90 minutes daily from 6am to 7.30am.

The schedule ofyogic procedures:

1. Prayer - 5 min.

2. Yogasan -30 min
3. Break - 10 min.
4. Pranayama - 40 min.
5. Prayer - 5 min.

The squence of Yogasanas was:

- Sandhi sanchalan
- SharirSanchalan
- Bhujangasan
- Dhanurasan
- Matsyasan
- Ardhmatsendriyasan
- Shavasan

The squence of Pranayama was:

- Nadishuddhi
- Anulonmaviloma
- Bhrastrika
- Anulonmaviloma
- KapalabathiKriya
- Anulonmaviloma
- Bhramari
- Shitali
- Shitakari
- Omkar

The session was started and concluded by prayer.

Observations:

Table No. 1: Observations of Heart rate and Respiration rate before and after yogic procedure

Sr.No.	HR (/min)		RR (/min)		Sr.No.
	Before	After	Before	After	
1	76	74	16	14	16
2	75	74	18	16	17	76	74	14	14
3	78	76	17	16	18	75	74	15	14
4	80	76	19	16	19	74	72	16	15
5	82	78	20	18	20	78	76	14	12
6	78	76	15	14	21	78	76	15	13
7	74	72	16	14	22	80	78	14	14
8	75	75	19	18	23	78	76	16	14
9	76	78	16	14	24	76	74	15	14
10	70	72	15	14	25	74	72	16	13
11	72	74	16	14	26	75	73	18	16
12	71	73	14	12	27	74	74	16	14
13	72	74	18	16	28	75	72	16	14
14	70	72	16	14	29	79	78	15	13
15	78	76	20	18	30	80	78	18	16

Table No. 2: Observations of Tidal Volume and Inspiratory reserved volume before and after yogic procedure

Sr.No.	TV (in ml)		IRV (in ml)		Sr.No.	TV (in ml)		IRV (in ml)	
	Before	After	Before	After		Before	After	Before	After
1	478	488	2560	2660	16	502	523	2950	3150

2	490	496	2600	2660	17	506	506	2540	2700
3	488	496	2700	2800	18	510	506	2590	2800
4	492	516	3200	3250	19	486	496	2960	3100
5	502	514	3210	3300	20	482	496	3100	3300
6	502	520	2800	3000	21	484	498	3200	3300
7	482	502	2950	3100	22	486	490	3210	3300
8	489	505	2900	3000	23	488	496	3250	3320
9	488	520	3300	3400	24	487	496	3200	3330
10	478	486	3200	3300	25	489	490	2500	2700
11	476	492	3200	3290	26	492	526	2490	2600
12	454	478	3250	3400	27	494	521	2590	2700
13	480	492	3120	3300	28	496	513	2650	2800
14	492	510	3160	3210	29	498	526	2580	2600
15	506	521	3020	3200	30	502	530	2600	2800

Table No. 3: Observations of Expiratory reserved volume and Forced expiratory volume before and after yogic procedure

Sr.No.	ERV (in ml)		FVC (in lit)		Sr.No.	ERV (in ml)		FVC (in lit)	
	Before	After	Before	After		Before	After	Before	After
1	820	920	3.8	3.9	16	860	860	4.0	4.1
2	880	950	3.9	4.1	17	780	850	3.9	4.1
3	950	970	3.7	3.9	18	790	850	3.8	3.9
4	960	970	3.9	4.1	19	840	950	4.2	4.2
5	880	900	4.1	4.2	20	860	950	4.1	4.1
6	860	910	4.0	4.2	21	860	910	3.9	4.2
7	790	820	4.3	4.5	22	900	950	3.8	3.9
8	900	950	4.2	4.3	23	740	820	3.6	3.8
9	980	1020	3.5	3.6	24	750	770	3.7	3.9
10	890	920	3.9	4.1	25	760	860	3.9	4.0
11	760	820	4.1	4.3	26	820	890	4.0	4.2
12	780	820	4.2	4.2	27	860	860	4.0	4.1
13	780	800	4.3	4.4	28	780	850	3.9	4.1
14	850	890	3.5	3.8	29	790	850	3.8	3.9
15	840	940	4.1	4.2	30	840	950	4.2	4.2

Table No. 4: Observations of maximal voluntary ventilation and Ratio-FEV1/FVC (Forced expiratory volume in one second) before and after yogic procedure

Sr.No.	MVV (L/min)		FEV1/FVC		Sr.No.	MVV (L/min)		FEV1/FVC	
	Before	After	Before	After		Before	After	Before	After

1	110	120	72	73.2	16	100	120	72.3	74.8
2	100	100	73	74.5	17	110	120	71.6	76.5
3	90	100	74.4	75.2	18	80	110	72.6	76.4
4	140	150	75.5	76.5	19	90	100	73.2	74.5
5	130	140	72.5	73.5	20	100	110	73.6	75.8
6	110	120	71.4	72.4	21	150	150	70	75.8
7	120	140	70.2	72.5	22	140	160	70.4	76.5
8	110	120	71.9	72.9	23	120	120	72.2	74.5
9	100	120	76.4	79	24	110	`120	72.4	76.5
10	80	100	74.2	76.5	25	130	140	72.2	76.2
11	90	90	74.9	78	26	100	110	75.8	76.2
12	100	120	75.2	76.8	27	80	90	75.2	76.8
13	110	140	74.2	78.5	28	90	100	74.3	75.9
14	80	110	72.2	76.4	29	110	120	73.2	76.2
15	90	100	71.3	76.2	30	80	90	71.2	76.2

Results and Analysis

Results were presented as Mean ± SD. Student t test (two tailed, independent) has been applied using software (SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0) to find the significance of study parameters. P value less than 0.05 was considered as significant.

Descriptive Statistics:

Parameters	Duration	Mean	N	Std. Deviation	Std. Error Mean
HR	Before	75.83	30	3.02	0.55
	After	74.76	30	2.04	0.37
RR	Before	16.36	30	1.75	0.31
	After	14.70	30	1.64	0.30
TV	Before	489.96	30	11.31	2.06
	After	504.96	30	14.13	2.58
IRV	Before	2919.33	30	286.19	52.25
	After	3045.66	30	279.35	51.00
ERV	Before	836.66	30	62.49	11.41
	After	890.33	30	60.19	10.99
FVC	Before	3.97	30	0.22	0.04
	After	4.11	30	0.20	0.03
MVV	Before	104.82	29	19.57	3.63
	After	117.58	29	19.20	3.56
FEV1	Before	72.98	30	1.717	0.31
	After	75.69	30	1.63	0.29

Student's paired t test:

Parameters	Paired Differences					t	df	p-value
	Statistical results			95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
HR	**1.06**	**1.79**	**0.327**	**0.39**	**1.73**	**3.24**	**29**	**0.003,S**
RR	1.66	0.71	0.124	1.40	1.93	12.83	29	0.0001,S
TV	-15.00	9.49	1.734	-18.54	-11.45	8.65	29	0.0001,S
IRV	-126.33	53.20	9.71	-146.20	-106.46	13.00	29	0.0001,S
ERV	-53.66	29.41	5.37	-64.65	-42.68	9.99	29	0.0001,S
FVC	-0.14	0.08	0.01	-0.17	-0.11	9.60	29	0.0001,S
MVV	-12.75	8.40	1.56	-15.95	-9.56	8.17	28	0.0001,S
FEV1	-2.71	1.62	0.29	-3.32	-2.10	9.14	29	0.0001v

Discussion

In the present study, respiratory rate decreases from 16.36±1.75 to 14.70±1.64 after two months of yogic practices with t-value 12.83 and $p < 0.0001$ which is highly significant. Similar finding was observed by Joshi (1992), Srivastava (2005), Jain (2005) and Makwana (1988).[12-14]

Because of pranayamic breathing by prolonged inspiration and expiration, bulbopontine complex is adjusted to a new pattern of breathing which is slower than basal breathing[12], Decline in respiratory rate is influenced probably by hypocapnea on medullary respiratory centre and persistent voluntary breathing producing inhibition of rhythmic spontaneous breathing by a phenomenon akin to over drive suppression [13]

In the present study, mean value of FVC (L) increases from 3.97±0.22 to 4.11±0.20 after 2 months with t-value 9.6 ($p<0.0001$) which is highly significant in study. However, Khanam (1996) reported no significant change in FVC. In the study, there is significant increase in mean FVC (litre), may be because of strengthening of respiratory muscle due to regular practice of pranayamic breathing during which lung and chest inflate and deflate to the fullest possible extent and muscles works to the maximumextent[14]

The study shows significant increase in IRV from 2919.33±286.19 to 3045.66±279.35 and ERV also increased significantly from 836.66±62.49 to 890.33±60.19 after two months. Mandanmohan et al who reported that, six months yoga training causes significant increases in IRV and ERV values in subjects of 12-15 age groups.

The study shows significant improvement in FEV1 from 72.98± 1.717 to 75.69±1.63 after yogic practices. In accordance to our findings, Joshi et al and Madanmohan et al showed statistically significant increase in FEV1 after yoga training which were statistically significant Makwana K et al also found significant increases in FEV1 after yoga training of 10 weeks Kadu P. Pet al concluded in their study that yogic exercise and *Pranayam* done regularly and for long term, improves respiratory efficiency.

Conclusion

The increased IRV and ERV after yogic practices indicate *Yoga* training improves the strength of expiratory as well as inspiratory muscles. *Kapalbhati* (expiratory strokes) included in the present training program involves powerful strokes of exhalation which trains the subjects to make full use of diaphragm and abdominal muscles. Slow, deep and full inspiration and expiration in *Pranayama* also trains the respiratory muscles and increases the strength of respiratory muscle.

Considering the observation, results and analysis, it is fair to conclude that yogic procedures can be beneficial in the promotion of the health of *Pranavahastrtas*.

Ethical Clearance: Taken from institutional ethics committee.

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