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Original Article

Physiology Section

Effect of Slow and Fast Pranayama Training on Handgrip Strength and Endurance in Healthy Volunteers

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ABSTRACT

Background: Pranayama has been assigned very important role in yogic system of exercises and is said to be much more important than yogasanas for keeping sound health. Also different pranayamas produce divergent physiological effects.

Aim: To study the effect of 12 weeks training of slow and fast pranayama on handgrip strength and endurance in young, healthy volunteers of JIPMER population.

Settings and Design: Present study was conducted in the Department of Physiology, JIPMER in 2011-12 (1.06.11 to 1.04.12).

Materials and Methods: Total of 91 volunteer subjects were randomised into slow pranayama (SPG) (n=29), fast pranayama (FPG) (n=32) and control groups (CG) (n=30). Supervised pranayama training (SPG - Nadisodhana, Pranav pranayama and Savitri pranayama; FPG - Kapalabhati, Bhastrika and Kukkuriya pranayama) was given for 30 minutes thrice a week for 12 weeks to both slow and fast pranayama groups by certified yoga trainer. Hand grip strength (HGS) and endurance (HGE) parameters were recorded using handgrip dynamometer (Rolex, India) at baseline and after 12 weeks of pranayama training.

Statistical Analysis Used: Longitudinal changes in each group were compared by using Student's paired *t*-test. Delta changes in each group were analysed by ANOVA with Tukey post-hoc analysis.

Results: In SPG significant improvement occurred only in HGE parameter from 83.95±45.06 to 101.62±53.87 (seconds) ($p<0.001$) whereas in FPG, significant improvement was observed in HGS from 33.31±9.83 to 37.9±9.41 (Kilograms) ($p=0.01$) as well as in HGE from 92.78±41.37 to 116.56±58.54 (seconds) ($p=0.004$). Using Students unpaired *t*-test difference between the groups in HGS is found to be 1.17±5.485 in SPG and in FPG is 4.59±7.26 ($p=0.39$); HGE difference in SPG is 1.77±21.17 and in FPG is 2.38±43.27 ($p>0.05$).

Conclusion: Pranayama training decreases sympathetic activity, resulting in mental relaxation and decreased autonomic arousal thereby, decreasing force fluctuations during isometric contraction. This is reflected as improvement in HGS and HGE.

Keywords: Pranayama, Physiological parameters

INTRODUCTION

The spiritual-scientific discipline of yoga incorporates a wide variety of practices and many scientific researches conclusively document its preventive, therapeutic and excelling powers in the individuals [1,2].

The versions of pranayama vary from single nostril breathing to bellow breathing and it consists of three phases: purak (inhalation), kumbhak (retention) and rechak (exhalation) and these phases can be practised in either slow or fast manner [3]. Hand grip strength (HGS) is an indicator of muscle function and nutritional status. It has been used as an objective clinical measure in a variety of situations including assessing the general strength in order to determine work capacity [4]. HGS is influenced by effort, skeletal muscle bulk and contractility. Regular practice of pranayama has shown improvement in HGS of both hands [5]. One previous study has compared the effect of six months practice of fast (FSN) and slow (SSN) practice of Suryanamaskar (SN) (type of yogasana) on adolescents and found out that both types of SN had positive physiological benefits but the effects of FSN were similar to physical aerobic exercises, whereas the effects of SSN were similar to those of yoga training [6]. As different types of pranayamas have also been demonstrated to produce different physiological benefits in the subjects [7–9], the present study was planned to study the effect of 12 weeks of slow and fast pranayama training on handgrip strength and handgrip endurance in young adult subjects of JIPMER population.

SUBJECTS AND METHODS

Present study was conducted in the Department of Physiology, JIPMER, Puducherry. The subjects were recruited from the students of various courses conducted in JIPMER, Puducherry as well as staff, friends and relatives of them. The study involved less than minimal risk.

Inclusion criteria

- Healthy volunteers of both gender in the age group of 18-30 years.

Exclusion criteria

- History of chronic respiratory illness.
- Subjects receiving medication for any chronic ailment.
- Smokers and alcoholics.
- Athletes.
- Any history of previous yoga or bio feedback techniques training in last one year.

The purpose of the study, procedures and benefits were briefed to them. The willing participants were randomised into SPG (n=29), FPG (n=32) and CG (n=30) after getting informed written consent, by simple randomisation method using random numbers generated through computer. Average age of the volunteers was average age of 18.58 ±2.27 (mean ± SD) were considered for analysis. Among these 91 volunteers, 72 were females and the remaining 19 were

Parameters	SPG (n=29)		FPG (n=32)		CG (n=30)	
	Baseline	Post test	Baseline	Post test	Baseline	Post test
HGS (Kg)	32.83 ± 11.33	34 ± 11.90	33.31 ± 9.83	37.9 ± 9.41*	30.43 ± 10.15	32.40 ± 9.25
HGE (s)	83.95 ± 45.06	101.62 ± 53.87***	92.78 ± 41.37	116.56 ± 58.54**	71.83 ± 40.86	65.80 ± 34.06

[Table/Fig-1]: Comparison of handgrip dynamometry parameters between baseline and post test amongst the study groups (Mean ± SD)
SPG - slow pranayama group, FPG - fast pranayama group,CG - control group. Handgrip strength (HGS) in Kilograms and handgrip endurance (HGE) in seconds. Analysis done by Student's paired *t*-test. *p<0.05, **p<0.01, ***p<0.001.

males. The study did not involve invasive procedures at any stage. Hand grip strength (HGS) and endurance (HGE) parameters were recorded at baseline and after 12 weeks of pranayama training using handgrip dynamometer (Rolex, India). The subjects were asked to sit comfortably and proper instructions were given to them. They were asked to perform maximum voluntary contraction (MVC) using the handgrip dynamometer. The test was repeated three times with a gap of two minutes and the highest value was recorded as HGS. Following HGS, the subjects were instructed to maintain one-third of HGS for as long as possible. Duration in seconds was noted as HGE using the stop watch. Supervised pranayama training (SPG - Nadisodhana, Pranav pranayama and Savitri pranayama; FPG - Kapalabhati, Bhastrika and Kukkuriya pranayama) was given for 30 minutes/ day, thrice/week for the duration of 12 weeks by certified yoga trainer as per the guidelines of Morarji Desai National Institute of Yoga, New Delhi. The details of pranayama training are as follows:

1. **Fast Pranayama:** Each cycle consisted of practicing one minute of Kapalabhati, Bhastrika and Kukkriya pranayama interspersed with one minute of rest between each pranayama. Subjects were asked to complete three or more cycles in each session.
   - Kapalabhati pranayama: The subjects forcefully expelled during the expiration but the inhalation was passive. One hundred and twenty rounds per sitting was the maximum allowed.
   - Bhastrika pranayama (Bellows): Subjects were instructed to take deep inspiration followed by rapid expulsion of breath following one another in rapid succession. This is called as 'bellow' type of breathing. Each round consisted of 10 such 'bellows'.
   - Kukkriyapranayama (Dog Pant): The subjects sat in vajrasana with both palms on the ground in front with wrists touching knees and fingers pointing forward. With wide open mouth and the tongue pushed out as far as possible subjects breathed in and out at a rapid rate with their tongue hanging out of their mouth. The whole practice was repeated for three rounds.
2. **Slow Pranayama:** Each round (seven minutes) of session consisted of practicing two minutes of nadishodhana, pranava and savitri pranayama interspersed with one minute of rest between each pranayama done in comfortable posture (sukhasana). Subjects were asked to perform nine or more rounds according to their capacity.
   - Nadishodhana pranayama: is rhythmic and slow alternate nostril breathing. One round consisted of inhaling through one nostril, exhaling through other nostril and repeating the same procedure through other nostril.
   - Savitri pranayama is a slow, deep and rhythmic breathing, each cycle having a ratio of 2:1:2:1 between inspiration (purak), held-in breath (kumbhak), expiration (rechak), and held out breath (shunyak) phases of the respiratory cycle.
   - Pranava pranayama is slow, deep and rhythmic breathing where emphasis is placed on making the sound AAA, UUU and MMM while breathing out for duration of two to three times the duration of the inhaled breath.

At the end of session, all SPG and FPG subjects were instructed to lie down in shavasana and relax for 10 minutes.

Parameters	SPG (n=29)	FPG (n=32)	CG (n=30)
HGS (Kg)	1.17 ± 5.28	4.59 ± 7.26	1.97 ± 7.42
HGE (s)	1.77 ± 21.17	2.38 ± 43.27	-6.03 ± 35.53*, ##

[Table/Fig-2]: Comparison of the delta changes (difference between post test & baseline) amongst the studygroups on handgrip strength (HGS) and endurance (HGE) parameters (Mean ± SD).
SPG - slow pranayama group, FPG - fast pranayama group, CG - control group. *with respect to slow pranayama group, # with respect to fast pranayama group. Analysis done by one way ANOVA with Tukey post-hoc analysis .*p<0.05, **p<0.01, ***p<0.001. #p<0.05, ##p<0.01, ###p<0.001.

Control Group: consisted of group of volunteers who were not included in 12 week training of pranayama.

RESULTS

The comparison of parameters between baseline and post test amongst the groups on hand grip dynamometry parameters are given in [Table/Fig-1]. The details on the comparison of handgrip dynamometry parameters considered for the study at baseline were comparable (p>0.05).

The analysis on the effect of 12 weeks of slow pranayama on HGS and HGE parameters shows a statistically significant improvement (p<0.001) for HGE and statistically insignificant change (p>0.05) for HGS parameter. The analysis on the effect of 12 weeks of fast pranayama on HGS and HGE shows statistically significant improvement in both HGS and HGE (p=0.01 and p=0.004, respectively).

In CG there was no significant change observed in both HGS and HGE parameters (p>0.05) after 12 weeks of study period. In HGS parameter, longitudinal changes amongst the groups were not statistically significant (p>0.05). In HGE parameter, changes amongst the groups were statistically significant (p=0.003).An average increase of 2.38 ± 43.27in FPG and 1.77 ± 21.17in SPG was observed (P=0.003 and P=0.03 respectively) compared to the CG.

Also, [Table/Fig-2] demonstrates that on comparing HGS and HGE parameters, there was no significant difference between SPG and FPG groups. Therefore, our study demonstrates that the effect of slow and fast pranayama groups can be considered comparable on handgrip dynamometer parameters (HGS & HGE).

DISCUSSION

Since pranayama can be practiced in either slow or fast manner [3], the beneficial effects obtained by the practice of different pranayamas may be derived from the differences in duration of the phases of the breathing cycle, tidal volume and other factors including the use of mouth, nostrils, constriction of the laryngeal muscles and position of the glottis [10].

Results of our study demonstrate that there was no significant difference in the baseline values of handgrip dynamometry parameters. Therefore, all the three groups can be considered comparable for the present study. There was significant improvement in HGS and HGE in fast pranayama group whereas in slow pranayama group, there was significant improvement in only HGE parameter (p<0.001) along with statistically non significant but definite trend towards increase in HGS. However, on comparing longitudinal changes

between fast and slow pranayama groups, there was no statistically significant difference between these groups. Therefore, our study demonstrates that both slow and fast pranayamas are beneficial on the handgrip dynamometer parameters (HGS & HGE) and the beneficial effect of the two groups can be considered comparable.

To the best of our knowledge, there is no previous study which compared the effect of slow and fast pranayamas on HGE and HGS. However, many previous studies had shown beneficial effect of integrated yoga practices which included various pranayama techniques. A study by Madanmohan et al., observed 21% increase in HGS on healthy volunteers with 12 weeks of yoga training [11]. Another study done by Raghuraj et al., on school children aged 11–18 years found that 10 days of pranayama training significantly improved HGS ranging from 4.1% to 6.5% without lateralised effect [5].

The improvement in HGS & HGE after pranayama training can be ascribed to the state of calm alertness, better subjective wellbeing and hypo metabolic state in the subjects which may have resulted in better concentration on the task. This may be due to improved autonomic tone resulting in increased parasympathetic drive, calming of stress responses, neuroendocrine release of hormones and thalamic generators [12]. Improved autonomic tone may reduce oxygen requirement by pranayama practice, as the availability of energy and oxidation of glucose is believed to influence the HGS [13]. Also, cognitive components and non specific arousal can be the possible factors for the improvement in HGS [14]. Ray et al., reported that yogic exercises produce significant increase in muscle endurance and delay in onset of fatigue [15]. Raju et al., also reported that yoga training resulted in a significant increase in maximal work output with a significantly reduced level of oxygen consumption per unit work [16].

To conclude, our results demonstrate that both slow and fast pranayamas are beneficial on handgrip dynamometry parameters and fast pranayama was more effective than slow pranayama.

KEY MESSAGES

Different pranayamas produce different physiological effects. Especially fast pranayama training when practiced regularly for longer duration, it produces parasympatho dominance in contrast to the short duration training which evokes sympathetic activity.

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