

Original article:

Effect of pranayama on cognitive functions of medical students

Dr Ruchi Jain, Dr (Mrs) P.S Tonpay

Department of Physiology, Sri Aurobindo Medical College & P.G Institute, Indore (M.P)

Corresponding author: Dr Ruchi Jain , Department of Physiology , Sri Aurobindo Medical College & P.G Institute, Indore(M.P)

ABSTRACT:

Anxiety , stress and mental strain are most commonly experienced by medical students due to academic burden .Excessive stress affects their mental health causing deterioration of their cognitive functions . Pranayama is a form of exercise which shifts the autonomic system towards parasympathetic side and helps to reduce stress.The present study was conducted on 67 healthy medical students(30 males and 37 females). The subjects belong to age group 18 to 25. The cognitive function tests were used to test their cognition.Then pranayama was practiced for four weeks by the students. Thereafter cognitive tests were repeated again . There was significant reduction in TMT-A and TMT-B ($p<0.0001$) scores and increase in forward digit span ($p<0.001$) and backward digit span($p<0.002$) after the intervention by pranayama. Mean total and net score of SLCT test was increased after pranayama whereas score of wrong letter cancellation was decreased post pranayama.Thus pranayama reduces stress and improves cognitive functions in medical students

Keywords: Cognitive functions, medical students, pranayama ,six letter cancellation test.

Introduction

Persistent competition, modern lifestyle and financial burden have lead to mental health deterioration causing anxiety and stress among general population[1]. Many studies have shown that medical students are more prone to stress[2-5], as compared to students from other fields due to academic burden ,long duration of studies ,heavy clinical postings. Executive functions are cognitive control system [6] which include working memory, concentration span, scanning and retrieval of stored information and mental flexibility, i.e., the ability to shift from one criterion to another in sorting or matching tasks [7,8]. Mental stress can lead to impairment of cognitive and executive functions [9,10].

Yoga and pranayama are primitive exercises which can be practice to relieve mental strain [11].

Pranayama constitutes voluntary breathing exercise

. Puraka(inhalation); kumbhaka (retention) and rechaka (exhalation) are the three main phases of pranayama[12, 13]. Pranayama is broadly divided into two types.i.e fast and slow. Fast one includes kapalabhati, bhastrika, kukriya and slow ones include nadishuddhi, savitri and pranav. All the pranayamas improves both physical and mental aspect of human health [14-16], but the physiological effects of both the pranayama are different in healthy individual [17]. Yoga and pranayama enhances oxygen consumption, improves blood circulation [18] shifts body towards parasympathetic side inducing calmness. Studies have reported that pranayama helps in processing of sensory information at the level of thalamus [19]. Thus, the present study aims to study theeffect of pranayama on cognitive functions in medical students.

Material and methods

Setting: Present study was conducted in the Department of Physiology, SAIMS Indore M.P.

Study design: This study is a prospective pre-experimental study and prior permission for the study was taken from the institutional human ethics committee. A total of 67 healthy medical students were recruited for the present study. They were nonsmokers, nonalcoholic and non-diabetic, having no evidence of physical and mental illness and not on any medication as inquired before including in the study. Subjects who practiced yogic techniques in past one year or with history of previous or current organic diseases or subjects were unable to practice pranayama due to physical abnormalities were excluded.

They were explained about the study procedure and their written informed consent was taken.

Subjects were asked to report to the Department of Physiology, Sri Aurobindo Medical College Indore, and Cognitive Functions Test Battery were recorded which includes the following

Letter Cancellation Test: This test is used to analyse concentrating ability, visual scanning, and response speed. The subject is presented with a sheet of letters of English alphabet, and is asked to cancel out specific alphabets. They were asked to cancel particular letters in the time duration of 90 seconds. Scoring was done by counting total number of cancelled letters, and no of wrong cancel letters. Net score is calculated by deducting the latter from the former.

Trail Making Test: Part A: This test checks visuomotor speed and attention. The subject were given a sheet of paper containing 25 circles containing numbers 1-25. They are made to join

these circles sequentially. Then the score is the time taken by the subject to complete the task.

Trail Making Test: Part B: It measures shift strategy, attention and visuomotor speed. In this the subject is instructed to connect 25 numbered and lettered circles by alternating between the two sequences. The score is the total time taken by the subject to finish the task.

Digit Span:

Forward digit span assesses immediate verbal memory span. In the test, examiner calls out series of digits of increasing length in front of the subjects. The subjects are asked to repeat back sequences of digits. The score is maximum number of digits that the patient can recall.

Backward digit Span: It evaluates short-term retentive capacity, auditory attention and the ability to manipulate information in the verbal working memory. The examiner calls out a series of digits to the subject. The subject has to repeat the sequences of digits which was said by the examiner in a reverse order. The score is the maximum number of such digits that the student is able to reverse.

Intervention

Pranayama training was given to the participants for 1 week. After the training 67 subjects were divided into three small batches and pranayama session was organized from 8:00AM to 9:00AM every day. Pranayama intervention was carried out for about thirty minutes a day, four times per week, for duration of 4 weeks. Participants practiced the pranayama in a quiet room which was maintained at a comfortable temperature ($25 \pm 2^{\circ}\text{C}$). No other physical activity such as sports or athletic training was allowed during that period of four weeks.

Bhramari: Students are instructed to close their ears with thumbs, place the index fingers on the temple above eyebrow and other three fingers on the side of nose. Slowly inhale through the nose and withhold the breath for a few seconds. Keeping the mouth closed, slowly exhale by making a humming sound. Repeat it for 5 times.

Anulomvilom: In this students were asked to close the index finger and the middle finger of right hand. Now, closing right nostril with thumb and slowly exhale air from the left nostril. After exhaling, slowly inhale through the same nostril. Withhold breath for 2 seconds. Then close left nostril with your ring finger and exhale through the right nostril. Now, inhale from the right one, hold it for 2 seconds and exhale from the left one closing your right nostril with the right thumb. Repeat this process for 2-5 minutes.

Kapalbhati: This is a process of passive inhalation and active exhalation. Subjects are instructed to inhale normally and exhale forcefully. During exhalation the stomach muscles are moved violently (pulling closer to back). Continue it for 2-5 minutes.

Bhastrika: Subjects were instructed to take deep inspiration followed by rapid expulsion of breath

following one another in rapid succession. After 10 expulsions, the final expulsion is followed by the deepest possible inhalation. Breath is suspended as long as it can be done with comfort. Deepest possible exhalation is done very slowly. This completes one round of Bhastrika.

After the completion of pranayama exercise for one month cognitive function tests were again repeated and data was statistically analyzed.

Results: The mean age of subjects was 19.11 ± 1.07 years. There were 30 male and 37 females. There was no significant difference in baseline body mass index, Trail making test A (TMT-A), Trail making test B (TMT-B) score, forward and backward digit span score and as well as Six letter Cancellation test score in male and female subjects (Table 1)

After the intervention by pranayama there was significant reduction in TMT-A ($p < 0.0001$) and TMT-B ($p < 0.0001$) scores and increase in forward digit span ($p < 0.001$) and backward digit span ($P < 0.002$). Mean total and net score of SLCT test was also found increased after pranayama whereas score of wrong letter cancellation was decreased post pranayama (Table 2)

Table 1: Baseline Demographic and Cognitive function test

	Male	Female	Total	P Value
N	30	37	67	-
Age	19.23 ± 0.97	19.03 ± 1.04	19.11 ± 1.07	0.409
BMI	21.6 ± 2.0	21.8 ± 1.6	21.75 ± 1.81	0.756
TMT A	32.80 ± 10.61	34.54 ± 10.03	33.76 ± 10.25	0.494
TMT B	63.40 ± 19.78	67.22 ± 19.53	62.76 ± 20.91	0.432
FDS	6.53 ± 1.85	6.11 ± 1.63	6.30 ± 1.75	0.336
BDS	3.67 ± 1.68	3.81 ± 1.39	3.75 ± 1.52	0.703
SLCT				
Total Score	30.26 ± 8.26	28.62 ± 7.85	29.35 ± 8.02	0.408
Net Score	29.33 ± 8.15	27.40 ± 7.76	28.26 ± 7.94	0.327
Score for wrong cancellation	0.93 ± 1.04	1.22 ± 1.56	1.09 ± 1.35	0.400

Table 2: Effects of pranayama on cognitive function test

Variables	Pre	Post	P value
TMT –A	33.76±10.25	30.65±8.61	<0.0001
TMT- B	65.51±19.59	60.73±17.3	<0.0001
FDS	6.30±1.75	6.61±1.57	0.001
BDS	3.75±1.52	3.94±1.56	0.002
SLCT			
Total Score	29.35±8.02	32.85±7.37	<0.0001
Net Score	28.26±7.94	32.16±7.31	<0.0001
Score for wrong cancellation	1.09±1.35	0.68±0.82	0.005

Discussion

In this study there was significant reduction in time taken to complete Tmt A and Tmt B and increase in scoring for forward digit span and backward digit span after pranayama intervention. Mean total and net score of SLCT test was also found to be increased whereas score for wrong letter cancellation was decreased after practicing pranayama for one month. .

A study was conducted to observe the effect of yoga has on six-letter cancellation task in students under examination stress. Results showed that the total and net scores were significantly higher after practicing yoga. There was also reduction in scores for wrong cancellation.[20]

A study was conducted to observe the effect of kapalbhathi on SLCT in different age groups- younger, medical students, middle age and older age groups. The result showed that in middle and older age groups, no change occurred in total errors after kapalbhathi, but net scores were increased after kapalbhathi by 32.5% and 16.4% respectively. The net scores did not change significantly in the medical students. Total errors were decreased in the younger and medical student group[15].

Another study showed that integrated practice of yoga causes improvement in cognitive functions like

remote memory, attention and concentration, delayed and immediate recall in perimenopausal women with climacteric syndrome.[21]

Thakur et al reported that right nostril yoga breathing (suryaanulomaviloma) leads to improvement in digit span forward and digit span backward and alternate nostril breathing increases the digit span backward task score [22]. Thus a significant improvement was seen in various cognitive areas: attention, memory retention capacity, visuo-motor speed was observed after pranayama intervention.

In the present study, hypothesis can be made that improvement in cognitive functions following pranayama might be due to decrease in stress level and improved parasympathetic tone.

The bidirectional vagal system is a major contributor of stress reduction following pranayama. The underlying mechanism regarding pranayama practice could be stretching of respiratory muscle, specifically the diaphragm [7,23]. During above tidal inhalation (as was seen in Hering Breuer's reflex), stretch of lung tissue leads to inhibitory signals in the vagus nerve, which ultimately shifts the autonomic nervous system into parasympatho-dominance, that results in a calm and alert state of mind [24].

Conclusion:

Thus Pranayama reduces stress in medical students and helps in improving their cognitive functions.

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