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Effect of Hyperventilation on Cognitive Functions

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Original Research Article

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Abstract: Hyperventilation causes various physiological changes and may lead to altered cognitive functions. This pilot study was done to assess the effect of hyperventilation on digit span forward task. 32 first year medical students were enrolled in the study. The subjects were equally divided into study group and control group. The study group performed voluntary hyperventilation for a maximum of three minutes. Digit span forward task was given prior to hyperventilation and following hyperventilation. The control group were made to sit silently for the same duration .There is no statistically significant difference in the performance between the two groups (P=0.06).However since this is a pilot study; further studies have to be done with larger number of subjects.
Keywords: Voluntary hyperventilation, Hypocapnia, cognitive functions.

INTRODUCTION

Hyperventilation occurs when the rate and quantity of alveolar ventilation of carbon dioxide exceeds the body's production of carbon dioxide [2]. Hyperventilation results in physiological and psychological changes [1].

When hyperventilation leads to respiratory alkalosis, it may cause a number of physical symptoms; dizziness, tingling in the lips, hands or feet, headache, weakness, fainting and seizures.

Controlled ventilation is frequently associated with purposeful or inadvertent arterial hypercapnia [4]. For digit span sequencing, the examiner is read a sequence of numbers and recalls the numbers in ascending order. The often cited experiments by George Miller in 1956 suggest that the number of objects an average human can hold in working memory known as memory span is between 5 & 9(7+/-2) which Miller described as the "magical number". Phonological loop has two components a short term phonological store with auditory memory traces that are subject to rapid decay and an articulatory loop that can revive the memory traces. The average span for letters was 7.3 and for numbers it was 9.3.The duration of short term memory between 15-30 seconds according to Alkenson and Shiffrin[5].Items can be kept in short term memory by repeating them verbally(acousting encoding) a process known as rehearsal.Baddeley theory of short term memory, a person has one store of immediate information processing which could only hold a total of 7 items plus or minus two items to be stored in a very short period of time a matter of seconds. The digit – span test is a perfect example of a measurement for classically defined short term memory.

AIM OF THE STUDY

Hyperventilation causing physiological alteration affects the cognitive performance & this was assessed by visual forward span digit test in young healthy medical students.

MATERIALS AND METHODS

A total number of 32 first year MBBS students (2016-2017batch) of Andhra Medical College, Visakhapatnam, were enrolled in the study after taking approval from the ethics committee. The enrolled group consists of 16 boys and 16 girls in the age group between 17 years and 20years.They were divided into two groups, with 8 boys and 8 girls in the study group and 8boys and 8 girls in the control group. Healthy young individuals included in the study.

Exclusion Criteria

- Individuals with a history of epilepsy.
- Individuals with h/o Asthma.
- Individuals with h/o fever.
- Individuals with h/o HTN/Surgeries.

Visual forward digit span cognitive test used which is a variant of a simple, non auditory digit span

test. The expected average is around 7 digits for the untrained.

Table-1: Distribution according to sex

Sex	No of students	Percentage %
Male	16	50
Female	16	50

The individuals in the study group were asked to voluntarily hyperventilate for a maximum period of three minutes and the readings are recorded prior to and after hyperventilation. The candidates in the control group were relaxed with normal breathing and readings were recorded before and after a rest period of three minutes.

RESULTS

The difference in the average span value before and after hyperventilation is taken in study group and control group and paired test calculated.

Table-2: Average span value before and after hyperventilation

	Control group			Study group		
S.No	Average span before	Average span after	difference	Average span before	Average span after	Difference
1	4.37	6.41	2.04	5.00	4.58	0.42
2	6.00	6.46	0.46	5.00	5.00	0.00
3	4.00	5.00	1.00	6.41	3.50	2.91
4	6.12	6.30	0.18	5.09	4.45	0.64
5	3.11	3.50	0.39	7.00	4.90	2.10
6	4.45	4.50	0.05	5.25	5.60	0.35
7	3.50	4.08	0.58	3.50	3.11	0.39
8	5.09	5.00	0.09	5.25	2.00	3.25
9	4.20	5.38	1.18	4.66	2.33	2.33
10	4.49	5.00	0.51	6.41	4.66	1.75
11	4.00	7.00	3.00	3.50	2.00	1.50
12	3.38	4.20	0.82	4.61	4.20	0.46
13	5.00	5.00	0.00	5.83	4.30	1.53
14	7.00	7.00	0.00	4.90	3.81	1.09
15	4.45	5.00	0.55	4.60	2.80	1.80
16	4.20	5.10	0.90	6.12	4.72	1.40

Mean =/- SD in group one is 0.73=/-0.8 and in the study group is 1.37 =/- 0.96.SD for the first group is 0.80 and for the second group 0.96

Group one is the control group and groups two is the study group. There is no statistically significant difference between the two groups (p value = 0.06). The hyperventilation period varied between 1min to 3 minutes. Subjects were questioned regarding the state of mind after the period of hyperventilation.12 out of 16 in the study group experienced dizziness after hyperventilation and 9 out of 16 in the study group had decreased concentration.

DISCUSSION

Controlled ventilation is frequently associated with purposeful or inadvertent arterial hypocapnia. The studies conducted by Kety showed a drop in PCo2 levels with hyperventilation below 30mmHg, decreasing the cerebral blood flow below 40ml/100gm/min [6], and a cerebral blood flow threshold below which increasing number of people develop manifestations of cerebral hypoxia. All people develop neurological manifestations below an arterial CO2 pressure of 20mmHg [7]. Baddeley theory of short term memory, a person has one store of immediate information processing which could only hold a total of 7 items plus or minus two items to be stored in a very short period of time a matter of seconds. In our study average span in the study group ranged between3.5 to 7.There were no significant difference between the two groups, as limitations could be a small study group, duration of hyperventilation not constant for all the subjects and sincerity in performing the test is more subjective.

CONCLUSION

We hypothesised that dizziness caused by hyperventilation leads to decreased performance in the digit span forward task. However there is no statistically significant difference between the two groups in the present study. However in the study the number of subjects is small and further studies have to be done taking larger number of subjects.

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