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RESEARCH ARTICLE

STUDY ON VENTILATORY ACCLIMATIZATION OF AMARNATH PILGRIMS AT THE HOLY AMARANTH CAVE

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ABSTRACT

Introduction: Breathing with low inspired oxygen tension leads to low Pao_2 and is frequently seen in Amarnath pilgrims during ascent to Holy amaranth cave. At Holy amaranth cave, when the partial pressure of oxygen in inspired air Pio_2 decreases and oxygen supply in the body is compromised, many compensatory mechanisms are made in an effort to deliver normal amounts of oxygen to the tissues. The present study was designed with the aim to Study on Ventilatory acclimatization of Amarnath pilgrims at the Holy Amaranth cave. **Material and Methods:** A total of 75 Amarnath pilgrims of both male and female of five different age groups were taken. An informed consent was taken from each yatri before the study. A wrist second watch was used for counting respiratory rate of Amarnath pilgrims. Counting of breathing rate was done for full 1 minute in lying down position. **Result:** There were a significant increase in respiratory rate was noted at holy cave from mean Respiration rate 15.53±1.87 breaths per minute to 31.39 cycles per minute with S.D. of 2.98. **Conclusion:** Ventilatory acclimatization among Amarnath pilgrims seen during yatra was highest at the Holy Amarnath cave.

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INTRODUCTION

Breathing with low inspired oxygen tension leads to low Pao_2 and is frequently seen in Amarnath pilgrims during ascent to Holy amaranth cave. How the body responds to high altitude has attracted physiologists for decades. The French physiologist Paul Bert was first to recognize that the harmful effects of high altitude are due to low oxygen tension. The percentage of oxygen does not change at high altitude but Po_2 decreases due to a decrease in Barometric Pressure (PB). Thus, the hypoxic response in Amarnath pilgrims at Holy amaranth cave is caused by a decrease in partial pressure of oxygen in inspired air (Pio_2) resulting from a decrease in Barometric Pressure (PB) and not from a change in fraction of inspired oxygen (Fio_2). At Holy amaranth cave, when the partial pressure of oxygen in inspired air Pio_2 decreases and oxygen supply in the body is compromised, many compensatory mechanisms are made in an effort to deliver normal amounts of oxygen to the tissues. Surprising fact is that increased respiration rate due to hypoxia is not significantly increased until the alveolar Po2 decreases to less than 60 mm Hg.

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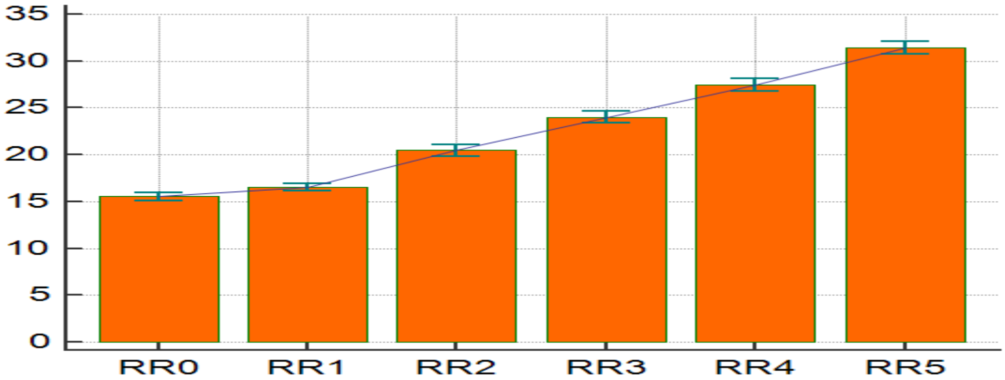
In a healthy Amarnath pilgrim, a fall in alveolar Po_2 to 60 mm Hg occurs at an altitude of approximately 12756 ft height of Holy amaranth cave. As height increases during journey to Holy Amarnath cave, the Amarnath pilgrim makes noticeable efforts to deliver more oxygen to the tissues. Important among these responses to high altitude is induced increased respiration rate that is, deeper breaths taken more rapidly in which alveolar ventilation is increased to fulfil the increased demand. The sequence of events for hypoxia-induced increased respiration rate as seen in Amarnath pilgrims were as follows: (a) a fall in Pio_2, (b) decreased alveolar tension (Pao_2), (c) decreased arterial oxygen tension (Pao_2), (d) increased firing of peripheral chemoreceptor, (e) hyperventilation, and (f) increased alveolar and arterial oxygen tension. Stimulus for ventilation during hypoxia was a decrease in Pao_2 rather than O_2 content or percent O_2 saturation. There was also an immediate increase in cardiac output to match the increase in ventilation to maintain normal ventilation perfusion ratio. The increase in cardiac output leads to an increase in pulmonary circulation. Increase in pulmonary blood flow reduces both the capillary transit time and pulmonary vascular resistance. Pulmonary vascular resistance was due to capillary recruitment, which occurs primarily in the top part of the lungs, resulting in more even blood flow throughout the lungs. Regional blood flow and airflow in the lungs were matched (i.e., improved ventilation/perfusion ratio).

Thus, the increased cardiac output indirectly increases gas exchange by decreasing transit time and improving the overall ventilation/perfusion ratio in the lungs of Amarnath pilgrim. The hypoxia-induced hyperventilation occurs in Amarnath pilgrims due to stimulation of the carotid bodies.

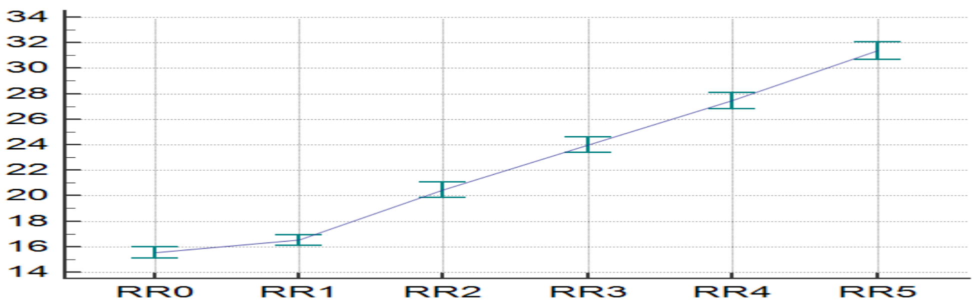
Although the physiologic mechanisms responsible for Ventilatory acclimatization or increased respiratory rate of Amarnath pilgrims were not completely understood, it was clear that two mechanisms were involved. First involves the chemoreceptor, and the second involves the kidneys. When ventilation is stimulated by hypoxia.

Table. Mean Respiration rate with S.D. of 75 Amarnath yatris at 5 altitudes

LOCATION (Amarnath Yatris Base Camp)	ALTITUDE(FEET)	CODE	MEAN Respiration rate	S.D.
Department of Physiology	500	R0	15.53	1.87
Jammu	1073	R1	16.53	1.81
Srinagar	5000	R2	20.45	2.62
Pahalgam	7500	R3	24.01	2.59
Chandanwari	9500	R4	27.45	2.85
Holy Amarnath Cave	12756	R5	31.39	2.98



Histogram of Respiratory Rate of Amarnath Yatri



Graph showing increasing pattern of respiration rate of yatris with increasing altitudes

However, the increase in respiratory rate of Amarnath pilgrims seen in the first phase was small compared with that of the second phase, in which ventilation continues to rise slowly over the next 8 hours. After 8 hours of lack of oxygen, increase in respiratory rate of Amarnath pilgrims was sustained. The reason for the first small rise in respiratory rate of Amarnath pilgrims seen in the first phase was due to hypoxic stimulation was strongly opposed by the decrease in $PaCo_2$ as a result of excess carbon dioxide washed out with height induced increased respiratory rate of Amarnath pilgrims. Hyperventilation increases PaO_2 but significantly decreases $PaCo_2$, resulting in increase in arterial P_H. Hypocapnia due to the decrease in arterial PCo_2 and the rise in blood P_H worked in concert to strongly blunt the hypoxic drive. Acclimatization in Amarnath pilgrims to altitude leads to a sustained increase in respiratory rate and this sustained increased ventilation seen in the second stage is referred to as Ventilatory acclimatization. Ventilatory acclimatization is defined as a time dependent increase in respiratory rate of Amarnath pilgrims that occurs over hours to days of continuous exposure to hypoxia.

CSF pH becomes more alkaline. The elevated CSF pH is brought closer to normal by the movement of bicarbonate out of the CSF. Also, during prolonged hypoxia, the carotid bodies increase their sensitivity to PaO_2. These changes result in a further increase in respiratory rate of Amarnath pilgrims. The second mechanism responsible for ventilator acclimatization involved the kidneys.

MATERIAL METHODS

A total of 75 Amarnath Yatris of both male and female of five different age groups were selected from healthy diagnosed Amarnath Yatris for this study which was done in July 2014 during Amarnath yatra. An informed consent was taken from each Amarnath Yatris before the comparative study. Places of work were department of Physiology and Holy Amarnath Cave (12756 feet). A wrist second watch was used for counting respiratory rate of Amarnath pilgrims. Counting of breathing rate was done for full 1 minute in lying down position. It was counted one rise and fall of watch placed on centre of abdomen by seeing horizontally as one breath cycle.

Amarnath Yatris were advised to take 15 minutes bed rest before taking respiration rate. Places of work were R0-Department of Physiology, R1-Amarnath Yatri Base Camp Jammu (1073 feet), R2-Base Camp Srinagar (5000 feet), R3 - Amarnath Yatri Base Camp Pahalgam (7500 feet), R4-Amarnath Yatri Base Camp Chandanwari (9500 feet), and R5-Holy Amarnath Cave (12756 feet). Respiration rate of selected healthy informed Amarnath Yatris were recorded at Holy Amarnath Cave (12756 feet) and at each places for two times in 7 P.M. and 9 P.M. and then average of these two was taken as case value. As in our study case and control were same so basal respiration rate recoded before Amarnath yatra were taken as control value.

RESULTS

Ventilatory acclimatization among Amarnath pilgrims seen during yatra was highest at the Holy Amarnath cave while control value was lowest before journey to the cave. There were a significant increase in respiratory rate was noted at holy cave from mean Respiration rate 15.53±1.87 breaths per minute to 31.39 cycles per minute with S.D. of 2.98. In this study we also studied the pattern of respiration rate during yatra to holy cave at 5 different altitudes coded as R0, R1, R2, R3, R4, & R5. We observed increasing pattern with increasing altitude during Amarnath yatra. At Srinagar as shown in table mean Respiration rate of Yatris was 20.45 per minute with standard deviation 2.62, while at Pahalgam it was 24.01 per minute with S.D 2.59 and at Chandanwari mean Respiration rate was 27.45 per minute with S.D. 2.85. These Respiration rate recordings showed increasing pattern with increasing altitudes among Amarnath Yatris.

Conclusion

Ventilatory acclimatization among Amarnath pilgrims seen during yatra was highest at the Holy Amarnath cave. The Ventilatory acclimatization of Amarnath pilgrims occurs due to stimulation of the carotid bodies, exposure to cold, oxygen less atmosphere and stimulation to sympathetic nervous system. However, the increase in respiratory rate of Amarnath pilgrims seen in the first phase was small compared with that of the second phase, in which ventilation continues to rise slowly over the next 8 hours.

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