Case Report

Mutual control of breathing and blood pressure: case report

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Study design: Trial outcome.

Objectives: To demonstrate the relationship between circulation and breathing with orthostasis in a tetraplegic man.

Setting: A long-term care unit at a Veterans Administration Hospital, USA.

Method: A tetraplegic patient with a history of orthostatic hypotension was monitored for blood flow at the level of the supraorbital artery, for breathing by nasal air flow, and for pulse oxymetry on a tilt table at 0, 45 and 0° of head elevation.

Results: Tilting up caused a coincidental reduction in blood flow and enhanced breathing. These effects were coincidentally reversed by tilting down. Oxyhemoglobin concentration and pulse rates increased with orthostasis and returned to baseline on tilting down.

Conclusion: A reciprocal relationship between breathing and circulation has been demonstrated in a tetraplegic patient challenged by orthostasis.

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Keywords: spinal cord injury; tetraplegia; orthostatic hypotension; breathing; hyperventilation

Introduction

Orthostatic hypotension (OH) is a common problem for those severely paralyzed due to spinal cord injury, both acutely and chronically.^{1,2} Dyspnea is also common among those with higher levels of paralysis and especially among those with OH.^{2,3} In practice, individual cases of heavy breathing at the time of OH have been noted, consistent with these reports. It is likely that monitoring will demonstrate more objectively the relative effects of orthostasis on breathing and blood pressure in tetraplegic patients. The results of such monitoring in one patient are reported.

Case report

A 39-year-old man had been paralyzed for 13 years at the C5 level, motor and sensory complete, following a motor vehicle accident. He was being treated intermittently with ephedrine for OH, but did not receive ephedrine on the day of the tilt test to be described. He did not smoke.

Photoelectric pulse sensors (Model 1010, UFI, Morro Bay, CA, USA) were held against the forehead over the supraorbital notch and over the temporal pulse with an elastic band. The half-layer penetration of the infrared signal being 2 mm, it is believed that arterial blood flow as well as microvascular flow is measured. A thermo-

couple transducer (Model TCT IR, Grass Instruments, Quincy, MA, USA) was clipped to one naris to measure breathing by nasal air flow. The patient was instructed to breathe only through the nose during testing. Although this transducer is commonly used to monitor respiratory rate during sleep, it responds to depth of breathing as well. Therefore, both rate and depth of breathing were recorded. Transducer signals were amplified and displayed using a polygraph with a strip chart recorder (Model 79 E, Grass Instruments). A pulse oxymeter (Pulsox by Nonin, Quitman, TX, USA) was attached to an index finger to measure oxygen saturation of hemoglobin and pulse rate.

The patient was placed on a tilt table. Measurements were recorded continuously without elevation for 1 min, during elevation of the head incrementally to 45° over 3 min, at that position for 1 min, and during rapid descent and holding at 0° elevation for 4 min.

I certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteer were followed during the course of this research.

Results

On tilting, the supraorbital and temporal blood flows diminished, breathing became deep, oxyhemoglobin saturation and pulse rate increased, and the patient reported, in retrospect, feeling short of breath and

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Figure 1 Effect of tilting on breathing and blood flow to the head in a tetraplegic man with orthostatic hypotension

Figure 2 Effect of tilting on the pulse oxymetry in a tetraplegic man with orthostatic hypotension

‘tingly.’ On returning the patient to 0° elevation, blood flow increased, breathing decreased and oxyhemoglobin saturation and pulse rate returned to baseline within 4 min. Figure 1 compares the breathing and blood flow measurements sequentially for untilted, tilted and untilted positions. Figure 2 compares oxygen saturation of hemoglobin and pulse rate with these positions.

Discussion

A coincidence of changes in breathing and circulation to the superficial arteries of the head has been demonstrated in a tetraplegic man after an orthostatic challenge. The changes were reversed, also coincidentally with correction of the orthostasis. The inverse relationship of breathing and blood flow to the head is

particularly striking. When blood flow is diminished, breathing is enhanced; when blood flow is restored, breathing is diminished.

Enhanced breathing with orthostasis is also evident in the increased blood oxygen content in that position and by the patient’s complaint, in retrospect, of dyspnea and ‘feeling tingly.’ The symptoms describe a hyperventilation syndrome and suggest hypocarbia with corresponding reduction in cerebral blood flow.⁴ The reversal of orthostasis relieved the dyspnea and the tingling sensation, further confirming a respiratory response to orthostasis. By analogy hypotension, hyperventilation and hypocarbia have been induced by orthostasis in an otherwise able-bodied individual with lumbodorsal sympathectomy.⁵ The impaired sympathetic response to orthostasis in the tetraplegic subject may be important in the genesis of the respiratory response.¹

In conclusion, a reciprocal relationship between blood flow to the head and breathing activity can be demonstrated in a tetraplegic subject, given an orthostatic challenge. Correction of OH may relieve associated distress of heavy breathing as well.

References

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