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How hyperventilation perturbs posture?

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Introduction

The capacity to maintain an upright posture is essential in daily and also sporting activities where it's one of the performance factors. In upright stance, respiratory movements constitute an internal perturbation for body balance (Bouisset and Duchêne, 1994; Hamaoui et al., 2002). During a physical activity, the ventilatory adaptation is well known to be accompanied by fuller respiratory movements but their effects on the postural maintenance remain poorly studied. The aim of this study was to investigate how an increase in ventilation would decrease postural stability characterized from postural sway analysis (Murray et al., 1975).

Material and method

Six voluntary healthy students participated in the study (age: 21.5± 2.1 yrs; weight: 71±10.2 kg; height: 1.8±0.1 m). The sway path (Xm) in the sagittal plane was calculated from the coordinates of the center of pressure recorded from a piezoelectric force plate (Kistler). It represents the antero-posterior pathway covered by the center of pressure during the recording time and was used as an index of postural stability (Hufschmidt et al., 1980). Tidal volume (Vt_{BTPS}) was measured by telemetry with a portable gas analyser (Cosmed K2). Beforehand, spirometric test were made to determine the vital capacity (VC) in order to express Vt in percentage of VC (%Vt/VC). This ratio was used as an index of thoracic deformation.

Two types of ventilatory perturbation were applied: an hyperventilation induced by an incremental exercise on ergocycle (HE) and a voluntary hyperventilation (HV) of three minutes with a respiratory frequency corresponding to the first ventilatory threshold and imposed by a metronome. Each perturbation was preceded by a first 30 seconds of postural recording (Pre-test). Then, other recordings were carried out during the first 30 seconds of each minute for 4 minutes following the perturbation. For HV, a postural recording was also performed during the perturbation. These 4 postural tests during recovery periods were termed PT_1 to PT_4. Mean values of each parameter before, during and after the ventilatory perturbation were compared using Wilcoxon test ($P<0.05$).

Results and discussion

The main results are reported in table 1. The incremental exercise led to a significant increase in Vt and %Vt/VC ($P<0.05$). Significant increase in Xm ($P<0.05$) was simultaneously found and remained high ($P<0.05$) 4 minutes after the end of HE. HV significantly increases Vt, %Vt/VC, and Xm ($P<0.05$). However, this is less pronounced by comparison with the incremental exercise. Also, at the end of voluntary hyperventilation, Vt and Xm were no significantly different compared to the initial Pre-test values.

These results, confirmed by the least squares method, showed a significant correlation ($P<0.0001$) between Xm and %Vt/VC ($r=0.7$) for the 2 types of ventilatory perturbations. For the strong increase in %Vt/VC, postural stance and Vt were still perturbed at the end 4 minutes of recovery, expressing the phenomenon of the oxygen debt.

Table 1. Ventilatory (Vt, %Vt/VC) and postural sway (Xm) parameters in hyperventilation induced by incremental exercise (HE) and voluntary hyperventilation (HV). (Mean ± SD) * $P<0.05$

HE	***Pre-test***	***PT_1***	***PT_4***
Xm (mm)	211±19.3	577.2±134.9*	394.2±129.3*
Vt (L)	0.8±0.1	2.8±0.5*	1.3±0.2*
%Vt/VC	13.4±1.8	48.6±8.9*	23.3±3.7*

HV	***Pre-test***	***In HV***	***PT_1***
Xm (mm)	233.8±50.3	381.6±111.7*	277.6±131.1
Vt (L)	0.7±0.1	1.5±0.4*	1.1±0.4
%Vt/VC	12.7±1.8	26.8±8.4*	19.3±7.1

Conclusion

This study has shown a strong correlation between the sway path and the degree of mobilization of the vital capacity. Thus, hyperventilation represents a significant input for the postural system control. Further investigations are needed to identify the strategies used by postural control to compensate these ventilatory perturbations.

References

Bouisset S, Duchene JL (1994): Is body balance more perturbed by respiration in seating than in standing posture? *Neuroreport 14:* 957:960.

Hamaoui A, Do MC, Poupard L, Bouisset S (2002): Does respiration perturb body balance more in chronic low back pain subjects than in healthy subjects? *Clin Biomech 17:* 548-550.

Hufschmidt A, Dichgans J, Mauritz KH, Hufschmidt M (1980): Some methods and parameters of body sway quantification and their neurological applications. *Arch Psychiat Nervenkr 228:* 135-150.

Murray MP, Seireg AA, Sepic SB (1975): Normal postural stability and steadiness: quantitative assessment. *J Bone Joint Surg 57:* 510-516.