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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Evaluation of a visual biofeedback on the postural control in Parkinson's disease



Évaluation d'un biofeedback visuel sur le contrôle postural dans la maladie de Parkinson

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Visual biofeedback;
Inertial motion sensors

Summary

Objectives. — Both stabilization and orientation components of postural control are affected in Parkinson's disease (PD). These deficits are partly due to proprioceptive impairments, which frequently coexist with a visual dependence. This study aimed to evaluate if a visual biofeedback — i.e. real time anteroposterior trunk and head orientations indicated with a simplified avatar and represented in a head-mounted display — could improve the postural control of PD patients in response to a postural disturbance. The influence of focusing on one specific component of the postural control (stabilization or orientation) was also examined.

Methods. — Seventeen medicated PD patients performed sequences of pull-tests, either with eyes open, eyes closed or visual biofeedback, crossed with the verbal instruction to focus either on the stabilization or on the vertical body orientation. Kinematics data were collected.

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MOTS CLÉS

Maladie de Parkinson ;
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Results. – Backward trunk tilts consequent to the pulls were unchanged across the different conditions. With eyes open and eyes closed, patients did not recover their initial vertical orientation by adopting a slightly tilted backward position. This bias disappeared with the visual biofeedback. Moreover, falls consecutive to the test were significantly less frequent with the visual biofeedback than in the two other visual conditions. These different orientation and stabilization parameters were not affected by the instruction.

Conclusion. – Unlike a verbal instruction, visualizing in real time their own body's geometry improved both components of postural control of PD patients. This provides evidences in PD about links between impaired vertical orientation, deficits in balance control, and contribution of supplementary sensory cues.

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Résumé

Objectifs. – La stabilisation et l'orientation posturale sont altérées dans la maladie de Parkinson, notamment en raison de déficits proprioceptifs, pouvant coexister avec une dépendance visuelle. L'objectif était d'évaluer l'effet d'un biofeedback visuel — indiquant en temps réel les orientations antéropostérieures du tronc et de la tête à l'aide d'un avatar affiché dans des lunettes — sur les réponses posturales des patients parkinsoniens. L'influence d'une consigne, centrée soit sur la stabilisation ou soit sur le maintien de l'orientation posturale, était parallèlement mesurée.

Méthode. – Dix-sept patients parkinsoniens médicamenteux effectuaient des séquences de tests de rétroimpulsion les yeux ouverts, fermés ou avec le biofeedback visuel en se focalisant sur le maintien de la stabilité versus l'orientation verticale. La cinématique était mesurée.

Résultats. – Les amplitudes des inclinaisons vers l'arrière consécutives à la rétroimpulsion étaient similaires dans les différentes conditions. Avec les yeux ouverts ou fermés, les patients ne se réalignaient pas sur l'orientation verticale initiale et adoptaient une position finale légèrement inclinée en arrière. Ce biais disparaissait avec le biofeedback. Les chutes étaient significativement moins fréquentes avec le biofeedback que dans les autres conditions visuelles. La consigne verbale n'avait pas d'effet sur ces différents paramètres.

Conclusion. – Chez les patients parkinsoniens, visualiser en temps réel sa géométrie corporelle améliore la stabilité et l'orientation, tandis que focaliser l'attention sur l'une de ces composantes ne le permet pas. Des liens fonctionnels entre l'altération de l'orientation verticale, les déficits dans le contrôle de l'équilibre et l'intégration d'indices sensoriels supplémentaires semblent exister dans la maladie de Parkinson.

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Introduction

In addition to cardinal symptoms like rigidity, bradykinesia and rest tremor, a defective axial motor control is often reported in Parkinson's disease (PD), combining locomotor and postural deficits. Impaired postural capacities in PD are characterized by deficits both on stabilization and orientation components of the postural control [9]. Postural instability and falls, which occur during the later stages of the disease [9,28], are poorly responsive to levodopa [10,14] and to subthalamic nucleus deep brain stimulation [47,56], and, therefore, compromise patients' autonomy and most of their daily activities [11]. Stability difficulties are observed both in the sagittal and transversal planes and could be increased by an impairment of the anticipatory postural adjustments [33,44] or by the use of an "in block" segmental strategy at the head-shoulder unit [38].

Contrary to the postural stabilization, only a few studies are dedicated to the control of postural orientation. It has been reported that PD patients have difficulties in coordinating the orientation of the superimposed axial segments along the spinal axis, for example during longitudinal spinal rotation [48,52,53]. Furthermore, postural deformities may

occur with a typical stooped posture, characterized by a forward bending of head and trunk and by flexed elbows and knees, as first described by James Parkinson as soon as 1817 [18]. In the most severe cases, these can take the form of a Pisa syndrome, which is characterized by a trunk's tilting in the lateral plane [20] or, in the sagittal plane, by an extreme neck flexion and a dropped head called antecollis [3], or an extreme thoracolumbar flexion of the spine (>45°) called camptocormia [17,18]. Interestingly, this latter extreme bending, apparent when patient is standing or walking, disappears when the patient lies supine, sits, or when he volitionally extends the trunk, leaning against a wall or with the help of a support [4]. This indicates that PD patients are able to improve their body's orientation with physical external cues of verticality, whereas Vaugoyeau et al. [51,55] have precisely shown that the control of body vertical orientation appears to be impaired in PD patients.

Both postural deficits, including instability and orientation disorders, are often considered as linked with the rigidity which affects PD patients and as consequent to motor weakness or to axial dystonia [18,28]. However, a challenging hypothesis suggests that not only the motor efferences but also the sensory control of motor program may be defective in PD. More specifically, proprioceptive

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