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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Multichannel recording of tibial-nerve somatosensory evoked potentials

Enregistrement multicanal des potentiels évoqués somesthésiques du nerf tibial

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Summary

Study aims. — The topography of the peaks of tibial-nerve somatosensory evoked potential (SEP) varies among healthy subjects, most likely because of differences in position and orientation of their cortical generator(s). Therefore, amplitude estimation with a standard one- or two-channel derivation is likely to be inaccurate and might partly cause the low sensitivity of SEP amplitude to pathological changes. In this study, we investigate whether 128-channel tibial-nerve SEP recordings can improve amplitude estimation and reduce the coefficient of variation.

Methods. — We recorded tibial-nerve SEPs using a 128-channel EEG system in 48 healthy subjects aged 20 to 70 years (47 provided analyzable data). We compared P39, N50, and P60 amplitudes obtained with a 128-channel analysis method (based on butterfly plots and spatial topographies) with those obtained using a one-channel conventional configuration and analysis. Scalp and earlobe references were compared.

Results. — Tibial-nerve SEP amplitudes obtained with the 128-channel method were significantly higher as compared to the one-channel conventional method. Consequently, the coefficient of variation was lower for the 128-channel method. In addition, in both methods, the N50-peak amplitude was sometimes hard to identify, because of its low amplitude. Besides, in some subjects, the N50 peak, as obtained with the conventional method, rather seemed to be a period between two positivities rather than an activation peak on itself.

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Conclusions. — The 128-channel method can measure tibial-nerve SEP amplitude more accurately and might therefore be more sensitive to pathological changes. Our results indicate that the N50 component is less useful for clinical practice.

MOTS CLÉS
Potentiels évoqués somesthésiques ;
Amplitude ;
128 canaux ;
Diagramme papillon ;
Âge

Résumé
Objectifs. — La variabilité interindividuelle de la topographie des différents pics du potentiel évoqué somesthésique (PES) du nerf tibial observée chez les sujets sains peut s'expliquer par des différences de position et d'orientation de leurs générateurs corticaux. Il existe donc un risque d'erreur de mesure de leur amplitude lorsque les enregistrements sont réalisés sur un ou deux canaux standard. Cela pourrait expliquer, en partie, la faible sensibilité de l'amplitude des PES aux altérations pathologiques. Dans cette étude, nous examinons si des enregistrements sur 128 canaux permettent d'améliorer l'estimation de l'amplitude des PES et de réduire leur coefficient de variation.
Méthodes. — Nous avons enregistré les PES du nerf tibial, en utilisant un système EEG à 128 canaux sur un groupe de 48 sujets sains âgés de 20 à 70 ans (47 sujets analysables) et comparé les amplitudes des pics P39, N50 et P60 obtenues avec une méthode d'analyse à 128 canaux (basée sur des diagrammes papillons et des topographies spatiales) aux amplitudes obtenues en utilisant la configuration et l'analyse conventionnelle à un canal. Des références au niveau du cuir chevelu et du lobe de l'oreille ont été comparées.
Résultats. — Les amplitudes obtenues avec la méthode à 128 canaux ont été significativement plus élevées par rapport à la méthode conventionnelle à un canal. Par conséquent, le coefficient de variation a été plus faible pour la méthode à 128 canaux. De plus, dans les deux méthodes, l'amplitude du pic N50 a été parfois difficile à identifier, en raison de sa faible amplitude. Chez certains sujets, le pic N50 obtenu avec la méthode conventionnelle semble davantage une image construite entre deux positivités qu'un pic en lui-même.
Conclusions. — La méthode à 128 canaux permet de mesurer plus précisément l'amplitude des PES du nerf tibial et pourrait être, par consequent, plus sensible à leurs altérations en pathologie. Nos résultats indiquent également que la composante N50 est moins utile en pratique clinique.

Introduction

Somatosensory evoked potentials (SEPs) are mostly used clinically to evaluate conduction in somatosensory pathways. For this purpose, analyses of (inter) peak ''latencies'' are performed. Cortical SEP amplitude has been proven to be clinically useful for monitoring during carotid and scoliosis surgery and for prognostic applications [8,15,16,29,30]. Regarding diagnosis, applications of SEP amplitude are restricted to cortical myoclonus [3,19,25]. The limited number of diagnostic SEP-amplitude applications might result from the high inter-subject amplitude variability in healthy subjects [4,7,9,28]. Interindividual variations in size, shape, and topography of the somatosensory cortical areas are thought to be one of the causes of this variability among subjects [4,10,18,31].

In our previous 128-channel median-nerve SEP study, we showed that the position of maximum median-nerve SEP amplitude at the scalp varies considerably among subjects and that a standard one-channel recording underestimates the maximum amplitude at the scalp considerably [36]. Furthermore, we found lower alternative coefficients of variation (aCOV) for amplitudes of the 128-channel compared to the one-channel method. These results suggest that 128-channel recordings can measure median nerve SEP-amplitude more accurately and might therefore be more sensitive to pathological changes.

Studies investigating the tibial-nerve SEPs already showed a large variety of P39 topographies among healthy subjects [4,6,18,24]. The maximum P39 amplitude can be found either just posterior to C_z or at adjacent sites ipsilateral to the stimulated leg.

One first cause of this interindividual P39 variability might be that several sources with different positions and/or orientations could be active around 40 ms [1,32–34]. The relative contributions of these different sources to the P39 amplitude could vary between subjects, due to variations in source strengths, positions, orientations, and latencies, thereby giving rise to differences in the position of the maximum SEP amplitudes.

A second cause might be the interindividual variations in position of the primary-sensory areas for the leg and foot on the medial part of the postcentral gyrus within the interhemispheric fissure. If the leg area is located at the superficial edge of the interhemispheric fissure, the orientation of the pyramidal cells would be radial to the scalp, resulting in a large positive field at the midline. On the contrary, if the position of the leg area lies deeper in the interhemispheric fissure, the orientation of the pyramidal cells would be more tangential with a positive field ipsilateral and a negative field contralateral to the side of stimulation [24]. In some cases, this may lead to the absence of the P39 in the CP_z–F_z derivation. Therefore, previous researchers and guidelines recommend to use multiple leads for accurate peak ''latency'' estimation; for example,