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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Startle responses after different stimulus modalities differ in stroke

Les réactions de sursaut à différentes modalités diffèrent dans l'AVC

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Auditory startle reflex;
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Summary
Objectives. — The auditory startle reaction (ASR) and startle reflex to somatosensory inputs (SSS) are stereotypical responses to sudden and unexpected stimuli, which are generated in the caudal brainstem reticular formation. Changes of ASR are relatively well known in stroke. Here, we aimed to investigate central pathways of SSS and plasticity changes of SSS circuits in different stages and localizations of stroke, by comparing with ASR.
Methods. — We prospectively included 39 patients with stroke between June 2009 and June 2013, and 23 age and gender-matched healthy subjects. ASR and SSS were recorded over orbicularis oculi, sternocleidomastoid, biceps brachii (BB), and abductor policis brevis muscles (APB) using surface electrodes.
Results. — There were supratentorial and infratentorial lesions in both acute and chronic stages. Overall, ASR probability was similar between groups ($P = 0.981$). However, ASR probability was increased for BB and APB recordings on symptomatic sides of stroke patients with high amplitudes and long durations, most prominently on symptomatic sides of pontine strokes. Latencies and presence rates of SSS did not differ between any subgroups of stroke and healthy subjects.
Conclusion. — ASR is facilitated in arm and hand muscles on symptomatic sides of stroke patients, whereas SSS did not show any significant changes according to stroke.

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MOTS CLÉS
Accident vasculaire cérébral ;
Maladie cérébrovasculaire ;
Réflexe de sursaut auditif ;
Réflexe de sursaut somatosensoriel

Résumé
Objectifs. — La réaction de sursaut à des stimulations auditives (RSA) ou somatosensorielles (RSS) sont des réponses stéréotypées à des stimuli soudains et inattendus, générées dans la formation réticulaire caudale du tronc cérébral. Les modifications des RSA sont relativement bien connues dans l'accident vasculaire cérébral (AVC). Dans ce travail, nous avons étudié les circuits centraux des RSS et leur plasticité selon différents stades ou localisations d'AVC, par comparaison aux RSA.
Méthodes. — Nous avons prospectivement inclus 39 patients ayant eu un AVC entre juin 2009 et juin 2013 et 23 sujets sains appariés selon l'âge et le sexe. Les RSA et RSS ont été enregistrées au niveau des muscles orbiculaire des paupières, sternocléidomastoïdien, biceps brachial (BB) et court abducteur du pouce (CAP) en utilisant des électrodes de surface.
Résultats. — Les patients présentaient des lésions supratentorielles ou tentorielles en phase aiguë ou chronique. La probabilité globale d'obtention des RSA était similaire entre les groupes ($p = 0{,}981$). En revanche, la probabilité d'obtention des RSA était augmentée pour les recueils sur les muscles BB et CAP au niveau des côtés symptomatiques des patients AVC, avec des amplitudes élevées et des durées prolongées, notamment pour les AVC protubérantiels. Les latences et taux de présence des RSS ne différaient pas entre les sous-groupes de patients AVC et les sujets sains.
Conclusion. — Les RSA sont facilitées au niveau des muscles du bras et de la main du côté symptomatique de patients victimes d'AVC, alors que les RSS ne montrent pas d'anomalies significatives en relation avec les AVC.

Introduction

The startle reaction (SR) is a stereotypical response to a sudden and unexpected stimulus, which is generated in a specialized brainstem nucleus, namely the nucleus reticularis pontis caudalis (nRPC), and propagates up the brainstem and down the spinal cord through the reticulospinal fibers, resulting in muscular contraction [2]. As a major descending paramotor pathway, the reticulospinal tract was thought to be responsible for gross movements of proximally located muscle groups. However, it was shown in primates that the reticulospinal pathway has various connections with the muscles of the upper limb, including the distal hand muscles [19].

Different stimulus modalities may trigger SR, since the nRPC is not stimulus specific [21]. Auditory as well as strong somesthetic stimuli may activate the nRPC [21] and once activation has occurred, SR to somatosensory inputs (SSS) may use the same circuitry as the auditory startle reflex (ASR). Experimentally, auditory stimulation is the most frequently used modality to evoke the reflex and therefore changes in ASR responses are rather well known in pathological conditions. In contrast, SSS have mainly been studied in healthy subjects [1] and more recently in generalized dystonia [10]. The pathway underlying SSS is yet to be defined.

Lesional studies (mainly in stroke patients) have led to the understanding that corticospinal tract injuries may cause reorganization of startle circuits both rostrally and caudally [4,16]. During the acute stage of hemispheric strokes, ASR was found to be enhanced and this was attributed to the loss of a predominantly inhibitory hemispheric drive to ASR generators [23]. Subsequent investigations also demonstrated exaggerated SR in pontine infarctions [9,24]. Li et al. [13], on the other hand, showed that ASR responses over impaired biceps muscle were exaggerated in subjects with spasticity, but not in subjects with normal tonus.

Vascular lesions, specifically isolated ones, provide a unique opportunity to evaluate the generators and pathways of electrophysiological networks. Likewise, extensively studied electrophysiological methods offer insights for neuroplastic reorganization after lesions of the nervous system. Therefore, we aimed to investigate central pathways of SSS and plastic changes in SSS in acute or chronic stages of stroke.

Methods

We prospectively included 39 patients with stroke who were hospitalized in our clinic or were followed up in our stroke outpatient clinic between June 2009 and June 2013 and 23 age- and gender-matched healthy subjects. The local ethical committee approved the study and all participants gave informed consent.

Neurological evaluation

All patients with the diagnosis of stroke were under the follow-up of one stroke specialist (M.B.) and underwent detailed neurological examination. Age, gender, disease duration, neurological findings, scores of the Modified Ashworth scale (MAS) and neuroimaging findings were obtained from the medical records. Strokes were classified clinically and radiologically in two ways:

- pontine, medullary, internal capsule (IC), or hemispheric (middle cerebral artery, MCA or anterior cerebral artery, ACA) lesions;