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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Central and peripheral motor drive to the palatal muscles

Commande motrice des muscles du palais

Rechdi Ahdab[a,b,c], **Wassim H. Farhat**[a,d], **Moussa A. Chalah**[a], **Philippe Kerschen**[a,d], **Jean-Pascal Lefaucheur**[a,b], **Samar S. Ayache**[a,b,c,*]

[a] *EA 4391, Excitabilité Nerveuse et Thérapeutique, Université Paris-Est-Créteil, Créteil, France*
[b] *Service de Physiologie, Explorations Fonctionnelles, Hôpital Henri Mondor, Assistance Publique—Hôpitaux de Paris, 51, avenue de Lattre-de-Tassigny, 94010 Créteil, France*
[c] *Neurology division, UMCRH, Beirut, Lebanon*
[d] *Service de Neurologie, Hôpital Henri Mondor, Assistance Publique—Hôpitaux de Paris, Créteil, France*

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Summary
Aim of the study. — To characterize the motor command of the soft palate muscles using a magnetic stimulation technique.
Material and methods. — Motor evoked potentials (MEPs) were recorded in 10 right-handed and 5 left-handed subjects at the midline of the palate or on the right or left hemipalate to peripheral and cortical magnetic stimulation.
Results. — Mean palatal MEP amplitude ranged from 0.06 to 0.26 mV to peripheral stimulation and from 0.36 to 1.09 mV to cortical stimulation. In hemipalate recordings, MEPs to peripheral stimulation had greater amplitude when recorded ipsilaterally to the stimulation side, whereas MEPs to cortical stimulation were symmetrical. In midline recordings, right-handed subjects showed greater palatal MEP amplitude to right (rather than left) peripheral stimulation and to left (rather than right) cortical stimulation. Mean palatal MEP latency ranged from 4.0 to 4.1 ms to peripheral stimulation and from 9.0 to 10.2 ms to cortical stimulation; mean central conduction time ranged from 4.9 to 6.2 ms.
Conclusion. — Palatal MEPs were easily and reliably obtained, including selective responses in each hemipalate. A bilateral cortical command of the palate is supported by our results, with a possible predominant motor drive from the left hemisphere in right-handed subjects.

* Corresponding author at: Service de Physiologie, Explorations Fonctionnelles, Hôpital Henri Mondor, Assistance Publique—Hôpitaux de Paris, 51, avenue de Lattre-de-Tassigny, 94010 Créteil, France. Tel.: +33 1 4981 2694; fax: +33 1 4981 4660.
E-mail address: samarayache@gmail.com (S.S. Ayache).

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MOTS CLÉS
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Palais ;
Stimulation magnétique transcrânienne

Résumé
Objectif. — Caractériser la commande motrice des muscles du palais à l'aide d'une technique de stimulation magnétique.
Méthodes. — Dix sujets droitiers et 5 sujets gauchers ont participé à l'étude. Les potentiels évoqués moteurs (PEM) ont été enregistrés au niveau de la ligne médiane du palais et sur l'hémi-palais droit ou gauche en réponse à des stimulations magnétiques périphériques ou corticales.
Résultats. — L'amplitude moyenne des PEM du palais variait entre 0,06 et 0,26 mV en réponse aux stimulations périphériques, et entre 0,36 et 1,09 mV en réponse aux stimulations corticales. Concernant les enregistrements latéralisés sur l'hémi-palais, les réponses obtenues du côté ispsilatéral à la stimulation périphérique avaient une plus grande amplitude que celles obtenues du côté controlatéral. En revanche, les réponses aux stimulations corticales étaient symétriques quel que soit le côté stimulé. Quant aux PEM enregistrés sur la ligne médiane, les sujets droitiers avaient une plus grande réponse à droite à la stimulation périphérique et à gauche à la stimulation corticale. La latence moyenne des PEM variait entre 4,0 et 4,1 ms pour la stimulation périphérique et entre 9,0 et 10,2 ms pour la stimulation corticale; le temps moyen de conduction centrale variait entre 4,9 et 6,2 ms.
Conclusion. — Les PEM du palais sont fiables et faciles à réaliser. Nos résultats plaident pour une commande motrice corticale bilatérale des muscles du palais. Toutefois, une prédominance de l'hémisphère gauche semble exister chez les sujets droitiers.

Introduction

The palatal musculature plays an essential role in velopharyngeal movements during speech, swallowing and respiration. In particular, the palatal muscles are involved in early phases of swallowing. At the transition from the oral to pharyngeal phase, the soft palate serves as a support against which the tongue squeezes to propel the food bolus into the open pharynx [23]. Additionally, it assures proper sealing of the nasopharynx to prevent nasal regurgitation of the swallowed bolus by moving superiorly and posteriorly by the combined action of the levator veli and tensor palatini muscles to approximate the posterior pharyngeal wall [17]. The palatal muscles are under voluntary control whether during speech or the early stages of swallowing [8]. While palatal dysfunction occurs in a set of neurological conditions such as stroke [14] and motor neuron disease [9], the electrophysiological assessment of palatal motor control using transcranial magnetic stimulation (TMS) has only recently been described [1]. TMS is a simple non-invasive way to explore motor pathways in humans by producing motor evoked potentials (MEPs) [3,7]. Although largely applied to upper and lower limb muscles, it is also helpful to study the muscles supplied by cranial nerves such as the trigeminal [4], facial [22], and hypoglossal [18] nerves. MEPs have also been recorded in pharyngeal muscles using ring electrodes placed onto a swallowed catheter [11]. In this study, we developed the technique of palatal MEP recording that we previously described [1] by investigating hemipalate MEPs in order to better understand the lateralization of the central and peripheral motor control of the palatal muscles.

Materials and methods

Fifteen healthy subjects (4 women, 11 men) were included. Their mean age was 30 years (range: 22—45). Ten subjects were right-handed and five subjects were left-handed. Handedness was assessed based on seven everyday tasks, which were writing, eating with a spoon, cutting with a knife, brushing one's teeth, throwing an object, and using scissors or a comb. The subjects who did not carry out all these tasks with the same hand were excluded from the study. The volunteers were hospital staff, medical students, or companions of patients referred to our center. No financial compensation was provided for participation in the study. They had no history, symptoms, or signs of neurological, psychiatric, or systemic disorders, and had no chronic medication use.

The motor cortex was stimulated using a large circular coil (90 mm diameter with a peak output of 2 T, Type 9784, Magstim Co., Carmarthenshire, UK) connected to a monophasic magnetic stimulator (Magstim 200, Magstim). For each subject, the position of the coil was optimized to produce palatal MEPs of maximal amplitude, i.e. approximately centered 2—6 cm lateral and 1—4 cm anterior to the vertex, with coil handle pointing backwards [1]. Stimulation of the left hemisphere was performed with the side A of the coil visible (anticlockwise direction of the coil current and clockwise direction of the induced tissue current) and stimulation of the right hemisphere was performed with the side B visible (current flow in the opposite direction to side A visible). In addition to cortical stimulation, we performed peripheral stimulation of the cranial nerves innervating the palate by positioning the circular coil over the parieto-occipital region (the bottom of the coil overlying the mastoid, the handle pointing antero-laterally), as previously described [1].

Palatal MEPs were recorded (bandpass filter 20 Hz—2 kHz) using pre-gelled disposable adhesive surface electrodes (ref. 9013S0242, Alpine Biomed, Skovlunde, Denmark) in a bipolar montage. After having gently dried the palate, the electrodes were first positioned 2 cm apart at the midline of the palatal dimple, the active electrode anteriorly [1]. In a second set of experiments, four electrodes were positioned laterally, two on each side of the palate (Fig. 1).