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ScienceDirect

Procedia - Social and Behavioral Sciences 193 (2015) 228 – 233

Procedia
Social and Behavioral Sciences

10th Oxford Dysfluency Conference, ODC 2014, 17 - 20 July, 2014, Oxford, United Kingdom

Neurophysiologic Markers of Motor Speech Related Cortical Areas

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Abstract

This is a unique study describing the methods for eliciting neurophysiologic markers of the primary motor cortex (M1) for laryngeal muscles and premotor cortex of inferior frontal gyrus (Broca's area).The neurophysiologic markers were elicited by: (a) navigated transcranial magnetic stimulation (nTMS) in a group of healthy participants, (b) direct cortical stimulation (DCS) in a group of patients during standard awake craniotomy treatment. The findings of this study are of particular importance for pathophysiologic studies aimed at understanding the mechanisms of motor speech disorders (stuttering).

Peer-review under responsibility of the Scientific Committee of ODC 2014.

Keywords: motor speech areas; neurophysiologic markers; magnetic stimulation; electrical stimulation

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Peer-review under responsibility of the Scientific Committee of ODC 2014.
doi:10.1016/j.sbspro.2015.03.264

1. Introduction

The primary motor cortex (M1) for laryngeal muscles has a role in execution and motor speech control, while the posterior inferior frontal gyrus, namely Broca's area, is regarded as an important motor speech cortical area which has a role in all stages of word encoding and their unification as well as sending coded ''commands'' to M1.

Short latency response (SLR)recorded in laryngeal muscles is elicited by electrical and/or magnetic stimulation of the M1 for laryngeal muscles in a group of healthy subjects and patients (Deletis, Fernandez-Conejero, Ulkatan, Costantino, 2009; Deletis et al., 2011; Espadaler et al., 2012). SLR corresponds/equals to corticobulbar motor evoked potential, and can be regarded as a neurophysiologic marker of M1 for laryngeal muscles. Additionally, Amassian, Anziska, Cracco, Cracco & Maccabee (1988) and Ertekin et al., (2001) recorded long latency response (LLR) in laryngeal muscles by magnetically stimulating prefrontal cortices, but without determining the exact origin of the response.

M1	primary motor cortex
SLR	short latency response
LLR	long latency response
nTMS	navigated transcranial magnetic stimulation
DCS	direct cortical stimulation
MEP	motor evoked potential
APB	abductor pollicisbrevis
SEP	somatosensory evoked potential
EMG	electromyography
PWS	people with stuttering

Box 1.Nomenclature

Developed methodology for detection of neurophysiologic markers of motor speech related cortical areas (M1 for laryngeal muscles and Broca's area) could be applied for the first time for testing cortical excitability in people with stuttering (PWS).Intra-cortical excitability of these motor speech related cortical areas has not been investigated in PWS. The most frequently studied region is non-specific speech area, the hand motor representation studied by a few groups of investigators (Sommer, Wischer, Tergau& Paulus, 2003; Sommer et al., 2009; Busan et al., 2009; Busan et al., 2013; Alm, Karlsson, Sundberg & Axelson, 2013). Only two groups studied intra-cortical excitability of a more "specific" M1 region for speech, namely M1 for tongue motor representation (Neef, Paulus, Neef, von Gudenberg, Sommer, 2011; Barwood et al., 2013).

2. Objectives

The aim of this study was to identify neurophysiologic markers of M1 and premotor cortex of inferior frontal gyrus (Broca's area), by magnetically and electrically stimulating these cortical areas and recording evoked responses from laryngeal muscles.

3. Methods and healthy subjects/patients

Ten right-handed healthy participants (three male and seven female, median age of31, range 22-66 years) underwent navigated transcranial magnetic stimulation (nTMS), and eighteen right handed patients(ten male and eight female, median age of 46, range 27-68 years)with tumors in the left hemisphere, underwent direct cortical