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研究課題名(和文) Correlation between brain activity and articulatory movement during speech in cleft lip/palate

研究課題名(英文) Correlation between brain activity and articulatory movement during speech in cleft lip/palate

## 研究代表者

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研究成果の概要(和文)：CLP患者における発音時の中枢神経基盤及び末梢器官運動の関連性を解明することを目的としてfMRI及びMRI movie双方を用いた。

結果：代償性構音を有する患者と有さない患者における発音時の解析を行ったその結果、健常者と構音障害を有さないCLP患者では末梢運動パターンならびに脳賦活パターンも類似した結果が認められたが、構音障害を有するCLP患者においては両者ともに異なるパターンを示した。

研究成果の概要(英文)：The overall goal of this study was undertaken to demonstrate the importance of the versatile evaluation of articulatory function in cleft lip and palate (CLP) from central and peripheral perspectives, using fMRI and MRI movie technique.

Following results were obtained; the peripheral movements of the articulators and cortical activation were similar in brain activation pattern between subjects with and without CLP, however the activation patterns for articulation was different between subjects with CLP with compensatory misarticulation, however is not related with the presence or type of CLP.

研究分野：顎顔面矯正学分野

キーワード：cleft lip and palate fMRI MRI movie overt articulation covert articulation

## 1 . 研究開始当初の背景

Subjects with CLP receive many surgical interventions to acquire normal craniofacial function, including articulation. As a result of surgery on oral and facial structures, subjects with CLP suffer from velopharyngeal insufficiency, poorly developed labial muscles, and three-dimensional deviation of the palate with a collapsed maxillary dental arch. Compensatory movements referred to as misarticulation (CMA) may also be seen, even after speech therapy.

In our pilot study findings, published in international peer-reviewed journals have suggested that there is a central mechanism for controlling articulators that may be closely related to peripheral movements, which a CLP with CMA showed differences movement pattern of the peripheral organs compared with healthy subjects (ref. 1).

## 2 . 研究の目的

Therefore, our purposes are to:

(1) To clarify the mechanical dysfunction by delineating the detail movements of speech articulators (lips, tongue and soft palate) in real time. The MRI movie technique was adapted for our institution; it offers an important technical advantage to fast capture detailed information of the organs in movement. Even when an ultrafast MRI sequence is used a minimum of up to 100 ms is needed to construct an image, this duration allows for unexpected motion of the target and results in contamination by noise and/or blurring. In contrast, using the MRI movie technique with short time resolution and good image quality, the next step after the technique implementation were to capture the 3D imaging for MRI movie to simultaneously visualize the movement of oropharyngeal structures, lateral and posterior pharyngeal walls during speech in a subject with

CLP using a non-invasive method. Applying the advances in MRI technology we have reduced the acquisition time and the number of repetitions required by the subject to achieve satisfactory spatial resolution with an appropriate time of resolution.

(2) To search the cause of the speech articulation disorders by comparing the brain activity during speech articulation between CLP and the normal subjects. The cortical activation pattern may be affected of cleft that is related to hypofunction of the sensory innervation of the scar tissue of the lip and palate. Brain activation associated with the same experimental speech protocol was obtained with functional MRI (fMRI). Brain activation patterns were analyzed for a small corpus of speech utterances that differ in a given sound and associated oral movement.

And (3) help to improve their rehabilitation, by using advanced MRI techniques.

## 3 . 研究の方法

(1) MRI movie technique: Custom-made circuitry was connected to a MRI apparatus to enable an external trigger pulse to control the timing of the scanning sequence and to provide an auditory cue for synchronization of the subject's utterance. Images were obtained by scanning 7 sagittal planes from the midline. The subjects (non CLP and CLP with CMA and without CMA) repeated a vowel-consonant-vowel syllable (i.e., /aka/).

(2) fMRI technique: We compared brain activation patterns during overt (O-task) and covert (C-task) articulation using functional magnetic resonance imaging. A 1.5T scanner provided T2\*-weighted gradient echo-type echo planar images. Participants (non CLP and CLP with CMA and without CMA) produced the same velar plosive /ka/ used for MRI movie, in a normal

tone (O-task) or in their mind (C-task).

#### 4 . 研究成果

(1) MRI movie: Articulatory movements in the midsagittal, horizontal and coronal planes were observed in a volumetric image of the 3-D MRI movie. Visualizing the articulation in sagittal plane the dorsum of tongue elevate to contact the palate and the soft palate elevate move backward contacting the posterior pharyngeal wall to produce the consonant sound of /k/. At the same time, the lips contact during rest on coronal view and during horizontal view the lateral and posterior pharyngeal wall were practically unmoving in non CLP volunteers and CLP without CMA. However in patient CLP with CMA those movements differ, the tongue don't elevate to produce the consonant, but move backward, the soft palate present short length and the lateral and posterior pharyngeal wall present a compensatory movement to produce the velopharyngeal closure. This technique represents an alternative dynamic image examination for videofluoroscopy and also nasoendoscopy because there is the possibility to navigate through the vocal tract, and the possibility to cut the image in different axes and levels. By adding fine MR images of the anatomical details of the lips, tongue and velopharyngeal structures, functional knowledge derived from 3D MRI movie could be applied to a wide range of pathological conditions.

(2) fMRI: In the O-task, motor-related areas including the premotor and primary sensorimotor cortices and the cerebellum were activated in CLP participants without CMA, which generally resembled the activation patterns in non CLP participants. Conversely, the posterior cingulate gyrus, but not motor-related areas, was activated in a CLP participant with CMA.

In the C-task, there were no significant differences in the activation patterns between participants.

It appears that there is little difference in the CNS for motor imaginary of articulation (C-task) between participants. However, there may be significant differences in the central nervous system (CNS) for execution of articulation (O-task) between participants with and without CMA irrespective of the presence of CLP.

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#### 5 . 主な発表論文等

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[ 雑誌論文 ] ( 計 3 件 )

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〔図書〕(計 件)

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〔その他〕

ホームページ等

6 . 研究組織

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