Proton MR Spectroscopy of the Primary Moter Cortex and Supplementary Motor Area in Parkinson's Disease.

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Synopsis

To investigate whether there are significant changes in regional brain metabolism in patients with Parkinson¯s disease after thalamotomy using proton magnetic resonance spectroscopy (1H MRS). NAA/Cr (or, NAA/Cho) ratios showed generally normal levels in the primary motor cortex (M1) and supplementary motor area (SMA) in Parkinson¯s disease patients with clinical improvement following thalamotomy. Our results suggest that NAA/Cr (or, NAA/Cho) ratios may not be a valuable criterion for evaluation of Parkinson¯s disease patients with the clinical improvement following surgery.

Abstract

To investigate whether there are significant changes in regional brain metabolism in patients with Parkinson's disease after thalamotomy using proton magnetic resonance spectroscopy (^{1}H MRS). NAA/Cr (or, NAA/Cho) ratios showed generally normal levels in the primary motor cortex (M1) and supplementary motor area (SMA) in Parkinson's disease patients with clinical improvement following thalamotomy. Our results suggest that NAA/Cr (or, NAA/Cho) ratios may not be a valuable criterion for evaluation of Parkinson's disease patients with the clinical improvement following surgery. Functional connectivity between the thalamus and other motor-related regions, such as the M1 and SMA might also not be reflected by the changes in metabolism after thalamotomy in the brain.

Introduction

In recent years, there has been an increasing interest in the stereotactic neurosurgical treatment of Parkinson's disease (1, 2). In the post-levodopa era, stereotactic thalamotomy has been reconsidered as a viable alternative in the treatment of parkinsonian tremor (3, 4). The pathophysiology of thalamic ablation for the relief of Parkinsonism, however, is not completely understood, and little information is available about changes in regional brain metabolism after thalamotomy in Parkinson's disease. Clinical improvement of Parkinsonian tremor after thalamotomy might be reflected by the changes in brain metabolism on ^{1}H MRS. Functional connectivity between the thalamus and other motor-related regions, such as the basal ganglia and the motor cortex might also be reflected by the changes in metabolism after thalamotomy in the brain. The purpose of this study is to investigate the utility of ^{1}H MRS in demonstrating metabolic changes of M1 and SMA after stereotactic thalamotomy in patients with Parkinson's disease.

Materials and Methods

Fifteen patients with Parkinson's disease of mean age 56.5 years (7 males and 8 females; mean age, 56.5 years) and mean disease duration 7.7 years (range 2-15 years) that have treated with levodopa were included. All patients with tremor experienced amelioration of their symptoms on the side contralateral to the thalamotomy. Complete abolition of tremor occurred in 87% (13/15) patients with significant improvement of tremor in additional two patients. In vivo ^{1}H MRS study was performed on a 1.5 T MRI system (GE Signa Advantage, version 4.8) using STEAM sequence after water suppression with CHESS RF pulse and dephasing gradients. As a single-voxel technique, ^{1}H MR spectra were obtained from the volume of interested regions in M1 and SMA of Parkinson's patients. Spectral parameters were: 20 ms TE, 2000 ms TR, 128 averages, 2500 Hz spectral width, and 2048 data points. Raw data were processed by the SAGE data analysis package. Peak areas of NAA, Cr, Cho, Ins, and sum (Glx) of γ-Amino butyrate (GABA) and glutamate were calculated by means of fitting the spectrum to a summation of Lorentzian curves using a Marquardt algorithm. After blindly processed, we calculated the metabolite ratios of NAA/Cho, NAA/Cr, Cho/Cr, Ins/Cr, and Glx/Cr. Ratios are given as the mean ± SD. Statistical significance was determined using Student's paired t-tests between control subjects and patients with Parkinson's disease, where $p<0.05$ was considered significant.

Results

Compared with age-matched controls, substantial difference of NAA/Cr (or, NAA/Cho) ratios from the voxels of region of interests in Parkinson's disease patients was not observed [1.41 ± 0.22 (or, 1.61 ± 0.29), 1.43 ± 0.28 (or, 1.63 ± 0.33)]. In all patients with clinical improvement following thalamotomy, NAA/Cr (or, NAA/Cho) ratios were not statistically established ($p > 0.05$) from the selected voxels in M1and SMA. Thus, NAA/Cr (or, NAA/Cho) ratios showed generally normal levels in M1 and SMA in Parkinson's disease patients with clinical outcome following thalamotomy.

Discussion

The results of this study indicated no postoperative metabolic changes of NAA/Cr (or, NAA/Cho) ratios in M1 and SMA of the hemisphere that did undergo surgery. Thus, the metabolic changes were not established in Parkinson's disease patients with clinical improvement. These changes didn't be consistent in both thalamus and motor cortex contralateral to the most affected side. Therefore, the surgical changes induced by thalamotomy may not directly affect the specific regional brain networks associated with clinical manifestations of parkinsonism. In conclusion, the present study suggests ^{1}H MRS may be a useful modality for the aid in better understanding the pathophysiologic process in patients. Indeed, an understanding of the functional basis for surgical response may have great importance in the design of new treatment strategies for Parkinson's disease and related disorders. It is necessary to investigate the MR spectral alterations after a long-term follow-up examination in patients with Parkinson's disease for further detail analysis.

Reference

1. Jankivic J, et al. Neurosurgery 37:680-686 (1995).
2. Lang AE, et al. N Engl. J Med 337:1036-1042 (1997).
3. David P, et al. Radiology 212:143-150 (1999).
4. Fox MW, et al. Neurosurgery 36:1118-1127 (1995).