Neurocognitive Mapping in Parkinson's disease and supranuclear palsy for Sustained Phonation and Phoneme Tasks

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Introduction: Parkinson's disease (PD) is associated with movement disorders. In addition, speech defects like inability to maintain loudness of voice, abnormalities of speech production, and syntactic comprehension has been associated with PD. In Progressive Supranuclear Palsy (PSP), mixed type of dysarthria with variable degrees of spasticity, hypokinesia, and ataxia is common in addition to movement disorders [1,2]. Functional imaging studies of motor and cognitive functions have shown abnormalities in the frontostriatal loop and increased recruitment of other cortical networks in patients with PD [3]. No study has studied this aspect in PSP patients. This study aimed to elucidate the basis of speech disorders in parkinsonian syndromes using functional magnetic resonance imaging (fMRI).

Materials and methods: Two groups of Hindi language speaking patients (22 PD and 18 PSP) were recruited from movement disorder clinic of AIIMS, New Delhi. Ten age-matched healthy controls were recruited from the employee population of the institute. History, physical examination and speech assessment were done by a neurologist. All imaging studies were performed on a 1.5-tesla MR imaging system (GE Medical Systems, Milwakee, WI). The anatomical images were acquired using T1- and T2-weighted sequences. EPI sequence (Slice thickness 3mm, TR 5.0s, TE 75.0 ms, FOV 230 mm, and resolution 64x64) was used to acquire four para-axial slices covering the areas of interest of the brain. BOLD imaging was carried out using EPI sequence with two experimental block-design speech paradigms of six alternate on-off cycles, with six measurements each. In the first paradigm, patient was required to say 'aah' (sustained phonation) and in the second, 'pathataka' (phoneme task). Pre-processing and post processing were performed using SPM2 software. Group analysis was carried out using one-way t-test. The variation between the two groups was estimated using two-way t-test.

Results and Discussion: Data from only 8 patients with PD, 7 patients with PSP and 6 healthy controls were considered for analysis, with acceptable motion parameters (<±1.5mm, <±1°). For sustained phonation paradigm, superior temporal gyrus area was activated in PD patients, and occipital cortex in PSP subjects in comparison to controls (Table 1). For phoneme paradigm, the patients with PD recruit lingual gyrus obviating the need for more efforts for the task. Wider areas as well as more clusters were activated in PD patients compared to controls (Fig. 1). Lingual gyrus was found to be strongly activated in PSP patients. Reduced activation of the primary areas with recruitment of remote areas was another prominent finding in PSP (Fig. 1). Good recruitment probably enables PD patient to speak loudly, comparable to the effect of voice therapy [4]. The different patterns of activation seen in patients with PD and PSP compared to age-matched healthy controls suggest a central basis for the speech dysfunction in extra-pyramidal disorders. The dysfunction of the executive loop in PD results in the spread of cortical activation to other areas. Widespread cortical dysfunction was evident in PSP.

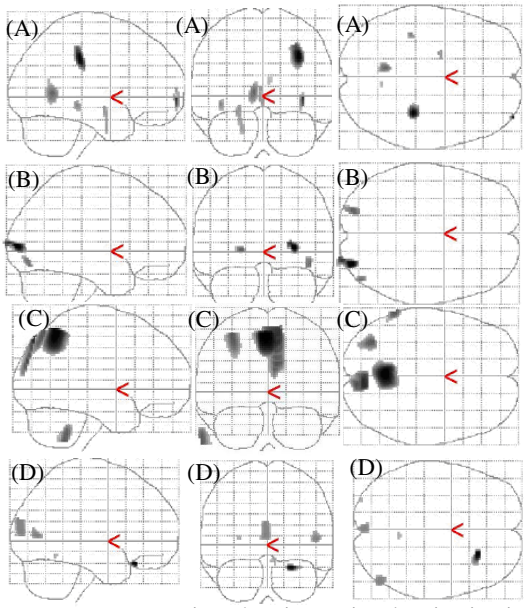

Figure 1. Glass brain view showing regional activation in a: (A) PD patient for sustained phonation, (B) PSP patient for sustained phonation, (C) PD patient for phoneme task and (D) PSP patient for phoneme task

Table 1. Group analysis results of fMRI in the three groups (control, PD, PSP);

Paradigm	Group	No. Clusters	Area of activation	Brodmann area
Sustained phonation	Control	50	Right Posterior Cingulate	30
		50	Right Cingulate gyrus	30
		50	Right Posterior cingulate	29
		42	Left Cingulate gyrus	30
		26	Left Cingulate gyrus	36
		7	Left Temporal lobe, fusiform gyrus	37
		11	Right Cuneus	17
		7	Left Superior temporal gyrus	22
	PD	229	Left Superior temporal gyrus, Left Cingulate gyrus	34, 35
	PSP	14	Left Inferior temporal gyrus	37
		2	Right Occipital lobe fusiform gyrus	19
		12	Right Cingulate gyrus	19
Phoneme task	Control	17	Right Middle temporal gyrus	21
		25	Left Temporal lobe Fusiform gyrus	20
	PD		No areas	
	PSP	60	Left Occipital lingual gyrus	18
		60	Left Occipital lingual gyrus	18
		5	Left Occipital fusiform gyrus	18

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