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Cortical Communication During Movement

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Introduction

Communication between distinct specialized regions of the cerebral cortex is likely to play a fundamental role in the normal functioning of the brain. How communication is initiated and terminated between cortical areas is an important aspect of this phenomenon and could play a role in pathological brain states such as Parkinson's disease. Deep brain structures may determine patterns of cortical communication through regulation of phase relationships at the level of the cortex.

Methods

We analyzed cortical data recorded from 39 subjects undergoing deep brain stimulation for essential tremor or Parkinson's disease (PD). Electrodes overlying sensorimotor cortex were identified using anatomic reconstruction and physiological approaches. Coherence, phase synchrony index and phase-amplitude relationships were analyzed during alternating epochs of rest and movement.

Results

PD subjects were grouped according to severity of rigid symptoms. Those with severe rigidity showed higher resting PSI, reduced PSI modulation and were unable to dynamically alter phase-amplitude relationships between sensorimotor cortical areas.

Conclusions

Phase-amplitude sensorimotor cortical relationships are crucial for permitting movement to take place. These modulatory events could represent the opening and closing of communication channels in the oscillatory fields of the cortex. Further study is required to ascertain the effects of DBS on these phase-amplitude relationships. Understanding how DBS affects these relationships could lead to more targeted and effective interventions in the patient cohort.

Learning Objectives

1. PD patients with severe rigidity are less able to alter sensorimotor phase amplitude relationships.

2. Coherence between motor and premotor cortices increases during movement.

3. Higher phase synchrony indices are associated with increased rigidity.