Comparison of Neural Activation in Chronic Migraine Patients During Optimal and Suboptimal Occipital Nerve Stimulation: A PET Imaging Study

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Introduction

Occipital nerve stimulation (ONS) is utilized to manage chronic migraine (CM) symptoms. Our knowledge of neural activity evoked during optimal (O-ONS) and suboptimal ONS (S-ONS) is limited, and in this study, we aim to elucidate the differences in central activation patterns during these stimulation conditions using functional PET imaging.

Methods

Five chronic migraine patients (Mean = 43.2±10 years) permanently implanted with ONS systems were categorized into high (HF;=50 Hz; n=3) or low (LF;<50 Hz; n=2) frequency responders based on their ONS frequency settings at enrollment (O-ONS). For S-ONS, HF responders were reprogrammed such that stimulation frequency was lower than 50 Hz, and vice-versa. An 18F-FDG PET/CT scan was performed for both O-ONS and S-ONS conditions. CM-related headache intensity was assessed using a numerical rating scale (NRS) prior to each scanning session. One -way ANOVA was utilized to compare the brain activity between the two stimulation settings.

Results

Headache intensity increased by an average of 70% during the S-ONS condition in 4/5 patients (no change in 1 patient). During the O-ONS condition, increased activity was observed bilaterally in the cerebellum as well as in the right cuneus. In contrast, during the S-ONS condition increased activity was observed in the bilateral anterior cingulate, superior frontal, temporal cortices, and pons.

Conclusions

Difference in central activation by optimal and suboptimal ONS for migraine in this study echoes functional imaging studies demonstrating persistent dysfunctional activity in pons, as well as increased activity during headache attacks in orbitofrontal area, anterior cingulate cortex, and insular/temporal area involved in anticipation and fear/anxiety towards perceived pain. Cerebellum is also found to be involved in pain modulation previously. Occipital nerve stimulation seems to decrease migraine-related headache intensity by modulating activity in areas involved in processing the affective, emotional and cognitive aspects of pain as well as anticipation of pain.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of investigating central activation pattern of occipital nerve stimulation for migraine, 2) Discuss, in small groups which areas of brain are involved in migraine as well as anticipation, fear of pain, and emotional components of pain, 3) Identify possible locations of central pain processing that ONS maybe modulating.

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