Distance Between Anode And Cathode Contacts Affects Electrical Impedance And Pulse Generator Longevity In Patients With Deep Brain Stimulation

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Introduction

Our aim was to evaluate whether the distance between the anode and cathode contacts used in the deep brain stimulation (DBS) electrode array is associated with changes in electrical impedance and alters implantable pulse generator battery longevity in patients with movement disorders.

Methods

We assembled a database of stimulation parameters in patients who underwent subthalamic and thalamic DBS for essential tremor and Parkinson's disease. This database also included individual electrode impedances measured during IPG interrogation in the outpatient setting. Based on the distance between anode and cathode electrode contacts used for routine care, the IPGs were subdivided into four categories: bipolar mode with contacts separated by 3, 6, and 9 mm and monopolar mode. We estimated IPG longevity across these groups using Kaplan Meier survival analyses, with statistical significance defined at p=0.05.

Results

In a sample of 240 IPGs where electrode impedances were measured, in bipolar stimulation configurations greater distance between anode and cathode contacts was associated with greater electrical impedance. Mean impedance was 1445.2 ohms for configurations with a 3mm contact distance, 1671.5 ohms for 6mm contact distance, and 1753.6 ohms for 9 mm contact distance. Bipolar stimulation configurations were associated with greater electrical impedance than monopolar configurations, for which the mean impedance was 1172.2 ohms. In a sample of 267 patients, median battery longevity with bipolar DBS were 44.1 [31.1, 62.6], 58.1 [43.4, 60.9], and 86.6 [70.8, 104.6] months for anode and cathode contacts separated by 3, 6, and 9 mm, respectively (median and 95% confidence interval, p=0.02, log rank test). Regardless of the distance between anode and cathode contacts, bipolar stimulation was associated with greater pulse generator battery longevity than monopolar stimulation (59.0 [50.2, 71.5] versus 45.1 [35.3, 48.9] months, p<0.001, log rank test).

Conclusions

Bipolar DBS with more widely spaced anode and cathode contacts was associated with greater electrode impedance and battery longevity than both bipolar mode with narrowly spaced adjacent contacts and monopolar stimulation. Optimization of DBS programming strategies and electrode design could be applied to decrease morbidity and expense associated with surgical replacement of expired pulse generator batteries.

Learning Objectives

After this presentation, attendees should understand the relationship between bipolar stimulation distance and battery longevity in DBS.