



Clinical Study

Impact of advancing age on post-operative complications of deep brain stimulation surgery for essential tremor



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ARTICLE INFO

Article history:

Received 30 July 2014

Accepted 3 November 2014

Keywords:

Age

Deep brain stimulation

Complications

Essential tremor

ABSTRACT

Essential tremor (ET) was the original indication for deep brain stimulation (DBS), with USA Food and Drug Administration approval since 1997. Despite the efficacy of DBS, it is associated with surgical complications that cause sub-optimal clinical outcomes. Given that ET is a progressive disease with increase in symptom severity with increasing age, this study evaluated the impact of increasing age on short-term complications following DBS surgery for ET. The Thomson-Reuters MarketScan database was utilized (New York, NY, USA). Patients selected were over age 18 and underwent DBS for ET between the years 2000 and 2009. Multivariable logistic regression analysis was used to calculate complication odds ratios (OR) for a 5 year increase in age, after controlling for other covariates. Six hundred sixty-one patients were included in the analysis. The mean (standard deviation) age was 61.9 (14.3) years, with 17% of individuals aged ≥ 75 years. Overall 56.9% of patients were male, and 44.6% had a Charlson Comorbidity Score of ≥ 1 . Additionally, 7.1% of patients experienced at least one complication within 90 days, including wound infections (3.0%), pneumonia (2.4%), hemorrhage or hematoma (1.5%), or pulmonary embolism (0.6%). Increasing age was not significantly associated with the overall 90 day complication rates (OR 0.89; 95% confidence interval [CI] 0.77–1.02; $p = 0.102$). The risk of the two most common procedure-related complications, hemorrhage and infection, did not significantly increase with age (hemorrhage: OR 1.02; 95%CI 0.77–1.37; $p = 0.873$; and infection: OR 0.88; 95%CI 0.72–1.07; $p = 0.203$). Our findings suggest that age should not be a primary exclusion factor for determining candidacy for DBS and also suggest a possible expansion of the traditional therapeutic window since post-operative complications remained relatively stable.

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1. Introduction

Essential tremor (ET) is one of the most common movement disorders in the USA with an estimated prevalence of up to 5% [1–3]. ET is characterized by postural and action tremor involving the upper extremities and less commonly the lower extremities, head and voice [4]. This causes significant functional disability in affected patients [5,6]. Due to the adverse effects and time-dependent loss of efficacy, medical management for ET has been associated with sub-optimal outcomes [4,7,8]. For ET patients with advanced and medically refractory symptoms or with complications to medical therapy, deep brain stimulation (DBS) of the ven-

tral intermediate (VIM) nucleus of the thalamus has been shown to dramatically reduce tremor-associated disability [9–11]. The safety, efficacy, adjustability, reversibility of adverse effects and non-destructive nature of DBS has driven its widespread adoption, replacing brain lesioning, with efficacy comparable to thalamotomy [12,13]. However, as with any surgical intervention, DBS is associated with potential peri- and post-operative complications such as infection, hemorrhage/hematoma and pneumonia [14].

The existence of comorbidities such as hypertension and diabetes in elderly patients creates an increased baseline risk of surgical complications following DBS for ET. The increased prevalence of ET in patients over 60 years [2,9] brings further importance to the impact of advancing age on DBS outcomes. With as many as 15–25% of ET patients being forced into early job retirement [15], there is a need for novel insights into the role of DBS on outcomes in

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elderly patients seeking surgical management for this exceedingly disabling pathology. Currently, there is a paucity of data addressing this paradigm. Given that the prevalence of ET increases nearly 10-fold with age [1–3], together with the aging USA population, we evaluated the step-wise impact of increasing age on short-term complications following DBS surgery. We hypothesized that increasing age would be associated with an increase in post-operative complications.

2. Methods

2.1. Data source

Data for the study were obtained using the Thomson-Reuters MarketScan database (New York, NY, USA). The MarketScan database contains claims records from employers, health plans, government, and public organizations for over 158 million patients in the USA since 1996. For this study, we used the Commercial Claims and Encounters, the Medicare Supplemental and Coordination of Benefits, and the Medicaid databases within MarketScan. In MarketScan, each patient is assigned a unique, encrypted enrollee identification number that can be used to link patient information across different tables. For this study, all patient data from the years 2000 to 2009 were examined including inpatient admissions, inpatient services, outpatient services, outpatient pharmaceuticals, and enrollment tables representing all available subsections of the MarketScan database.

2.2. Study sample

Diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM]) and procedure (CPT) codes were used to identify patients diagnosed with ET (ICD-9-CM: 333.1) having undergone DBS (ICD-9-CM: 02.93; CPT-4: 61683, 61687 or 95961) for inclusion in the study. Only patients 18 years and older at the time of the index hospitalization were retained for the analysis.

2.3. Main outcome measures

For purposes of describing the population, patients were divided into 5 year epochs, ranging from <50 up to 90 years of age. Primary outcomes were the overall complication rate and also, specifically, pneumonia, post-operative infection, pulmonary embolism, and intracranial hemorrhage or hematoma within 90 days after surgery.

2.4. Statistical analysis

In statistical models, age was analyzed as a continuous variable. Mortality, lead removal or revision, and generator removal or revisions within 90 days from surgery were summarized but only descriptive statistical analysis was performed. Univariable and multivariable logistic regression models were constructed to evaluate the impact of age on 90 day post-operative complications. Multivariable models were adjusted for Charlson Comorbidity Index (dichotomized as 0 or ≥ 1), insurance type (Medicare, Medicaid, or commercial), and sex. Possible nonlinear effect of age was examined by including terms in the models, but tests for nonlinearity were not statistically significant. Statistical significance was defined by $p < 0.05$. All analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Patient cohort

A total of 661 patients met the inclusion criteria and underwent DBS for ET between 2000 and 2009. Demographic characteristics of the cohort are listed in Table 1. The mean (standard deviation) patient age was 61.9 (14.3) years, with 17.1% of individuals aged ≥ 75 . Overall, 56.9% of patients were male, and 44.6% had a Charlson Comorbidity Score of ≥ 1 . The majority of the patients had either commercial (43.9%) or Medicare (47.2%) insurance. Figure 1 shows the distribution of ET patients with or without DBS surgery across all the age groups. The majority of patients (119) were ≤ 50 years old, with an overall trend towards decreased DBS intervention with advancing age.

Overall, 7.1% of patients experienced at least one complication within 90 days of surgery. The most common complication observed within 90 days was wound infection (3.0%), followed by pneumonia (2.4%), hemorrhage or hematoma (1.5%), and pulmonary embolism (0.6%). Within 90 days, lead replacement or revision was performed for 0.3% of patients and generator removal or revision in 1.1% of patients. Additionally, 2.0% of patients had a length of stay following surgery greater than 1 day and only one (0.2%) patient died within 90 days of DBS. The distribution of 90 day post-operative complications is summarized in Table 2.

3.2. Multivariate analysis

After adjusting for covariates (sex, Charlson score and insurance type), increasing age ranging from <50 to 90 years was not significantly associated with overall 90 day complication rates (odds ratio [OR] 0.89 per 5 year increase; 95% confidence interval [CI] 0.77–1.02; $p = 0.102$). The two most common procedure-related complications, hemorrhage and infection, were not significantly associated with older age (hemorrhage: OR 1.02; 95%CI 0.77–1.37; $p = 0.873$; and infection: OR 0.88; 95%CI 0.72–1.07;

Table 1
Baseline demographic characteristics of patients with essential tremor

	Overall
Patients	661 (100.0)
Age	
Mean (SD)	61.9 (14.3)
Median (Q1, Q3)	63.0 (55.0–72.0)
Age group	
≤ 50	119 (18.0)
50 to <55	57 (8.6)
55 to <60	91 (13.8)
60 to <65	97 (14.7)
65 to <70	87 (13.2)
70 to <75	97 (14.7)
75 to <80	76 (11.5)
80 to <85	31 (4.7)
85 to <90	6 (0.9)
Sex	
Male	376 (56.9)
Female	285 (43.1)
Charlson Score	
0	366 (55.4)
≥ 1	295 (44.6)
Insurance type	
Commercial	290 (43.9)
Medicaid	59 (8.9)
Medicare	312 (47.2)

Data are presented as number (%) unless otherwise indicated. Q1 = quartile one, Q3 = quartile three, SD = standard deviation.

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