Gait & Posture 52 (2017) 205–210

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Review

Subthalamic nucleus stimulation and gait in Parkinson's Disease: a not always fruitful relationship

Giovanni Cossu[a], Massimiliano Pau[b,*]

[a] "G. Brotzu" General Hospital, Department of Neurology, Cagliari, Italy
[b] Department of Mechanical, Chemical and Materials Engineering, University of Cagliari, Cagliari, Italy

ARTICLE INFO

Article history:
Received 30 July 2016
Received in revised form 19 November 2016
Accepted 24 November 2016

Keywords:
Deep brain stimulation (DBS)
Subthalamic nucleus (STN)
Parkinson's Disease (PD)
Gait
Kinematics

ABSTRACT

Deep brain stimulation (DBS) of the subthalamic nucleus (STN) provides efficient treatment for the alleviation of motor signs in patients with advanced Parkinson's disease (PD), but its specific effects on gait is sometimes less successful as it may even lead to an aggravation of freezing of gait. To better understand when axial symptoms can be expected to improve and when they may worsen or be resistant to STN-DBS, we propose here a narrative review that considers the recent literature evidences based on instrumental gait analysis data. Our aim is to report about the efficacy of STN-DBS on PD gait, analyzing the clinical and procedural factors involved, and discussing the strategies for optimizing such effectiveness in patients with advanced PD.

1. Introduction

In 1993, high frequency stimulation of the subthalamic nucleus (STN-DBS) was reported for the first time as an efficient tool for alleviating symptoms and improving levodopa (L-dopa)-induced motor complications [1], also allowing a significant decrease in dopaminergic drug treatment [2] in patients with advanced Parkinson's Disease (PD). While the efficacy of DBS on segmental motor symptoms, i.e. rigidity, tremor and appendicular akinesia, is well established, its effect on axial disability remains controversial [3–5]. Several authors report an improvement of posture, gait and balance control after globus pallidus interna (GPi) or STN-DBS, (with a greater improvement with STN-DBS) when these symptoms were responsive to levodopa treatment before surgery [6–20] even though such effects tend to taper-off with time [18–20]. Moreover, some authors suggest that STN-DBS may induce or aggravate freezing of gait and postural instability with falls in PD patients [3,5,21]. A comprehensive and detailed systematic review of the effects of STN-DBS or GPi on balance, gait initiation and automatic gait was recently proposed by Collomb-Clerc and Welter [22].

However, given the existence of the above mentioned non-linear effect, it appeared worthy of interest to examine the recent literature to evaluate the relationship between STN-DBS and gait from two distinct, but interrelated, perspectives: by analyzing the kinematic and biomechanical changes of gait induced by STN-DBS and identifying key variables that may affect the clinical outcome. For this purpose we present, in this narrative review, findings from a broad range of data, analyzing the mechanism of STN-DBS action on gait, briefly describing the state-of-the-art techniques that enable an accurate quantitative analysis of spatio-temporal and kinematic parameters during gait, and their use in studying the effects of DBS on gait control parameters. We also evaluate the different clinical and procedural factors that may impact on the effectiveness of surgery and discuss strategies for optimizing the effect of STN-DBS on gait issues and in patients with advanced PD.

2. Methods

The PUBMED, Scopus and Web of Science databases were searched for articles based on original scientific investigations concerning the effects of STN-DBS on gait published in the period 1993–2016. The search terms, which included several combinations of the keywords 'subthalamic deep brain stimulation', 'STN deep brain stimulation' and subthalamic DBS' with the keywords 'gait'; 'freezing' and 'falls'; yielded 452 related citations. However considering the nature of the present review – which analyzes some aspects associated with STN-DBS either still partly unexplored or under debate and privileges the studies in which gait was assessed using state-of-the-art techniques for human movement analysis (i.e. three-dimensional gait analysis performed using motion capture systems or other devices widely used for the

* Corresponding author at: Department of Mechanical, Chemical and Materials Engineering, University of Cagliari, Piazza d'Armi, 09123 Cagliari, Italy.
E-mail address: massimiliano.pau@dimcm.unica.it (M. Pau).

http://dx.doi.org/10.1016/j.gaitpost.2016.11.039
0966-6362/