A Submammarian Approach for Cosmetically Improved Implantation of Deep Brain Stimulation Generators

Ralf Stroop[1,2], Frank Holms[3], Makoto Nakamura[2], Ralph Lehrke[1]

■ BACKGROUND: **Deep brain stimulation (DBS) indications include movement disorders, psychiatric affections, or epilepsy in which patients risk social isolation heightened by abnormal motions or behavioral patterns. Further stigmatization after DBS surgery from head shaving, visible scarring, or disfigurement from bulky lead insertion points should be avoided.**

■ OBJECTIVE: **We present a cosmetically optimized, adapted submammarian approach for DBS neurostimulator implantation that leaves the décolletage untouched.**

■ METHODS: **Over 24 months, 61 patients suffering from Parkinson disease, dystonia, or tremor underwent DBS surgery. The modified, submammarian approach was compared with the conventional infraclavicular approach regarding clinical outcome, complications, and limitations over a 5-year follow-up.**

■ RESULTS: **Neurostimulators were implanted in a paraumbilical ($n = 20$) or infraclavicular position ($n = 41$; Parkinson disease, $n = 27$; dystonia, $n = 9$; tremor, $n = 5$), the latter using a standard ($n = 16$), modified juxta-axillary ($n = 6$), or submammarian approach ($n = 19$; 18 women, 1 man with significant gynecomastia). After 12 months, there was no significant difference in the infection rate and one event of rebleeding in each group. Overall, operation time was longer (+20 minutes) for the submammarian versus standard, infraclavicular approach, but acceptable. Neurostimulator replacement was, necessary within 5 years due to advanced battery discharge ($n = 32$). Battery replacement was easily achieved using the submammarian approach ($n = 14$), again with increased surgical time (+20 minutes), and iatrogenic damage to extensions was avoidable.**

■ CONCLUSIONS: **A submammarian approach might be an alternative for infraclavicular implantation of DBS neurostimulators, particularly in female patients in the context of cosmetically optimized surgery. Patients' self-perception and self-esteem may be strengthened, potentially enabling them to better cope with disease.**

INTRODUCTION

Deep brain stimulation (DBS) was introduced in 1987, and the surgical procedure is now routine after implantation of more than 100,000 patients worldwide.[1,2] Movement disorders are the most frequent indications for DBS, including idiopathic Parkinson disease (PD), with refractory severe motor fluctuations even under optimized antiparkinsonian drugs[3] (most effective cerebral targets are the subthalamic nucleus, globus pallidus internus or, for tremor-dominant PD, the ventrointermediate nucleus[4,5]), primary dystonia (usually generalized or focal, juvenile or adult, commonly targeting the globus pallidus internus[6]), or tremor (e.g., essential tremor, Holmes tremor, encephalitis disseminata or PD, targeting the ventrointermediate nucleus[7]). Potential new indications[8] include mental disorders (e.g., depression, obsessive–compulsive disorders,[9] Tourette syndrome,[10] anxiety disorders[11]), dependency,[12] pain,[13] intractable forms of epilepsy,[14] and even Alzheimer disease.[15]

Common to all of these indications is the fact that patients have suffered severely for a long period of time and run the risk of sustained social isolation boosted by striking, accentuated motions, or behavioral patterns.[16] One of the expectations for DBS is that in addition to improvements in motor symptoms and mental disability, there may also be a significant reduction in psychological strain and renewed hope for social reintegration.[17] Therefore, it is crucial that DBS surgery will cause as little

Key words
- Aesthetic surgery
- Deep brain stimulation
- Positive self-perception
- Submammarian approach

Abbreviations and Acronyms
DBS: Deep brain stimulation
IMF: Inframammary fold
PD: Parkinson disease

From the [1]Department of Stereotactical Neurosurgery, Barbara-Hospital, Hamm; [2]Department of Neurosurgery, Academic Hospital Cologne-Merheim, Cologne; and [3]Department of Gynaecology and Obstetrics, St. Barbara-Hospital, Hamm, Germany

To whom correspondence should be addressed: Dr. Ralf Stroop, M.Sc. [E-mail: ralf@stroop.de]

Citation: World Neurosurg. (2017). https://doi.org/10.1016/j.wneu.2017.10.057

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

scarring as possible and not adversely affect a patient's appearance.[18] A body that is perceived to be mostly physically intact supports patients' self-esteem and enables them to cope more easily with their disease.[19]

Therefore, our surgical strategy for DBS surgery has been optimized to consider the cosmetic appearance of DBS. Although newer neurostimulators are smaller in size, they remain inherently bulky and may cause a significant bulge under the skin. Thus, positioning is important. Standard locations for the implantation of a 2-channel DBS pulse generator are typically a one-sided subcutaneous/epifascial infraclavicular position or the abdominal paraumbilical position. Via the use of a standardized surgical technique, generator implantation is either performed immediately after electrode insertion or, after a period of temporary electrode externalization for evaluation procedures, within a few days.[20,21] Less often, a bilateral single-channel generator will be implanted, for example, if the implantation of a second electrode or even of a second pair of electrodes is necessary during the course of the disease (e.g., if tremor reduction in subthalamic nucleus-stimulated PD is insufficient). In rare cases, implantation of 2 less bulky single-channel generators might be considered.[22]

The lifespan of the neurostimulator must also be considered. The overall lifetime of nonrechargeable neurostimulators is limited because of their falling battery capacity. Even for rechargeable devices (Activa RC [Medtronic, Inc., Minneapolis, Minnesota, USA], Vercise [Boston Scientific, Marlborough, Massachusetts, USA], Brio [St. Jude Medical, St. Paul, Minnesota, USA]), lifespan may be restricted to a predefined period. The endurance of nonrechargeable generators depends on the impulse duration, frequency, and voltage used for stimulation, as well as the electrode impedances. In dystonia or psychiatric disorders, in which greater stimulation voltages are usually required and in which DBS surgery often will be performed in younger patients, frequent surgical exchange of generators may be necessary, which has an impact when planning the implantation site for the neurostimulator.

The paramedian abdominal position may be favored for very slender patients, in whom infraclavicular implantation would project too much and be cosmetically displeasing; however, discomfort can occur if the generator comes into contact with the iliac crest or the rip bow while stooping or sitting down. An abdominal generator position also may be favored because a long distance to the cranial lead insertion point may restrict potential infection and prevent the infection travelling to the leads if it occurs at the generator pouch.[23] Infraclavicular aggregate implantation is advantageous in terms of maintaining free moving space. However, an infraclavicular approach to implantation of a DBS pulse generator risks extension into the décolletage, designated a "no-go" area (as in breast surgery) as it can be uncomfortable, is associated with a risk of scarring keloids (Figure 1), and may even be a reason for a female patient to refuse DBS surgery. Therefore, we describe a new approach using an infraclavicular position via a submammarian approach, allowing cosmetically improved implantation of a DBS neurostimulator (Figure 2).[24,25] Cosmetically advantageous submammarian approaches have already been described previously for the implantation of cardiac pacemakers, implantable cardioverter defibrillators, and spinal cord stimulators, providing high patient acceptance and long-term satisfaction, with few complications.[26-28]

METHODS

Patient Enrollment

Over 24 months, 61 patients suffering from movement disorders such as PD, dystonia, or different tremor entities underwent DBS surgery at the Department of Stereotactical Neurosurgery at the St. Barbara-Hospital in Hamm, Germany. Neurostimulators were implanted in accordance with patient preference and based on informed consent, in a paraumbilical or infraclavicular position using one of three approaches: the conventional infraclavicular approach, a modified juxta-axillary access for an epifascial

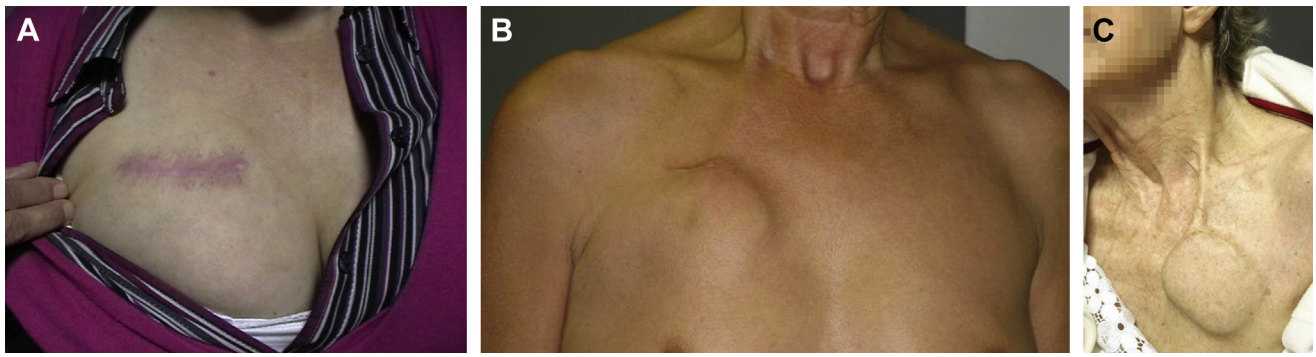

Figure 1. (**A**) Right infraclavicular generator implantation of a 46-year-old woman suffering from cervical dystonia, 6 months after surgery. Despite satisfactory stimulation, generator implantation was cosmetically poor, with inappropriate scarring and projection of the generator. (**B**) A 58-year-old patient with dystonia, with cosmetically inappropriate positioning of the neurostimulator. (**C**) Left infraclavicular generator implantation of a 74-year-old woman with Parkinson disease, 6 years after deep brain stimulation surgery. Due to the very slim habitus of the patient, infraclavicular implantation of the generator resulted in significant bulging of the skin and the generator position encroached into the décolletage.