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TECHNIQUE OF MICROELECTRODE INSERTION INTO THE SUBTHALAMIC NUCLEUS IN DEEP BRAIN STIMULATION FOR PATIENTS WITH PARKINSON'S DISEASE

321.21 NEUROSURGERY

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INTRODUCTION

Parkinson's disease (PD) is the second most frequent neurodegenerative disorder after Alzheimer's disease, with a prevalence of 1% in people over 60 years old and up to 4% by the age of 80 [1]. In the Republic of Moldova, estimates suggest around 12,000 patients, corresponding to a prevalence of 1–3% in the elderly population. Motor manifestations (tremor, rigidity, bradykinesia, postural instability) are commonly accompanied by non-motor symptoms with a major impact on quality of life. Pharmacologic therapy with levodopa and dopamine agonists is effective in the early stages, but in advanced phases motor fluctuations and dyskinesias emerge, significantly reducing benefits. In such cases, neurosurgical options become indispensable.

Deep brain stimulation (DBS), introduced in the 1990s, has become the reference method for managing PD refractory to medical treatment, with the subthalamic nucleus (STN) as the main target [2–4]. The accuracy of electrode placement is optimized by intraoperative microelectrode recording (MER), which enables real-time functional identification of the STN and complements stereotactic imaging data [5,6].

This work aims to evaluate the role of MER in DBS for PD, analyzing technical aspects, clinical effectiveness, and the implications of this method for safety and optimization of surgical management.

Topicality and significance of the topic

Because the success of subthalamic nucleus stimulation (STN-DBS) in PD depends critically on selecting the right patient and placing the electrode as precisely as possible, different approaches are currently used to optimize the process. Target localization can be determined by imaging methods or based on atlas coordinates, while the electrophysiological variability of the STN makes finding the optimal target a subject of debate among practitioners and researchers [7,8]. Some neurosurgeons rely exclusively on imaging, while others use complementary methods such as multiple microelectrode recording (mMER) and/or intraoperative local stimulation at the target area [9,10].

Despite advances in neuronavigation and modern imaging, MER remains the gold standard for intraoperative identification of the functional activity of the STN, especially in centers experienced in DBS. Multichannel recording (mMER) offers a three-dimensional approach that allows not only localization of the STN motor zone but also differentiation among functional compartments (sensorimotor, associative, and limbic)—an essential element for avoiding neuropsychiatric adverse effects.

In an era in which millimetric precision dictates clinical outcome and the incidence of complications, choosing the neurosurgical trajectory is a determinant of therapeutic result. A central versus lateral position of the DBS electrode can influence the rate of improvement of motor symptoms as well as the risk of complications—particularly intracranial hemorrhage and cognitive or behavioral adverse effects.

The lack of international consensus on the optimal trajectory strategy (centralized or decentralized), combined with individual variability of STN anatomy and the need to reduce surgical risks, makes this a topic of utmost relevance for functional neurosurgeons. The present

study addresses this need through a rigorous comparative analysis of the trajectory's impact on clinical outcome and on the incidence of complications, using an extended cohort and standardized recording and evaluation protocols.

Two main outcomes determine the procedure's success: stimulation efficacy and the incidence of adverse effects, especially symptomatic hemorrhage. There is a trend suggesting that a larger number of penetrations increases the risk of intracranial hemorrhage, though these comparisons have relied on data from different centers and involve many other factors, including implantation and planning techniques in addition to the use of mMER. While some studies indicate an increased hemorrhage risk [11,12], others found no significant difference in hemorrhage incidence between groups (no mMER, single MER, or Ben's Gun) [9]. De asemenea, riscul de sângerare pare să varieze în funcție de zona țintă, fiind cel mai mare pentru *globus pallidum intern*, mediu pentru STN și cel mai mic pentru *talamus* [10,13]. The bleeding risk also appears to vary by target region, being highest for the internal globus pallidus, intermediate for the STN, and lowest for the thalamus [10,13]. A 2001 analysis reported a mean of 3.8% ± 3.8 (mean ± SD) hemorrhages across 75 studies [14].

Clinical outcome is quantified objectively using the motor score of the Unified Parkinson's Disease Rating Scale (UPDRS), assessed exclusively under stimulation. In a small monocentric cohort, patients in whom mMER was used had better results than those without [15]. A double-blind study comparing mMER with single MER, based on UPDRS scores, documented improvements in some aspects of quality of life in the mMER group; in that small study, no hemorrhages were reported.

The aim of the study was to analyze the impact of the position of stimulation electrodes on clinical outcomes and on the safety of subthalamic nucleus deep brain stimulation in patients with Parkinson's disease, using intraoperative microelectrode recording (MER).

Research objectives:

1. Comparative analysis of global motor outcomes (UPDRS-III) in patients with bilateral electrodes implanted along centralized trajectories versus those with bilateral electrodes implanted along decentralized trajectories.
2. Clinical evaluation of patients with both electrodes in a central position versus patients with at least one electrode along a decentralized trajectory.
3. Analysis of clinical outcomes by assessing hemibody motor scores in relation to the position of the stimulating electrode (central vs. decentral).
4. Determination of the impact of the neurosurgical trajectory on the main cardinal motor symptoms of Parkinson's disease (akinesia, rigidity, tremor, postural instability and gait disturbance), in order to identify clinical response patterns.
5. Establishment of the incidence and structure of postoperative complications in the cohort under study, in the context of trajectory selection, and assessment of the correlation between the number of intracerebral MER penetrations and the occurrence of hemorrhagic complications.

6. Adaptation and integration of the microelectrode recording (MER) technique into neurosurgical practice as a stage of technological transfer and development of operative competence in deep brain stimulation.

RESEARCH METHODOLOGY

To achieve the stated aim and objectives, this observational-analytical research received approval from the Ethics Committee of Nicolae Testemițanu State University of Medicine and Pharmacy (minutes no. 60 of 01.06.2020). The study is a retro- and prospective cohort analysis of data collected from the database of patients treated in the Departments of Neurosurgery and Neurology of Universitätsklinikum Schleswig-Holstein, Kiel, Germany, during 1999–2018. With the patients' informed consent for scientific analysis of the data obtained, 981 medical records and intraoperative protocols were analyzed. The author of the research was present in the operating room for 60 cases and analyzed the results of all patients included in the study.

Inclusion criteria were idiopathic Parkinson's disease and treatment by STN-DBS surgery. General data such as age at surgery, disease duration, sex, timing of the intervention, as well as the micro- and macro-electrode positions (central, lateral, anterior, medial, posterior) were collected and analyzed. UPDRS scores before and after surgery were recorded, along with immediate postoperative complications.

For the population studied with regard to treatment effectiveness, patients with incomplete data, those lost to follow-up (beyond 3 months postoperatively), and patients with previous surgical interventions for Parkinson's disease were excluded. After applying these criteria, two working sub-cohorts were defined:

- **The safety cohort (n = 569)** that included all eligible patients with valid data on postoperative complications. This cohort was used to assess the incidence and typology of complications associated with STN-DBS, providing a solid basis for analyzing procedural risks in a large and heterogeneous sample.
- The efficacy cohort (n = 400) includes only patients with complete clinical charts, available pre- and postoperative UPDRS scores, and exact data on the trajectories used for each electrode. This cohort was used for detailed comparative analyses regarding the therapeutic efficacy of different trajectories (central vs. decentral), evaluation of motor symptoms, and differentiated hemibody response.

This two-cohort structure enabled a balanced methodological approach, maximizing statistical robustness for the safety analysis while ensuring precision and internal consistency in the detailed analysis of clinical efficacy.

Scientific novelty and originality

This research contributes original insights by integrating the evaluation of clinical efficacy and safety of deep brain stimulation (DBS) targeting the subthalamic nucleus, with emphasis on the influence of the surgical trajectory and the use of intraoperative microelectrode recording (MER). The novelty of the study consists of:

- Demonstrating the contribution of MER to increasing the precision of stimulator electrode placement, correlated with significant improvement of postoperative motor scores (UPDRS-III), thereby validating the use of this technique to optimize functional targeting in STN-DBS.
- A rigorous comparative analysis of centralized and decentralized trajectories and their influence on motor efficacy and the safety profile. The study shows that centralized trajectories associate with superior clinical improvement and a significant reduction in the risk of hemorrhagic complications, providing an objective basis for choosing the optimal trajectory in neurosurgical practice.

Dissemination of scientific results

Preliminary and final results of the research have been published as peer-reviewed articles, summaries, and abstracts.

The research has been presented at national and international conferences:

- **Jahrestagung der Sektion Stereotaxie und Radiochirurgie Congress, Hamburg, Germany, February 2019**
- **18th Biennial Meeting of The World Society for Stereotactic and Functional Neurosurgery (WSSFN), New York, United States of America, June 2019**
- **Congress dedicated to the 75th anniversary of the founding of "Nicolae Testemițanu" State University of Medicine and Pharmacy, Chișinău, 2020**
- **7th Congress of the Society of Neurologists Issue of the Republic of Moldova, Chișinău, Moldova, 16–18 September 2021**
- **National Conference of Modern Neurosciences "Parkinson's Disease and Other Movement Disorders," Iași, Romania, 6–8 April 2023**
- **International Congress of the European Association of Neurosurgical Societies, Sofia, Bulgaria, October 2024.**

Keywords: Parkinson's disease, PD, STN, DBS, MER, trajectory, central, decentral, complications, hemorrhage, subthalamic nucleus, deep brain stimulation, micro-electrode recording.

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SUMMARY OF CHAPTERS

CHAPTER 1 includes a comprehensive analysis of current scientific materials relevant to the thesis topic, concerning the theoretical foundation of techniques for inserting microelectrodes into the subthalamic nucleus for deep brain stimulation in patients with Parkinson's disease.

Parkinson's disease (PD) is the second most common neurodegenerative disorder worldwide, with a prevalence of 1% in individuals over 60 years old and up to 4% by 80 years of age [16]. The etiology of this complex disease involves the convergence of genetic susceptibility (mutations in SNCA, PARK2, PINK1, DJ-1, LRRK2) and toxic-environmental exposures (pesticides, solvents, heavy metals), leading to pathological aggregation of alpha-synuclein as

Lewy bodies, mitochondrial dysfunction, and impairment of protein-degradation systems. These pathogenic processes cause progressive degeneration of dopaminergic neurons in the substantia nigra pars compacta, with consequent striatal dopamine deficiency [17].

The basal ganglia circuitry—comprising the striatum, globus pallidus (external and internal), subthalamic nucleus (STN), and substantia nigra—plays a fundamental role in motor control. In PD, dopamine deficiency disrupts the balance between the direct pathway (mediated by D1 receptors) and the indirect pathway (mediated by D2 receptors), resulting in hyperactivity of the STN and internal globus pallidus, with excessive inhibition of the thalamus and motor cortex [18]. This functional disorganization manifests clinically through the classic motor triad: resting tremor (4–6 Hz), rigidity, bradykinesia/akinesia, and later postural instability [19].

Clinically, the disease typically begins unilaterally with a 4–6 Hz tremor that worsens with stress and disappears during sleep; bradykinesia becomes the most disabling feature (hypokinesia, micrographia, hypomimia), and rigidity may present as "cogwheel" or "lead-pipe" [20,21]. Over time, axial disturbances appear (short steps, "en bloc" turns), with freezing episodes and instability; the non-motor spectrum (hyposmia, autonomic dysfunction, sleep, affective, and cognitive disorders) can precede motor manifestations by years. Under dopaminergic therapy, fluctuations ("wearing-off," "on-off") and dyskinesias (peak-dose, diphasic, "off" dystonias) emerge—the classic signal that simple pharmacologic escalation is no longer sufficient.

Deep brain stimulation (DBS) has emerged as the reference neurosurgical method for advanced PD, revolutionizing management since the 1990s [22]. The history of functional neurosurgery shows evolution from initial ablative procedures (thalamotomies, pallidotomies) to modern reversible stimulation techniques, enabling bilateral treatment under improved safety. DBS devices have evolved from simple electrodes to sophisticated systems with directional leads and adaptive stimulation capabilities, optimizing therapeutic precision.

The effects of STN stimulation on motor symptoms are remarkable, with clinical studies demonstrating 40–75% improvements in UPDRS-III motor scores in the "off" state, a 30–60% reduction of levodopa dose, and significant amelioration of dyskinesias. Compared with traditional lesional procedures, DBS offers decisive advantages: reversibility, postoperative adjustability, the possibility of bilateral treatment, and a superior safety profile [23–25].

Candidate selection for DBS requires strict criteria: confirmed diagnosis of idiopathic PD with evolution ≥4 years, positive levodopa response ≥30% on the MDS-UPDRS-III, presence of disabling motor fluctuations and/or dyskinesias, absence of dementia, and control of medical comorbidities. The choice of anatomical target (STN vs. GPi vs. VIM) depends on the patient's symptom profile, with STN preferred for overall motor control and medication reduction, while GPi is prioritized for severe dyskinesias [26,27].

Intraoperative neuromonitoring via microelectrode recording (MER) is the gold standard for functional identification of the STN, enabling recognition of characteristic neuronal activity (irregular, burst-like signal of increased amplitude) and optimizing placement of the electrode in the motor territory of the nucleus. Multichannel technique (mMER) offers three-dimensional mapping, reducing the risk of malposition and improving therapeutic outcomes [28,29].

DBS complications include surgical risks (intracranial hemorrhage 1–3%, infection 2–5%), hardware defects, and stimulation-related adverse effects (dysarthria, paresthesias, cognitive disturbances) [22,30]. Managing these complications requires multidisciplinary expertise and long-term monitoring.

The literature indicates that although DBS is a mature technique with validated clinical results, optimizing microelectrode insertion techniques and positioning strategies within the STN remains an active research area, justifying comparative studies to improve therapeutic outcomes and reduce procedural risks.

CHAPTER 2 describes the methodology.

The study has an observational-analytical design, with retrospective and prospective components, based on the Universitätsklinikum Schleswig-Holstein (Kiel) database for STN-DBS interventions performed between 1999 and 2018. Initial documentation included 981 charts and intraoperative protocols. For efficacy, a cohort of 400 patients with idiopathic PD and bilateral implantation with a complete set of standardized pre- and postoperative clinical data was constituted (Figure 1); for safety, an efficacy population of 569 patients was analyzed to evaluate complications. The research was approved by the ethics committee, and data were anonymized according to institutional norms.

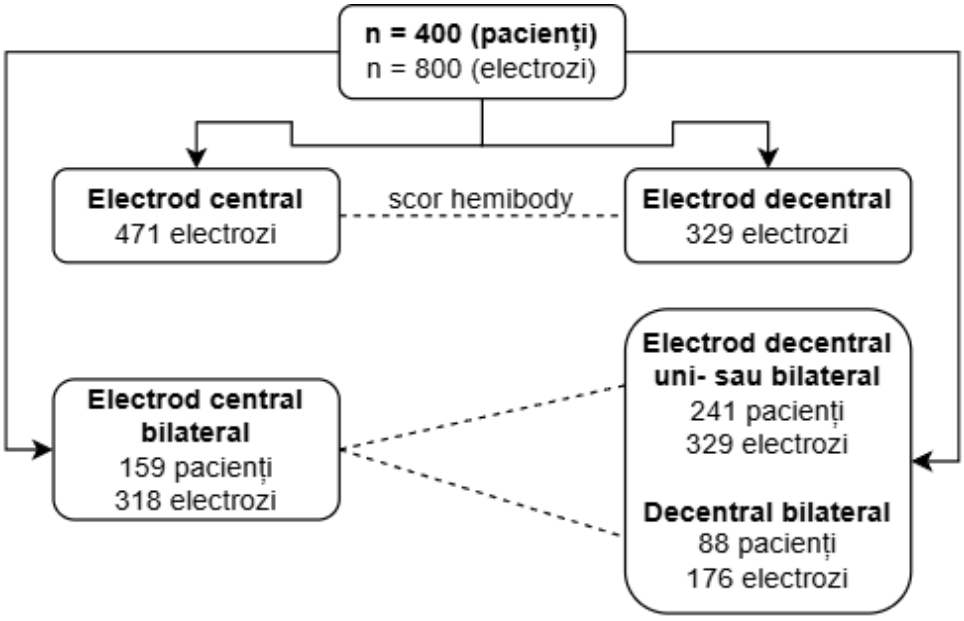

Figure 1. Flow diagram of patients examined

Inclusion criteria targeted clinically confirmed idiopathic PD, adult age, documented dopaminergic response, and neurosurgical eligibility. Exclusions comprised atypical parkinsonism, decompensated major neuropsychiatric comorbidities, insufficient clinical data, early revision procedures, or technical deviations that impeded postoperative localization of the electrode. Demographic (age, sex, disease duration), clinical (phenotype, severity), therapeutic (levodopa equivalent dose), and vascular variables (arterial hypertension, antiplatelet/anticoagulant treatments) were collected systematically.

Stereotactic targeting of the subthalamic nucleus was based on imaging planning (MRI/CT) with pre-/postoperative fusions and neurophysiologic guidance through microelectrode recording (MER) in a Ben-Gun configuration (3–5 parallel channels). MER enabled functional mapping of the STN, identification of the dorsolateral "sensorimotor" margin, and selection of the trajectory with optimal signal; intraoperative macrostimulation was used for clinical validation (motor thresholds, therapeutic window, adverse effects), in line with current practice. Final fixation of the electrodes was followed by control CT and CT/MRI fusion to confirm position.

Trajectory classification was performed postoperatively by localizing contacts relative to the STN and a functional atlas: "central" when contacts corresponding to the analyzed hemisphere projected to the dorsolateral (sensorimotor) STN territory; "decentral" when the main projection was outside of it (lateral/medial/anterior/posterior). For bilaterally implanted patients, three categories were defined: bicentral (both hemispheres central), bidecentral (both hemispheres decentralized), and mixed (one central, one decentralized). The number of intracerebral penetrations (per hemisphere and per patient) and technical parameters (microelectrode type, depths, active channels) were recorded systematically.

Clinical evaluation included UPDRS-III in standardized states (OFF medication/ON stimulation for the DBS effect on motor function), lateralized hemibody scores (items 20–26) and subdomains (tremor, rigidity, akinesia, PIGD) at 3–12 months postoperatively, in accordance with CAPSIT-PD recommendations. ADL/QoL and levodopa equivalent dose were collected to quantify therapeutic changes. In the safety cohort, events were operationally defined: symptomatic/asymptomatic intracranial hemorrhage (imaging-confirmed), system-related infective/mechanical complications (pocket, lead, IPG), and other perioperative events; antithrombotic prophylaxis and management were recorded.

The primary efficacy endpoint was the absolute and percentage change in UPDRS-III (global and per hemibody) by trajectory position (central vs. decentral, including symmetric comparisons bicentral vs. bidecentral). Secondary endpoints included analysis of motor subdomains, dynamics of dopaminergic doses, and correlations between contact position and clinical response. For safety, the primary endpoint was the association between the number of penetrations and intracranial hemorrhage; secondary endpoints: the complication profile by trajectory and other clinico-technical factors.

Statistical analysis included tests of normality and mean comparisons (t-test/ANOVA or nonparametric alternatives), tests for proportions (χ^2/Fisher), and multivariate models to adjust for confounders (age, sex, severity, hypertension, dopaminergic doses, electrode type, number of penetrations). Effects were reported with confidence intervals, effect-size measures, and significance threshold $p<0.05$, with robustness checks (subgroup analyses bicentral vs. bidecentral; sensitivity excluding "mixed" cases). Missing data were handled by list-wise exclusion when proportions were small or simple imputation for auxiliary variables, without altering key outcome variables.

Quality assurance included UPDRS scoring by trained raters with standardized procedures and internal checks; postoperative localization followed a single workflow (CT/MRI fusion, atlas, contact projection), and the database included audit logs for the sequence of steps (planning, MER,

macrostimulation, fixation, imaging control). Procedures and definitions sought to minimize selection and information bias so that trajectory comparisons would reflect as faithfully as possible the contribution of position to efficacy and of technique to safety.

CHAPTER 3 is dedicated to the stages of the DBS neurosurgical intervention.

The STN-DBS intervention followed a standardized protocol focused on functional placement of the electrode and risk control. Preoperative planning combined high-resolution MRI with stereotactic CT, with fusion to define the target and safe trajectories; anatomical references were verified against functional atlases and major vascular landmarks to minimize traversal of risk areas. Targeting explicitly aimed at the dorsolateral (sensorimotor) STN territory, and alternative trajectories (medial, lateral, anterior, posterior) were planned from the outset to allow selection according to intraoperative signal. The procedure was usually performed with the patient awake/minimally sedated to allow rapid clinical testing during mapping and macrostimulation.

Neurophysiologic guidance was based on MER in a Ben-Gun configuration (3–5 parallel channels), with controlled advancement toward the STN and characterization of activity patterns at entry/exit. Discharge density and background noise were used to delineate the dorsolateral pole; when the functional contour was uncertain or the main trajectory did not produce the expected signal, an adjacent channel was used, following a “stepwise proximity” rule to avoid large positional jumps. Concentric-bipolar macrostimulation along the same tracts served as clinical validation: the improvement threshold (rigidity/tremor/bradykinesia), the threshold for adverse effects (paresthesias, contractions, dysarthria), and the therapeutic window were noted; a wide window, with early motor effect and late adverse reactions, indicated a favorable trajectory.

Selection of the “final” trajectory followed a decision algorithm: (1) if MER and macrostimulation converged on a channel with robust STN signal and an adequate therapeutic window, that channel became the implant trajectory; (2) if the window was narrow or adverse effects appeared early, a neighboring channel (usually lateral or posterior) was tried with fine depth adjustment; (3) if the signal remained inconsistent or the anatomy suggested deviation from the target, planning was re-evaluated with reference to image fusion, accepting discontinuation of that channel to avoid additional penetrations without functional value. Throughout, a conservative threshold for the number of penetrations per hemisphere was maintained, prioritizing mapping quality over quantity. The selected trajectory was mechanically fixed, followed by control CT and CT/MRI fusion to confirm contact positions relative to the STN; only after confirmation was the intracranial stage closed.

Risk control was integrated throughout: strict blood-pressure management, careful hemostasis, gentle irrigation, minimization of pneumocephalus, standardized antithrombotic conduct (interruption/bridging according to patient profile), and anti-infective prophylaxis. Recording the number of penetrations per hemisphere/patient was mandatory, as was documenting periprocedural complications (symptomatic/asymptomatic hemorrhage, seizures, transient disturbances of consciousness) and hardware-related events (erosion, pocket infection, lead defects). The literature indicates that hypertension is a consistent risk factor for hemorrhage,

and the direct association “more penetrations = more risk” is heterogeneous across series; therefore, the decision to continue mapping on additional channels was made case by case, depending on signal quality and utility/risk balance.

Initial programming was performed at 2–4 weeks, after the microlesion effect subsided. The programming strategy started from contacts located in the dorsolateral STN, with conservative settings (high frequency, short pulse width) and gradual increases of amplitude, adjusted to symptoms and adverse effects. In the presence of neighborhood effects (paresthesias, dysarthria at low thresholds), adjacent contacts were used or, if needed, directional configurations with lateral steering to widen the therapeutic window; reduction of dopaminergic doses was undertaken only after motor response stabilization.

Data quality was ensured through written protocols for each stage (planning, MER, macrostimulation, fixation, imaging control, initial programming), standardized UPDRS-III scoring in defined states, and internal audit of fusions and contact projection.

CHAPTER 4 is dedicated to the analysis of surgical treatment outcomes.

This chapter presents the main results regarding the efficacy and safety of STN-DBS in relation to trajectory position (central vs. decentralized) and the number of intracerebral penetrations. Analyses were performed in two populations: the efficacy cohort (n=400; bilateral implants; standardized UPDRS-III clinical evaluations at 3–12 months in CAPSIT-PD states) and the safety cohort (n=569; hemorrhagic events and system complications). Trajectory classification was performed postoperatively through CT/MRI fusion and a functional atlas, defining bicentral, bidecentral, and mixed groups; for lateralized analyses, “hemibody” scores (items 20–26) were calculated.

In the efficacy population, the overall UPDRS-III improvement in the OFF-medication/ON-stimulation state was comparable between bilateral central and bilateral decentralized positioning. The mean difference did not reach statistical significance ($p \approx 0.56$ for the direct comparison bicentral vs. bidecentral) and remained non-significant in the contrast bicentral vs. “any position with ≥1 decentralized electrode” ($p \approx 0.52$) (Tables 1–2).

Table 1. Comparison of UPDRS scores between patients with both central and decentralized trajectories. (EoS: effect of surgery; UPDRS III: Unified Parkinson’s Disease Rating Scale; PIGD: Postural Instability and Gait Disorder)

	Bicentral (n = 159 patients)			**Bidecentral (n = 88 patients)**			
	preop Med_OFF Stim_OFF	**postop Med_OFF Stim_ON**	**EoS (%)**	**preop Med_OFF Stim_OFF**	**postop Med_OFF Stim_ON**	**EoS (%)**	**p**
	Mean ± SD						

UPDRS III	44.25 ± 12.08	24.83 ± 12.87	44.4 ± 22.71	40.31 ± 10.73	22.30 ± 8.81	43.22 ± 16.94	0.56
Akinesia	18.07 ± 6.41	10.19 ± 6.48	43.71± 29.29	16.22 ± 5.35	9.52 ± 4.49	39.91 ± 20.13	0.15
Rigidity	7.72 ± 3.71	3.35 ± 3.28	57.01± 32.39	7.26 ± 3.53	2.39 ± 2.05	64.86 ± 25.22	0.16
PIGD	8.23 ± 2.96	5.45 ± 3.15	32.37± 25.16	7.53 ± 2.67	4.67 ± 2.52	30.8 ± 23.27	0.6
Tremor	6.83 ± 5.65	2.92 ± 3.75	54.68± 51.5	6.17 ± 4.85	2. 7 ± 3.08	57.5 ± 38.98	1

Table 2. Comparison of UPDRS scores between patients with central electrodes and the rest of the population (unilateral or bilateral decentralized electrodes). (EoS: effect of surgery)

	Bicentral (n = 159)			**Uni/bidecentral (n = 241)**			
	Med_OFF Stim_OFF	**Med_OFF Stim_ON**	**EoS (%)**	**Med_OFF Stim_OFF**	**Med_OFF Stim_ON**	**EoS (%)**	**p**
	Mean ± SD						
UPDRS III	44.25 ± 12.08	24.83 ± 12.87	44.4 ± 22.71	40.65 ± 11.92	22.93 + 9.76	44± 17.28	0.5162
Akinesia	18.07 ± 6.41	10.19 ± 6.48	43.71 ± 29.29	16.32 ± 5.84	9.78 ± 5.04	42.26 ± 22.59	0.2389
Rigidity	7.72 ± 3.71	3.35 ± 3.28	57.01% ± 32.39	7.37 ± 3.66	2.64 ± 2.37	62.86 ± 27.03	0.1731
PIGD	8.23 ± 2.96	5.45 ± 3.15	32.37% ± 25.16	7.7 ± 2.93	5.03 ± 2.72	31.53 ± 23.03	0.6245
Tremor	6.83 ± 5.65	2.92 ± 3.75	54.68 ± 51.5	6.11 ± 5.3	2.73 ± 3.31	58.10 ± 38.67	0.93

Analyses by hemibody did not show lateral advantages of the "central" trajectory: contralateral motor scores relative to central vs. decentralized electrodes were similar (p≈0.83), and subdomains (akinesia, rigidity, tremor, PIGD) evolved in parallel, with p-value intervals of ~0.17 to 1.00.

Table 3. Comparison between centrally and decentralized placed electrodes using the UPDRS hemibody score.

	Central electrode (n = 471)			**Decentral electrode (n = 329)**			
	Med_OFF Stim_OFF	**Med_OFF Stim_ON**	**EoS (%)**	**Med_OFF Stim_OFF**	**Med_OFF Stim_ON**	**EoS (%)**	**p**
Hemi-score	14.32 ± 5.14	7.35 ± 4.57	49.83 ± 25.85	13.47 ± 5.02	7 ± 3.79	48 ± 22.87	0.22

The results remain stable after multivariate adjustments (age, disease duration, baseline severity, levodopa equivalent dose, electrode type) and in sensitivity analyses excluding "mixed" cases, underlining that fine position contributes mostly to ease of programming rather than to a measurable difference in short-term global motor score. The internal distribution of the cohort (159 bicentral, 88 bidecentral, 153 mixed)—a total of 800 trajectories (471 central, 329 decentralized)—provides sufficient power to detect moderate effects; the absence of a robust differential signal suggests that, in this cohort, centralization is not a major determinant of the magnitude of clinical response.

In the safety study, analysis of the extended population (n=569) found no robust association between the number of intracerebral penetrations and intracranial hemorrhage (symptomatic/asymptomatic). Technical variables (including Ben-Gun schema, mapping depths, microelectrode type) did not modify this absence of association consistently. Conversely, arterial hypertension behaved as a repeatable risk factor for hemorrhagic events, while age and sex showed no robust independent effects after adjustment. Hardware-related complications (erosion, pocket infection, lead defects) occurred at frequencies in line with the literature and were mostly manageable by revision or targeted treatment; stimulation-related events (paresthesias, dysarthria) predominantly resolved through reprogramming without impact on primary endpoints. These findings support a prudent strategy: prioritize mapping quality (MER + macrostimulation) and early decisions to abandon channels with narrow therapeutic windows, instead of "arithmetically" increasing the number of trajectories.

Overall, the results indicate that in a setting with standardized technique and rigorous programming, differences in central vs. decentralized position do not translate into statistical superiority on UPDRS-III (global or lateralized) at 3–12 months, while the safety profile is driven more by clinical factors (hypertension) than by the number of penetrations. This aligns with current practice of MER-guided pursuit of a clinically "good enough" trajectory without penalizing the patient through unproductive additional penetrations.

CONCLUSIONS

1. Comparative analysis of global motor clinical outcomes (UPDRS-III) shows that placing the electrode centrally in both hemispheres does not offer a statistical advantage over bilateral implantation along decentralized trajectories ($p = 0.557$); at the global score level, benefit is equivalent regardless of trajectory, provided stimulation is optimally programmed.
2. When the cohort with bilateral central positioning is compared with the entire population including at least one decentralized electrode, the difference in UPDRS-III improvement remains non-significant ($p = 0.516$); deviation of a single electrode from the ideal zone does not compromise overall efficacy, supporting flexibility of stereotactic approach in patients with variable anatomy.
3. Hemibody scores (UPDRS-III items 20–26) do not differ when the centrally stimulated side is compared with the decentralized side ($p = 0.825$); contact position does not yield a lateralized functional advantage.
4. Individual motor sub-scores show similar responses in akinesia, rigidity, and the axial component (PIGD) regardless of trajectory (p-values between 0.173 and 1.000); none of the cardinal symptoms evaluated is decisively influenced by the exact placement of contacts.
5. Symptomatic intracranial hemorrhage occurred in 1.05% of patients, without significant differences between central and decentralized vectors ($p > 0.05$); choice of trajectory does not change the safety profile. The number of microelectrode penetrations (mean 7.48 ± 2.14) correlates neither with motor improvement (Pearson coefficient = –0.08; $p = 0.434$) nor with hemorrhage risk ($p > 0.05$).
6. The implementation and use of the microelectrode recording (MER) technique enabled the development of operative competence and the standardization of technical steps in subthalamic nucleus deep brain stimulation (STN-DBS) procedures, contributing to increased procedural accuracy and to the consolidation of the methodological basis for applying DBS in neurosurgical practice.

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LIST OF PUBLICATIONS

- **Articles in ISI/SCOPUS-indexed journals and other international databases:**

1. Gavriliuc O., Paschen S., **Andrusca A**., Schlenstedt C., Deuschl G. Prediction of the effect of deep brain stimulation on gait freezing of Parkinson's disease. *Parkinsonism & Related Disorders*. 2021; 87:82-86. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2021.04.006 **(Scopus, IFISI: 3,9)**
2. Gavriliuc O., Paschen S., **Andrusca A**., Helmers AK., Schlenstedt C., Deuschl G. Clinical patterns of gait freezing and their response to interventions: an observer blinded study. *Parkinsonism & Related Disorders*. 2020; 80:175–180. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2020.09.043 **(Scopus, IFISI: 4,3)**
3. Gavriliuc O., Paschen S., **Andrusca A**., Helmers AK., Schlenstedt C., Deuschl G. Spin turns in advanced Parkinson's disease: a new clinical gait sign. *Parkinsonism & Related Disorders*. 2019; 69:19–22. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2019.10.011 **(Scopus, IFISI: 4,3)**

- **Articles in accredited national scientific journals:**

  - ✓ **Category B+ journals**

4. Gavriliuc O., **Andrușca A**., Popil L., Gavriliuc M. Low-dose anticholinergic therapy causes cognitive impairment in Parkinson's disease patients. *Moldovan Medical Journal*. 2021; Nr. 4(64) / 2021 / ISSN 2537-6373 / ISSNe 2537-6381

5. Gavriliuc O., **Andrușca A**., Gavriliuc M. Clinical indicators of gait freezing in Parkinson's disease. *Moldovan Medical Journal*. 2020; 63(2): 31-33. ISSN: 2537-6381. Disponibil online la: http://doi.org/10.5281/zenodo.3866002

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6. **Andrușca A**., Gavriliuc M., Zapuhlîh G., **Gavriliuc O**., Galearschi V. Stimularea cerebrală profundă în boala Parkinson și alte tulburări de mișcare. Buletinul AȘM. 2017; 5(57): 110-116. ISSN 1857-0011. Disponibil online la: https://old.asm.md/administrator/fisiere/editii/f58.pdf
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8. A. Caldarov, O. Gavriliuc, L. Rotaru, **A Andrușca**, P. Fala, M. Gavriliuc, Comorbidități la pacienții cu boala Parkinson. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale 71 (3), 30-34 2021

  - ✓ **Articles in other journals in the Republic of Moldova**

9. Fala P., Gavriliuc P., Andronachi V., **Andrușca A**., Gavriliuc O., Diagnosticul diferențiat al demenței în hidrocefalia normotensivă idiopatică. Buletinul Academiei de

Ştiinţe a Moldovei. Ştiinţe Medicale Nr. 3(71) / 2021 / ISSN 1857-0011, 2022

10. Gavriliuc O., Fala P., Gavriliuc M., **Andrușca A**. Tremorul esențial - criterii de diagnostic și modalități de tratament. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale, Nr. 3(71) / 2021 / ISSN 1857-0011, 2022

- **Abstracts in proceedings of international scientific conferences:**

11. **Andrușca A.,** Gavriliuc O., Synowitz M. , Paschen S. , Mehdorn M. , Falk D. , Deuschl G. , Helmers A-K. The role of microelectrode recording during Deep Brain Stimulation of Subthalamic Nucleus in patients with Parkinson's disease, *7th Congress of the Society of Neurologists Issue of the Republic of Moldova*

12. **Andrușca A.,** Gavriliuc O., Synowitz M. , Paschen **S.** Riscurile și beneficiile înregistrării cu microelectrod în chirurgia bolii Parkinson, Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină şi Farmacie „Nicolae Testemiţanu", 2020, Chișinău

13. Gavriliuc O**.** , Pashen S., **Andrusca A**., Schlenstedt C., Deuschl G. Predicting the influence of deep brain stimulation on Parkinson's disease gait freezing. *Movement Disorders.* Vol. 35, Suppl. S1, 2020

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15. Gavriliuc O**.**, Paschen S., **Andrusca A**., Berg D., Schlenstedt C., Deuschl G. Spin turns in advanced Parkinson' s disease: A new clinical gait sign. *Movement Disorders*. Vol. 34, Suppl. S2, 2019

16. O. Gavriliuc, **A. Andrușca**, M. Gavriliuc, Strategia de întoarcere spin în boala parkinson avasată: un nou semn clinic? Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină și Farmacie "Nicolae Testemițanu", 2020

17. O. Gavriliuc, S. Paschen, **A. Andrușca**, C. Schlenstedt, GD. Deuschl, Predicting the influence of deep brain stimulation on Parkinson's disease gait freezing,. Abstract book of European Academy of Neurology Congress, 1005-1005, 2020

18. **A Andrușca**, O Gavriliuc, M Synowitz, S Paschen, Riscurile și beneficiile înregistrării cu microelectrod în chirurgia bolii Parkinson Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină și Farmacie "Nicolae Testemițanu, 2020

19. O. Gavriliuc, **A. Andrușca**, M. Gavriliuc, I. Moldovanu, Postural disorders in Parkinson's disease and their response to interventions, MedEspera 8, 138-139, 2020

20. O Gavriliuc, S Paschen, **A Andrușca**, C Schlenstedt, GD Deuschl, Spin turns and step turns in advanced Parkinson's disease: a new clinical gait sign?, Abstract book of European Academy of Neurology Congress, 875-875, 2019

21. O. Gavriliuc, S. Paschen, **A. Andrușca**, C. Schlenstedt, GD Deuschl, Clinical patterns of gait freezing in Parkinson's disease and their response to interventions: an observer-blinded study Abstract book of European Academy of Neurology Congress, 874-874, 2019

22. O Gavriliuc, **A Andrușca**, HIV encephalopathy mimicking Huntington's Disease, Abstract book of European Academy of Neurology Congress, 675-675, 2018

- **Presentations at scientific meetings:**

  ✓ **International**

23. Andrusca A., M. Synowitz, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers " Risks and benefits of microelectrode recording for surgery in Parkinson's disease", European Association of Neurosurgical Societies 2024, Sofia, Bulgaria

24. Andrusca A., Cercetarea tehnicii de inserare a microelectrozilor în nucleul subtalamic în intervenția de stimulare cerebrală profundă la pacienți cu Boala Parkinson, Conferința Națională de Neuroștiințe Moderne "Boala Parkinson & Alte Tulburări de Mișcare, Iași, Romania, Aprilie 2023

25. Andrusca A., M. Synowitz, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers "Clinical outcome after STN-DBS-central versus decentral trajectory", Jahrestagung der sektion stereotaxie und radiochirurgie, 22-23 February, 2019, Hamburg, Germania

  ✓ **National**

26. A. Andrușca, O. Gavriliuc, M. Synowitz, S. Paschen, MH. Mehdorn, D. Falk, The role of microelectrode recording during Deep Brain Stimulation of Subthalamic Nucleus in patients with Parkinson's disease, 7th Congress of the Society of Neurologists Issue of the Republic of Moldova, 2021

27. Andrusca, M. Synowitz, S. Paschen, M. Mehdorn, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers „ Risks and benefits of microelectrode recording for surgery in Parkinson's disease", Oral presentation, Congress USMF "N. Testemitanu", 22 October 2020

28. Andrușca A, O. Gavriliuc, P. Gavriliuc, A. Andronachi "3D volume rendering for preoperative planning of neurosurgical interventions", Medespera, September 2020 (2nd place)

29. Andrușca A "Tehnica chirurgicala a stimulării cerebrale profunde în boala Parkinson", prezentator Workshop" Tulburări de mișcare" Congres USMF "N. Testemițanu", 23 Octombrie 2020

30. O. Gavriliuc, **A. Andrusca**. "Postural disorders in parkinson's disease and their response to interventions", Medespera, September 2020 (1st place)

31. P.Gavriliuc, P. Fala, **A. Andrusca**, Andronachi V. " Differential diagnosis of intracerebral haemorrhages. Cases from the institute of neurology and neurosurgery", Medespera September 2020.

32. Fala P., Andronachi V., Gavriliuc P., **Andrușca A.**, Gavriliuc O.. "Idiopathic normotensive hydrocephalus: systemic review", Oral Presentation, Congress USMF "N. Testemitanu", 22 October 2020

33. Gavriliuc O., **Andrușca A.**, Gavriliuc M.. "Spin-turn in Advanced Parkinson's Disease avasată: a new clinical sign?", Oral Presentation, Congress USMF "N. Testemitanu", 22 October 2020

- **Poster presentations at scientific meetings:**

  ✓ **International**

34. **Andrusca A**., "Outcome in STN-DBS in PD: central vs. decentral trajectory", The 18th Biennial Meeting of The World Society for Stereotactic and Functional Neurosurgery (WSSFN), New-York, United States of America, Iunie 2019
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36. **Andrusca A "** Treatment perspectives using deep brain stimulation in patients with Parkinson's Disease in the Republic of Moldova, World Fedarion of Neurosurgical Societies, Istanbul, Turkey, August 2017
37. **Andrusca A**., Gavriliuc O., Gavriliuc M., Treatment perspectives using deep brain stimulation in patients with Parkinson's Disease in the Republic of Moldova, The German International Congress on "Deep brain stimulation in brain disorders", Dusseldorf, Germany, martie 2016
38. **Andrusca A**., Gavriliuc O., Gavriliuc M., Treatment perspectives using deep brain stimulation in patients with Parkinson's Disease in the Republic of Moldova, "First Russian Congress of Functional and Stereotactic Neurosurgery," Moscow, Russia, martie 2016

✓ **National**

39. **Andrusca A**., International Medical Congress, 75 Years Anniversary USMF "Nicolae Testemitanu", Chisinau, Republic of Moldova, Octombrie 2020
40. O. Gavriliuc, S. Pashen, **A. Andrusca**, C. Schlenstedt, G. Deuschl. "Predictig the influence of deep brain stimulation on Parkinson's disease gait freezing." *Movement Disorders, Vol. 35, Suppl. S1, 2020*
41. Galearschi Vasile, Mindrigan Eugeniu, Andronachi Victor, **Andrusca Alexandru**, Preguza Ion. "Ultrasonografia intraoperatorie în chirurgia tumorilor cerebrale", Congress USMF, octombrie 2020.
42. **Andrușca A.,** Gavriliuc M., Gavriliuc O., Treatment perspectives using deep brain stimulation in patients with Parkinson's Disease in the Republic of Moldova, Clinical Neurophysiology 127 (9), e193-e194, 2016

LISTA PUBLICAȚIILOR LA TEMA TEZEI

- **Articole în reviste ISI, SCOPUS și alte baze de date internaționale:**

43. **A. Andrușca,** O. Gavriliuc, M. Synowitz, S. Paschen, M. Mehdorn, D. Falk, G. Deuschl, , A-K. Helmers Risks and benefits of microelectrode recording for surgery in Parkinson's disease, Journal of Neurology, Neurosurgery and Psychiatry (submission phase) (**Scopus**, **IFISI: 11,1)**
44. Gavriliuc O., Paschen S., **Andrusca A**., Schlenstedt C., Deuschl G. Prediction of the effect of deep brain stimulation on gait freezing of Parkinson's disease. *Parkinsonism & Related Disorders*. 2021; 87:82-86. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2021.04.006 (**Scopus**, **IFISI: 3,9)**
45. Gavriliuc O., Paschen S., **Andrusca A**., Helmers AK., Schlenstedt C., Deuschl G. Clinical patterns of gait freezing and their response to interventions: an observer blinded study. *Parkinsonism & Related Disorders*. 2020; 80:175–180. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2020.09.043 (**Scopus**, **IFISI: 4,3)**

46. Gavriliuc O., Paschen S., **Andrusca A**., Helmers AK., Schlenstedt C., Deuschl G. Spin turns in advanced Parkinson's disease: a new clinical gait sign. *Parkinsonism & Related Disorders*. 2019; 69:19–22. ISSN: 1353-8020. Disponibil online la: https://doi.org/10.1016/j.parkreldis.2019.10.011 (**Scopus**, **IF$_{ISI}$: 4,3)**

- **Articole în reviste științifice naționale acreditate:**

  - ✓ **articole în reviste de categoria B+**

47. Gavriliuc O., **Andrușca A**., Popil L., Gavriliuc M. Low-dose anticholinergic therapy causes cognitive impairment in Parkinson's disease patients. *Moldovan Medical Journal*. 2021; Nr. 4(64) / 2021 / ISSN 2537-6373 / ISSNe 2537-6381

48. Gavriliuc O., **Andrușca A**., Gavriliuc M. Clinical indicators of gait freezing in Parkinson's disease. *Moldovan Medical Journal*. 2020; 63(2): 31-33. ISSN: 2537-6381. Disponibil online la: http://doi.org/10.5281/zenodo.3866002

  - ✓ **articole în reviste de categoria B**

49. Andrușca A., Gavriliuc M., Zapuhlîh G., **Gavriliuc O**., Galearschi V. Stimularea cerebrală profundă în boala Parkinson și alte tulburări de mișcare. Buletinul AȘM. 2017; 5(57): 110-116. ISSN 1857-0011. Disponibil online la: https://old.asm.md/administrator/fisiere/editii/f58.pdf

50. Andrușca A., Gavriliuc M., Cercetarea perspectivelor de tratament prin metoda de stimulare cerebrală profundă la pacienții cu maladia Parkinson, Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale 47 (2), 45-50, 2015

51. A. Caldarov, O. Gavriliuc, L. Rotaru, **A Andrușca**, P. Fala, M. Gavriliuc, Comorbidități la pacienții cu boala Parkinson. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale 71 (3), 30-34 2021

  - ✓ **articole în alte reviste din RM**

52. Fala P., Gavriliuc P., Andronachi V., **Andrușca A**., Gavriliuc O., Diagnosticul diferențiat al demenței în hidrocefalia normotensivă idiopatică. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale Nr. 3(71) / 2021 / ISSN 1857-0011, 2022

53. Gavriliuc O., Fala P., Gavriliuc M., **Andrușca A**. Tremorul esențial - criterii de diagnostic și modalități de tratament. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţe Medicale, Nr. 3(71) / 2021 / ISSN 1857-0011, 2022

- **Rezumate/abstracte/teze în lucrările conferințelor științifice internaționale:**

54. Andrușca A., Gavriliuc O., Synowitz M. , Paschen S. , Mehdorn M. , Falk D. , Deuschl G. , Helmers A-K. The role of microelectrode recording during Deep Brain Stimulation of Subthalamic Nucleus in patients with Parkinson's disease, *7th Congress of the Society of Neurologists Issue of the Republic of Moldova*

55. Andrușca A., Gavriliuc O., Synowitz M. , Paschen **S.** Riscurile și beneficiile înregistrării cu microelectrod în chirurgia bolii Parkinson, Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină și Farmacie „Nicolae Testemițanu", 2020, Chișinău

56. Gavriliuc O**.** , Pashen S., **Andrusca A**., Schlenstedt C., Deuschl G. Predicting the influence of deep brain stimulation on Parkinson's disease gait freezing. *Movement Disorders.* Vol. 35, Suppl. S1, 2020

57. Gavriliuc O**.**, Paschen S., **Andrusca A**., Helmers AK., Schlentedt C., Deuschl G. Clinical patterns of gait freezing in Parkison's disease and their response to interventions: an observer-blinded study. *Movement Disorders.* Vol. 34, Suppl. S2, 2019

58. Gavriliuc O**.**, Paschen S., **Andrusca A**., Berg D., Schlenstedt C., Deuschl G. Spin turns in advanced Parkinson' s disease: A new clinical gait sign. *Movement Disorders*. Vol. 34, Suppl. S2, 2019

59. O. Gavriliuc, **A. Andrușca**, M. Gavriliuc, Strategia de întoarcere spin în boala parkinson avasată: un nou semn clinic? Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină și Farmacie "Nicolae Testemițanu", 2020

60. O. Gavriliuc, S. Paschen, **A. Andrușca**, C. Schlenstedt, GD. Deuschl, Predicting the influence of deep brain stimulation on Parkinson's disease gait freezing,. Abstract book of European Academy of Neurology Congress, 1005-1005, 2020

61. A Andrușca, O Gavriliuc, M Synowitz, S Paschen, Riscurile și beneficiile înregistrării cu microelectrod în chirurgia bolii Parkinson Congresul consacrat aniversării a 75-a de la fondarea Universității de Stat de Medicină și Farmacie "Nicolae Testemițanu, 2020

62. O. Gavriliuc, **A. Andrușca**, M. Gavriliuc, I. Moldovanu, Postural disorders in Parkinson's disease and their response to interventions, MedEspera 8, 138-139, 2020

63. O Gavriliuc, S Paschen, **A Andrușca**, C Schlenstedt, GD Deuschl, Spin turns and step turns in advanced Parkinson's disease: a new clinical gait sign?, Abstract book of European Academy of Neurology Congress, 875-875, 2019

64. O. Gavriliuc, S. Paschen, **A. Andrușca**, C. Schlenstedt, GD Deuschl, Clinical patterns of gait freezing in Parkinson's disease and their response to interventions: an observer-blinded study Abstract book of European Academy of Neurology Congress, 874-874, 2019

65. O Gavriliuc, **A Andrușca**, HIV encephalopathy mimicking Huntington's Disease, Abstract book of European Academy of Neurology Congress, 675-675, 2018

- **Participări cu comunicări la foruri științifice:**

  - ✓ **Internaționale**

66. Andrusca A., M. Synowitz, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers " Risks and benefits of microelectrode recording for surgery in Parkinson's disease", European Association of Neurosurgical Societies 2024, Sofia, Bulgaria

67. Andrusca A., Cercetarea tehnicii de inserare a microelectrozilor în nucleul subtalamic în intervenția de stimulare cerebrală profundă la pacienți cu Boala Parkinson, Conferința Națională de Neuroștiințe Moderne "Boala Parkinson & Alte Tulburări de Mișcare, Iași, Romania, Aprilie 2023

68. **Andrusca A.,** M. Synowitz, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers "Clinical outcome after STN-DBS-central versus decentral trajectory", Jahrestagung der sektion stereotaxie und radiochirurgie, 22-23 February, 2019, Hamburg, Germania

✓ **Naționale**

69. **A. Andrușca,** O. Gavriliuc, M. Synowitz, S. Paschen, MH. Mehdorn, D. Falk, The role of microelectrode recording during Deep Brain Stimulation of Subthalamic Nucleus in patients with Parkinson's disease, 7th Congress of the Society of Neurologists Issue of the Republic of Moldova, 2021
70. **Andrusca,** M. Synowitz, S. Paschen, M. Mehdorn, O. Gavriliuc, D. Falk, D. Günther, A.-K. Helmers „ Risks and benefits of microelectrode recording for surgery in Parkinson's disease", Oral presentation, Congress USMF "N. Testemitanu", 22 October 2020
71. **Andrușca A,** O. Gavriliuc, P. Gavriliuc, A. Andronachi "3D volume rendering for preoperative planning of neurosurgical interventions", Medespera, September 2020 (2nd place)
72. **Andrușca A** "Tehnica chirurgicala a stimulării cerebrale profunde în boala Parkinson", prezentator Workshop" Tulburări de mișcare" Congres USMF "N. Testemițanu", 23 Octombrie 2020
73. O. Gavriliuc, **A. Andrusca**. "Postural disorders in parkinson's disease and their response to interventions", Medespera, September 2020 (1st place)
74. P.Gavriliuc, P. Fala, **A. Andrusca**, Andronachi V. " Differential diagnosis of intracerebral haemorrhages. Cases from the institute of neurology and neurosurgery", Medespera September 2020.
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- **Participări cu postere la foruri ştiinţifice:**

✓ **Internaţionale**

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NEURONAVIGAREA PRIN REALITATE AUGMENTATĂ A INSERȚIEI ELECTROZILOR ÎN INTERVENȚIA DE STIMULARE CEREBRALĂ PROFUNDĂ

Inovaţia a fost înregistrată pe data de
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Se recunoaşte calitatea de autor(i)

ANDRUȘCA Alexandru,
GROPPA Stanislav, ZAPUHLÎH Grigore

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OPTIMIZAREA PROCEDURII DE INSERȚIE A MICROELECTROZILOR ÎN NUCLEUL SUBTALAMIC PENTRU STIMULAREA CEREBRALĂ PROFUNDĂ ÎN TRATAMENTUL BOLII PARKINSON

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UTILIZAREA SUBSCALII UPDRS-III PENTRU EVALUAREA EFICACITĂȚII INTERVENȚIEI DE STIMULARE CEREBRALĂ PROFUNDĂ LA PACIENȚII CU BOALA PARKINSON

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ANNOTATION

The doctoral thesis *"technique of microelectrode insertion into the subthalamic nucleus in deep brain stimulation for patients with Parkinson's disease"* explores the relationship between surgical electrode trajectory and both clinical efficacy and safety in subthalamic nucleus deep brain stimulation (STN-DBS), emphasizing the intraoperative use of microelectrode recording (MER). This observational-analytical study included 981 patients operated between 1999 and 2018 at the Universitätsklinikum Schleswig-Holstein, Kiel. Of these, 400 patients were analyzed for clinical efficacy and 569 for procedural safety, based on UPDRS motor scores and lateralized assessments.

Patients were divided into two main subgroups: L1 "bicentral" (both electrodes centrally placed) and L0 "bidecentral" (both decentralized), with additional hemisphere-level analyses. The results revealed no statistically significant differences between groups in UPDRS-III improvement (≈44% in both), med_OFF/stim_ON values, or motor sub-scores (akinesia, rigidity, gait/postural instability). Deviation of one electrode from the central trajectory did not compromise overall clinical benefit.

Safety analysis showed no correlation between the number of trajectories or brain penetrations and the incidence of intracranial hemorrhage. The overall complication rate was comparable to international benchmarks, confirming that MER-guided targeting, when performed by experienced teams, does not increase hemorrhagic risk.

The study concludes that the choice between centralized and decentralized trajectories provides no statistical advantage in motor outcomes or sub-scores, provided that postoperative programming is optimized. Microelectrode recording remains justified as the intraoperative functional gold standard for accurate subthalamic nucleus identification, enhancing targeting precision while maintaining procedural safety.
Keywords: Parkinson's disease, STN, DBS, MER, trajectory, UPDRS-III, complications, hemorrhage.