Advances in functional neurosurgery: Surgical techniques for neurological disorders and anesthetic complications

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ABSTRACT

Advances in functional neurosurgery have revolutionized the treatment of neurological disorders, offering techniques such as rhizotomy and chordotomy for the relief of chronic pain. Despite their benefits, the anesthetic risks and complications associated with these procedures should be considered. In this sense, the choice of technique should be based on a careful evaluation of the available treatment options. This study aimed to study advances in the surgical techniques of functional neurosurgery for the treatment of neurological disorders and to examine the anesthetic complications associated with these procedures. The methodology of this research was based on a systematic review of the literature to examine advances in the surgical techniques of functional neurosurgery and the associated anesthetic complications. The search was carried out in the Medical Literature Analysis and Retrieval System Online (MEDLINE), Latin American and Caribbean Literature on Health Sciences (LILACS) and Public Medline (PubMed) databases, using specific descriptors selected by consulting the BIREME Health Sciences Descriptors (DECs). After initial analysis of titles and abstracts, 4 articles met all the inclusion criteria and were analyzed qualitatively. Based on the analysis of the results, it was concluded that, although advances in the surgical techniques of functional neurosurgery have improved the safety and efficacy of the procedures, the management of anesthetic complications remains essential. Multidisciplinary collaboration is crucial to maximize the benefits of neurosurgery and minimize the associated risks. However, the application of these advances may be limited in contexts with inadequate resources.

Keywords: Functional neurosurgery, Neurological disorders, Anesthetic complications.

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INTRODUCTION

Functional neurosurgery is an ever-evolving field that seeks to intervene in the neurophysiological mechanisms underlying various disabling neurological conditions. With the advancement of surgical techniques and the introduction of minimally invasive approaches, functional neurosurgery has been shown to be an effective alternative for the treatment of neurological disorders, especially those related to chronic and neuropathic pain (Conti; Olive tree; Pereira, 2024).

Among the main surgical techniques used in functional neurosurgery, rhizotomy, chordotomy, and myelotomy stand out. According to Rodrigues *et al.* (2024), rhizotomy, for example, involves the section or ablation of nerve roots to relieve chronic pain, and is often indicated in patients with refractory neuropathic pain who do not respond to conservative treatments. This technique is particularly effective in cases of trigeminal neuralgia, where inflammation of the fifth pair of cranial nerves causes intense episodes of facial pain. Chordotomy, in turn, is performed in the lateral spinothalamic tract, affecting the fibers responsible for pain and temperature perception, providing significant relief for patients with chronic pain.

Despite the advances and benefits of these interventions, the associated risks and complications should be considered. Anesthetic complications and side effects of surgical techniques can vary depending on the type of procedure and the nerves involved. For example, according to Silva (2022), glycerin rhizotomy can result in nausea, vomiting, infections, and sensory changes, while radiofrequency rhizotomy can cause weakness, dizziness, and more serious complications, such as meningitis and spinal deformities. Therefore, careful evaluation of the patient's profile and the conditions for performing the procedure is essential to minimize risks and ensure adequate pain management.

In addition, the choice of surgical technique should be preceded by a careful analysis of the available treatment options. The use of analgesics, physiotherapy, and nerve blocks should be considered before opting for surgical interventions, ensuring that rhizotomy or other techniques are indicated only when conservative methods prove ineffective (Vaz, 2022).

Advances in functional neurosurgery have provided new hope for patients with neurological disorders, offering therapeutic options that can significantly improve quality of life. However, the complexity of the procedures and the potential associated risks require a careful and informed approach, where the medical decision should be based on the best available evidence and the individual needs of each patient (Barreto et al., 2022).

In this context, this study aimed to study advances in the surgical techniques of functional neurosurgery for the treatment of neurological disorders and to examine the anesthetic complications associated with these procedures.

The relevance of this study is understood because continuing education and research in the field are essential to improve surgical techniques and minimize complications, ensuring that the benefits of functional neurosurgery are widely accessible and safe for all patients.

METHODOLOGY

The methodology of this research was based on a systematic review of the literature to examine advances in surgical techniques of functional neurosurgery and the anesthetic complications associated with these procedures. The search was performed in electronic databases, including *Medical Literature Analysis and Retrieval System Online* (MEDLINE), Latin American and Caribbean Literature on Health Sciences (LILACS) and *Public Medline* (PubMed).

To ensure the scope and relevance of the research, specific descriptors selected by consulting the BIREME Health Sciences Descriptors (DECs) were used. The descriptors considered included terms in Portuguese and English such as "functional neurosurgery", "neurological disorders" and "anesthetic complications".

To combine the descriptors and tracking the publications, the logical operators "AND", "OR" and "NOT" were used. Initially, 53 publications potentially eligible for inclusion in this review were identified. Specific inclusion criteria were then applied: studies should address surgical techniques in functional neurosurgery, discuss anesthetic complications, and be published in English, Portuguese, or Spanish. Previous systematic review studies, original human research articles, and publications up to December 2023 were included, while theses, dissertations, and monographs were excluded due to the logistical infeasibility of a systematic search for these sources.

After the initial analysis of the titles and abstracts, 19 articles were considered eligible for the second phase, which consisted of the complete reading of the texts. In the end, 4 articles met all the inclusion criteria.

The qualitative analysis of the data extracted from the selected studies allowed the identification of trends, knowledge gaps and areas that need further investigation, contributing to the continuous development and improvement of practices in the area of functional neurosurgery.

RESULTS AND DISCUSSION

As seen, the sample selected for this study, after applying the inclusion and exclusion criteria, comprised 4 scientific articles, from which the main information was extracted (Chart 1).

Table 1 - Selected studies - August 2024

Author/year	Title	Objective	Results
Barreto *et al.* (20224)	Functional neurosurgery: evaluation of clinical outcomes and complications	To evaluate the clinical outcomes and complications associated with functional neurosurgery, providing a detailed perspective on the efficacy and safety of these procedures.	Functional neurosurgery is a promising area, with the potential to offer substantial benefits to patients. However, close monitoring of complications is imperative to optimize outcomes and ensure patient safety
Kundu *et al.* (2023)	Functional Neurosurgery—A Neglected Aspect of Global Neurosurgery: Call to Action	Highlight the importance of functional neurosurgery and address the limitations and challenges faced in its practice in low- and middle-income countries (LMICs).	Despite the growing demand for functional neurosurgery in low- and middle-income countries, the availability and quality of services are severely limited, requiring a collaborative approach and the creation of tailored protocols to improve access and outcomes for patients.
Kanmounye *et al.* (2022)	The role of neurosurgery in global health epilepsy, movement disorders, and psychiatric diseases	To analyze advances in functional neurosurgery surgical techniques for the treatment of neurological disorders and to examine the anesthetic complications associated with these procedures.	Despite significant advances in functional neurosurgery surgical techniques that improve clinical outcomes, the management of anesthetic complications remains a critical concern that must be addressed to ensure patient safety during these procedures.
Roz *et al.* (2021)	Psychosurgery for the treatment of obsessive-compulsive disorder.	To evaluate the efficacy of psychosurgery as a treatment for obsessive-compulsive disorder (OCD) by analyzing the neurobiological changes associated with OCD, the surgical techniques used, and the clinical and neuropsychological outcomes after the procedures.	The technical advances of the surgical procedure, aided by knowledge neurophysiological, psychosurgery has become more precise and safer.

Source: Prepared by the authors.

In the discussion of the results of this study, significant advances in the surgical techniques of functional neurosurgery are presented, including the use of minimally invasive approaches, innovative technologies such as robotics and high-resolution intraoperative imaging, and the importance of personalization of treatments to improve clinical outcomes. The studies analyzed also

highlight the need for proactive management of anesthetic complications and a multidisciplinary approach to ensure patient safety. In addition, there is an emphasis on international collaboration and the development of protocols adapted to local realities, especially in low- and middle-income countries, to overcome challenges and improve access to effective treatments.

The study prepared by Barreto *et al.* (2024) analyzes advances in surgical techniques of functional neurosurgery, highlighting the evolution of minimally invasive approaches and the incorporation of innovative technologies, such as robotics and high-resolution intraoperative imaging. These innovations have allowed safer and more effective procedures to be performed, expanding the therapeutic possibilities for patients with neurological disorders. Personalization of treatment is emphasized, recognizing that each patient has unique characteristics that demand an individualized approach, which in turn contributes to better clinical outcomes and increased patient satisfaction.

In addition to addressing advances in surgical techniques, the study also examines the anesthetic complications associated with these procedures. The proactive management of complications, according to Barreto *et al.* (2024), is considered essential to minimize risks and promote a faster and more satisfactory recovery. The article highlights the importance of a multidisciplinary approach, where different medical specialties collaborate to ensure patient safety during surgery. This collaboration is critical for the early identification of complications and the implementation of appropriate treatment strategies, ensuring that the benefits of functional neurosurgery are maximized while the risks are minimized.

The study by Kundu *et al.* (2023) analyzes advances in the surgical techniques of functional neurosurgery, highlighting the importance of methods such as deep brain stimulation and ablative surgery in the treatment of neurological disorders, such as epilepsy and dystonia. The authors emphasize that despite significant progress in high-income countries, the implementation of these techniques in low- and middle-income countries still faces substantial challenges, including a lack of adequate infrastructure, limited financial resources, and a shortage of trained professionals. The research suggests that international collaboration and the development of protocols tailored to local realities are essential to overcome these barriers and improve access to effective treatments.

In addition, Kundu *et al.* (2023) also examine the anesthetic complications associated with these surgical procedures, which may include risks such as adverse reactions to anesthetics, respiratory and cardiovascular complications. Kundu et al. underscore the need for a multidisciplinary approach involving neurosurgeons, anesthesiologists, and other healthcare professionals to ensure patient safety during interventions. The analysis of anesthetic complications is crucial for the formulation of guidelines that can minimize risks and optimize surgical outcomes,

especially in contexts where resources are limited and experience in functional neurosurgery is scarce.

Kanmounye *et al.* (2022) reflect on advances in functional neurosurgery surgical techniques, highlighting the evolution of minimally invasive approaches and the use of advanced imaging technologies that improve the accuracy of procedures. These innovations have allowed for more effective treatment of neurological disorders such as epilepsy, movement disorders, and psychiatric conditions. In addition, the study emphasizes the importance of personalizing surgical interventions, taking into account the individual characteristics of patients, which can result in better clinical outcomes and a faster recovery.

Regarding the anesthetic complications associated with these procedures, Kanmounye *et al.* (2022) examine the risks that may arise during functional neurosurgery, including adverse reactions to anesthetics and complications related to the patient's position on the operating table. Analysis of these complications is crucial, as functional neurosurgery often involves delicate interventions in critical areas of the brain, where careful monitoring and proper management of anesthesia are essential to ensure patient safety. The study concludes that while advances in surgical techniques have significantly improved outcomes, understanding and mitigating anesthetic complications remains a priority in clinical practice.

Roz *et al.* (2021) analyze advances in the surgical techniques of functional neurosurgery, highlighting how these advances have contributed to the safety and efficacy of procedures used in the treatment of neurological disorders, such as obsessive-compulsive disorder (OCD). With the development of stereotactic methods and the use of neuroradiological imaging, surgical interventions have become more precise, allowing a more accurate localization of the brain structures involved. These technical advances have not only improved clinical outcomes but also reduced the morbidity associated with surgeries, making them a viable option for patients who do not respond to conventional treatments.

In addition, the research by Roz *et al.* (2021) examines the anesthetic complications that may be associated with these procedures, emphasizing the importance of a careful and multidisciplinary evaluation before performing psychosurgery. The research suggests that while current procedures are considered relatively safe, there are still risks that must be managed, such as hemorrhages and adverse reactions to anesthesia. The inclusion of a multi-professional team to assess patients and discuss the risks and benefits of surgery is critical to ensure that patients and their families fully understand the implications of treatment, promoting an ethical and informed approach to decision-making.

FINAL CONSIDERATIONS

The study successfully achieved its overall objective of analyzing advances in functional neurosurgery surgical techniques and examining associated anesthetic complications. It was found that advances in surgical techniques, such as the use of minimally invasive approaches and innovative technologies, such as robotics and high-resolution intraoperative imaging, have provided safer and more effective procedures for the treatment of neurological disorders. Personalization of treatment has also proven to be key to optimizing clinical outcomes and patient satisfaction.

In addition, the analysis of anesthetic complications revealed the importance of proactive management and multidisciplinary collaboration to minimize risks and promote rapid recovery. Integrating different medical specialties is crucial to identify and treat complications early, ensuring that the benefits of functional neurosurgery are maximized and the risks minimized.

The main conclusion of the study is that, although advances in surgical techniques have significantly improved the results of procedures, the management of anesthetic complications remains a priority to ensure patient safety. The study's limitation lies in its applicability in resource-limited contexts, where the lack of infrastructure and the scarcity of trained professionals can hinder the implementation of these advances.

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