"CAROL DAVILA" UNIVERSITY OF MEDICINE AND PHARMACY
BUCHAREST
DOCTORAL SCHOOL
FIELD OF MEDICINE

Improving microvascular decompression outcomes: the role of endoscopic assistance and integrated outcome assessment in trigeminal neuralgia and hemifacial spasm

PhD THESIS SUMMARY

PhD supervisor:
PROF. UNIV. DR. GORGAN RADU MIRCEA

PhD student:
PĂTRĂȘCAN ALEXANDRA MIHAELA

2026

TABLE OF CONTENTS

I. GENERAL PART

CHAPTER 1: TRIGEMINAL NEURALGIA AND HEMIFACIAL SPASM - GENERAL CONCEPTS

Neurovascular compression syndromes of the cranial nerves are disorders characterized by direct contact between a blood vessel and the cisternal portion of a cranial nerve, resulting in mechanical irritation and associated neurological dysfunction[1]. The most common forms are trigeminal neuralgia and hemifacial spasm, conditions with a major impact on quality of life due to severe pain or functional and social impairment [2-5]. The bibliometric analysis conducted within this thesis highlights the growing interest in the literature regarding microvascular decompression and the integration of endoscopic techniques in the treatment of these disorders.

From a historical perspective, the development of the neurovascular conflict concept culminated in the work of Dandy, Gardner, and Jannetta, who demonstrated the role of vascular compression in symptom generation and introduced microvascular decompression as a non-ablative treatment method [6-9]. The procedure subsequently became the therapeutic gold standard for classical trigeminal neuralgia and hemifacial spasm [10].

The pathophysiology of these syndromes is related to compression occurring predominantly at the transition zone between central and peripheral myelin, where demyelination processes and ephaptic transmission develop [11-14]. In trigeminal neuralgia, the superior cerebellar arteries and the superior petrosal venous system are most frequently involved [15-19], whereas in hemifacial spasm, compression of the facial nerve by the anterior inferior cerebellar artery and its branches predominates [20]. Recent studies also suggest an important role of arachnoid adhesions and genetic factors in the development of neurovascular conflict [21-28].

The diagnosis of these disorders is primarily clinical, while imaging plays a role in confirming and characterizing their etiology. Trigeminal neuralgia is characterized by paroxysmal episodes of electric shock-like pain triggered by apparently innocuous stimuli, such as facial movements or mastication[29-31], whereas hemifacial spasm causes progressive involuntary contractions of the facial musculature [32, 33]. High-resolution MRI and MR angiography, particularly 3D CISS/FIESTA and TOF sequences, are essential for identifying neurovascular conflict and excluding secondary causes [34-36]. Although neuroimaging is primarily used to detect a specific etiology of trigeminal neuralgia and to exclude secondary trigeminal neuralgia [37], careful evaluation of the patient's medical history remains essential.

Pharmacological treatment represents the first-line therapeutic approach in trigeminal neuralgia; however, many patients develop refractory disease or intolerance to medication [38, 39]. In such cases, microvascular decompression provides the best long-term outcomes compared with neuroablative procedures [40-45]. In hemifacial spasm, although botulinum toxin may temporarily alleviate symptoms, microvascular decompression addresses the primary cause and may achieve remission rates of approximately 90% [46-49]. Contemporary series report high remission rates, particularly when intraoperative monitoring is used to verify the effectiveness of decompression and preserve hearing [50].

CHAPTER 2: SURGICAL ASPECTS AND COMPLEMENTARY TECHNOLOGIES IN MICROVASCULAR DECOMPRESSION

The second chapter develops the technical and technological foundations of microvascular decompression, highlighting the transformation of this procedure into a modern neurosurgical standard for classical trigeminal neuralgia and primary hemifacial spasm when refractory to medical treatment [51]. From the earliest observations on neurovascular conflict described by Babinski and Dandy to the establishment of the technique by Jannetta, microvascular decompression has undergone continuous refinement, evolving into a procedure dependent not only on anatomical considerations, but also on surgical expertise, meticulous dissection, and the appropriate use of adjunctive instruments.

From a technical perspective, the success of the procedure largely depends on complete exposure of the region of interest, accurate identification of the offending structure, and achievement of adequate decompression without additional trauma to the nerve or adjacent structures [52-54]. Surgical failure is frequently related to insufficient exploration of the Root Entry Zone, improper handling of the interposition material, anatomical variations, or incomplete decompression of the involved structure [54, 55]. Even in experienced centers, symptom recurrence may occur, sometimes without an immediately identifiable cause, emphasizing that this procedure requires not only theoretical knowledge, but also substantial operative experience and precise intraoperative judgment [56, 57].

In addition to the classical Teflon interposition technique, non-compressive vascular transposition methods have been developed, aiming to separate the vessel from the nerve without the use of interposition material [58-60]. Furthermore, purely venous conflicts represent a distinct category, often difficult to diagnose radiologically and associated with a higher risk of recurrence and facial hypoesthesia. Their management requires careful decision-making between preservation of venous drainage and selective sacrifice of small-caliber veins[61-66]. Arachnoid adhesions and anatomical variations of the superior petrosal venous complex may significantly influence both surgical difficulty and postoperative outcomes [21, 67].

Although the success rate of microvascular decompression is high, the procedure may be associated with complications such as facial paralysis, hearing loss, cerebrospinal fluid fistulas, or, more rarely, cerebellar infarction [68, 69]. Over recent decades, the development of complementary technologies has contributed to improving the precision and safety of the intervention. Endoscopic assistance, including the use of the QEVO endoscopic micro-inspection tool, enables visualization of subtle or difficult-to-access neurovascular conflicts that may not be adequately exposed through the conventional microscopic approach [70-73]. In addition, fully endoscopic techniques have demonstrated promising results in selected series [74-76]. Neuromonitoring, intraoperative neuronavigation, robotic surgery, and awake procedures represent modern directions of development that may further optimize surgical outcomes [77-84].

Overall, these intraoperative technologies, ranging from endoscopic visualization to intraoperative monitoring, may enhance the safety and precision of microvascular decompression. By reducing the risk of unidentified conflicts, incomplete decompression, or procedure-related complications, they directly contribute to minimizing therapeutic failure in trigeminal neuralgia and hemifacial spasm.

II. PERSONAL CONTRIBUTIONS

CHAPTER 3: WORKING HYPOTHESIS AND GENERAL OBJECTIVES

Microvascular decompression represents the surgical treatment of choice for classical trigeminal neuralgia, primary hemifacial spasm, and classical glossopharyngeal neuralgia, providing very good long-term clinical outcomes in appropriately selected cases. The success of the procedure depends fundamentally on the accurate identification and adequate decompression of the neurovascular conflict at the level of the root entry/exit zone of the cranial nerves. In certain situations, adequate intraoperative identification of the neurovascular conflict may be limited under standard microscopic visualization, particularly in cases involving complex anatomical configurations, suspected multiple conflicts, or when preoperative MRI fails to demonstrate a clear neurovascular conflict.

Endoscopic assistance during microvascular decompression enables extended exploration of the cerebellopontine angle and visualization from angles that are difficult to access using the operating microscope, thereby facilitating the identification of potentially hidden or residual neurovascular conflicts. Nevertheless, the benefit of endoscopic assistance is not uniform across all cases and is influenced by the anatomical particularities of each patient.

In this context, **the primary hypothesis** of the present research is that the use of endoscopic assistance in microvascular decompression, as a complementary method to the microscopic technique, allows additional exploration of the root entry/exit zone of the cranial nerves and of neurovascular relationships, facilitating the precise and complete identification of neurovascular conflicts. This may contribute to optimization of the surgical procedure and, consequently, of postoperative outcomes by reducing the risk of insufficient decompression. **The secondary hypothesis** of the study is that, in the absence of a standardized method for selecting cases in which endoscopic assistance has a significant impact on postoperative outcomes, predictive factors of the benefit of this technique may be identified. The identification of such factors would represent a novel contribution, with the potential to enable individualized indications for endoscopic assistance and optimization of the microvascular decompression strategy. In addition to these hypotheses, it is considered that the use of standardized scales in the evaluation of postoperative outcomes may provide a more objective and reproducible assessment of treatment efficacy.

Accordingly, **the general objectives** of the research were as follows:

Objective 1 - To evaluate the role of endoscopic assistance in optimizing the outcomes of microvascular decompression in patients diagnosed with trigeminal neuralgia, hemifacial spasm, and glossopharyngeal neuralgia, with emphasis on identifying cases in which it provides additional intraoperative benefit

Objective 2 - To identify factors that may indicate the utility of endoscopic assistance and to develop an exploratory pilot score for estimating its benefit, with a potential role in patient stratification and surgical decision-making

Objective 3 - To analyze postoperative outcomes following microvascular decompression using standardized instruments such as the Barrow Neurological Institute (BNI) score and the Patient Global Impression of Change (PGIC) scale, as well as to analyze the relationship between these measures

Objective 4 - To perform an applied analysis of endoscope-assisted microvascular decompression through the presentation of particular clinical cases, highlighting both the surgical strategy and the utility of three-dimensional reconstruction as a complementary tool for surgical analysis and planning

CHAPTER 4: GENERAL RESEARCH METHODOLOGY

The present thesis was designed as a retrospective, observational, single-center study with a mixed methodological approach, including descriptive, comparative, and exploratory analyses. The study included 40 adult patients treated by microvascular decompression between January 2020 and November 2025 in the Department of Neurosurgery of the "Bagdasar-Arseni" Emergency Clinical Hospital in Bucharest. The cohort consisted predominantly of patients with classical trigeminal neuralgia and primary hemifacial spasm, and also included one case of classical glossopharyngeal neuralgia with a similar pathophysiological mechanism, treated using the same surgical technique.

Patient selection was performed through interrogation of the hospital's electronic databases using pathology-specific terms such as "neurovascular compression syndrome," "microvascular decompression," "Jannetta," "trigeminal neuralgia," "hemifacial spasm," and "glossopharyngeal neuralgia," followed by individual review of medical records to verify inclusion and exclusion criteria. Across all studies, inclusion criteria comprised patients older than 18 years with a confirmed diagnosis of classical trigeminal neuralgia, classical glossopharyngeal neuralgia, or primary hemifacial spasm, treated by microvascular decompression in the Department of Neurosurgery by senior neurosurgeons with comparable operative experience. Patients with incomplete data, atypical symptomatology, or secondary etiologies of neurovascular compression were excluded.

The analyzed data were derived from medical records, operative protocols, and intraoperative video recordings, including clinical, imaging, and intraoperative information, as well as postoperative outcome assessment. Outcomes were evaluated using standardized scales: the Barrow Neurological Institute (BNI) score for pain control assessment [85-87] and the Patient Global Impression of Change (PGIC) scale for global evaluation of clinical outcome [88, 89].

Particular attention was given to cases in which the QEVO® endoscopic micro-inspection tool (Carl Zeiss Meditec AG, Oberkochen, Germany), integrated into the Zeiss Kinevo 900 operating microscope available within the department, was utilized in order to evaluate the contribution of this technology to the identification of additional, hidden, or residual neurovascular conflicts and to the optimization of surgical outcomes.

Statistical analysis was performed using Microsoft Excel, Python, and GraphPad Prism. Descriptive methods and statistical tests appropriate to the analyzed variables were applied, including the Chi-square, Fisher, Fisher-Freeman-Halton, and Mann-Whitney U tests. Correlations were evaluated using the Spearman coefficient, agreement through Cohen's Kappa coefficient, and associations between variables through calculation of Odds Ratios. ROC curves were used for predictive performance analysis, and the Propensity Score method with IPTW was applied to reduce selection bias. Statistical significance was established at $p < 0.05$.

The studies included in the thesis were conducted retrospectively on the same overall patient cohort, with different analyses of clinical, imaging, and intraoperative data according to the hypothesis and objective of each individual study. The principal limitations of the research were the retrospective design, the small patient cohort, and the lack of randomization regarding the use of the QEVO endoscopic micro-inspection tool.

CHAPTER 5: STUDY I - MICROVASCULAR DECOMPRESSION IN TRIGEMINAL NEURALGIA AND HEMIFACIAL SPASM: ASSESSMENT OF OUTCOMES AND THE ROLE OF ENDOSCOPIC ASSISTANCE

This study was based on **the hypothesis** that the use of endoscopic assistance during microvascular decompression contributes to improved identification of neurovascular conflicts, more rigorous confirmation of adequate decompression, and optimization of the intraoperative strategy. Accordingly, it was assumed that patients in whom this technique was employed would demonstrate superior clinical outcomes and a lower risk of recurrence compared with those undergoing standard microscopic microvascular decompression.

The **primary objective** of the study was to evaluate the outcomes of surgical treatment by microvascular decompression in neurovascular compression syndromes and to analyze the role of intraoperative endoscopic assistance in optimizing the surgical procedure. The study specifically aimed to assess the clinical and imaging characteristics of the cohorts, the concordance between MRI findings and intraoperative observations, the impact of QEVO utilization on surgical strategy, and the comparison of postoperative outcomes between the QEVO and non-QEVO groups.

The study had a retrospective, single-center design and included 40 adult patients treated by microvascular decompression at the Department of Neurosurgery of the "Bagdasar-Arseni" Clinical Emergency Hospital, Bucharest, between January 2020 and November 2025. The cohort consisted predominantly of patients with trigeminal neuralgia (80%), followed by patients with hemifacial spasm (12.5%), one case of glossopharyngeal neuralgia, and two mixed cases (trigeminal neuralgia associated with hemifacial spasm). In 22 cases (55%), intraoperative endoscopic assistance was utilized through the QEVO instrument integrated into the Zeiss Kinevo 900 operating microscope.

Demographic analysis demonstrated a predominance of female patients and a mean age of 57.3 ± 11.4 years. Patients with hemifacial spasm were significantly younger compared with those diagnosed with trigeminal neuralgia (47.4 ± 9.7 years versus 59.2 ± 11.0 years; $p = 0.0431$). The median symptom duration was 48 months, with considerable variability among patients.

Regarding the characteristics of the neurovascular conflict, arterial conflicts represented the predominant form. All patients with hemifacial spasm presented arterial compression, whereas both arterial and venous conflicts were identified in trigeminal neuralgia cases. Analysis of concordance between preoperative MRI and intraoperative findings demonstrated an overall concordance rate of approximately 75%; however, the low Kappa coefficient suggested limitations of MRI in accurately identifying the type of neurovascular conflict, particularly in venous conflicts. In several cases, conflicts interpreted radiologically as arterial were found intraoperatively to be venous in origin.

One of the most important findings of the study was the association between the use of QEVO endoscopic assistance and a lower rate of postoperative recurrence compared with the exclusively microscopic group (0/22 versus 4/18; $p = 0.033$). Furthermore, patients in the QEVO group demonstrated more favorable functional outcomes assessed using the BNI score, with the difference reaching statistical significance ($p = 0.039$), although these findings should be interpreted cautiously given the limited sample size.

Endoscopic micro-inspection served both to confirm subtle or hidden neurovascular conflicts and as an intraoperative decision-making tool. In certain situations, the use of QEVO led to modification of the surgical strategy, including the need for additional decompression, repositioning of the Teflon material, or identification of additional vascular structures involved in the neurovascular conflict. In the analyzed cohort, endoscopic assistance had a major impact on intraoperative management in 18.2% of cases and served as a confirmatory tool for adequate decompression in the majority of procedures.

To reduce the risk of selection bias between the QEVO and non-QEVO groups, the Propensity Score method with Inverse Probability of Treatment Weighting (IPTW) was applied, improving the comparability of the analyzed groups. Nevertheless, it should be emphasized that QEVO utilization was not randomized and depended on the neurosurgeon's intraoperative decision and the gradual adoption of the technique within the department, aspects that represent important limitations of the study.

The obtained results support the conclusion that microvascular decompression remains an effective treatment modality for neurovascular compression syndromes, while the use of endoscopic assistance may contribute to optimization of the surgical procedure by improving intraoperative visualization and reducing the risk of insufficient decompression. Furthermore, the study highlights the utility of integrated clinical and imaging assessment and underscores the importance of adapting the surgical strategy to the anatomical particularities of each individual case.

CHAPTER 6: STUDY II - ALEXA-Y: A PROPOSED PILOT SCORE FRAMEWORK FOR PREDICTING HIGH-IMPACT ENDOSCOPIC YIELD IN MICROVASCULAR DECOMPRESSION FOR TRIGEMINAL NEURALGIA AND HEMIFACIAL SPASM

The present study builds upon the research direction established in the previous study, focusing on the role of endoscopic assistance in microvascular decompression (MVD). Although endoscopic visualization has become increasingly utilized in MVD procedures over the last decade, its actual intraoperative impact has not yet been systematically evaluated. At present, no standardized method exists to identify the cases in which endoscopic assistance provides a clinically meaningful benefit. Therefore, this study aimed to identify the main factors predictive of high-impact endoscopic yield in MVD performed for trigeminal neuralgia (TN) and hemifacial spasm (HFS), with the long-term objective of developing a predictive score that could subsequently be validated in larger cohorts.

A key aspect of the study was the definition of "high-impact endoscopic yield." In this context, the term refers specifically to situations in which QEVO endoscopic inspection not only confirmed the presence of a neurovascular conflict, but also resulted in a significant intraoperative contribution. A high-impact yield score of 1 was assigned when endoscopic assistance led to modification of the neurosurgical strategy, such as the need for supplementary decompression, repositioning of the Teflon material, or identification of an additional neurovascular conflict, and/or when endoscopy revealed a hidden offender that was not clearly visualized using microscopy alone. Conversely, a high-impact yield score of 0 was assigned when endoscopy served solely as a confirmatory tool for adequate decompression, without identifying additional offenders or altering the surgical strategy.

Based on this framework, we proposed an exploratory pilot scoring model, termed ALEXA-Y, designed to identify factors associated with an increased likelihood of obtaining clinically relevant endoscopic benefit during MVD. The working hypothesis was that specific clinical and perioperative characteristics may predict the probability of achieving a high-impact endoscopic yield. The primary objective of the study was therefore the development of an exploratory pilot score capable of anticipating cases in which endoscopic assistance may provide substantial intraoperative value.

This retrospective study initially included 37 patients with trigeminal neuralgia and hemifacial spasm treated by microvascular decompression, of whom 19 endoscopy-assisted cases were included in the score derivation cohort. Overall, the cohort demonstrated high rates of postoperative improvement, with favorable outcomes observed both at discharge and during follow-up, supporting the effectiveness of the surgical treatment.

Several candidate predictive variables were subsequently analyzed. The selected domains were based on exploratory statistical analyses, correlated with findings from the literature and clinical experience, and included: patient age (Age), symptom duration (Length of symptoms), timing of endoscope utilization (Endoscopy timing), smoking status (eXposure to smoking), and associated comorbidities (Associated comorbidities), while the "Y" component represented the endpoint ("yield"). Among these variables, symptom duration demonstrated the strongest and most consistent predictive signal. Patients with symptom duration $\leq$ 24 months showed a higher probability of achieving a major endoscopic benefit, with ROC analysis demonstrating good discriminative performance (AUC = 0.854). By contrast, the remaining variables did not demonstrate stable predictive value within the pilot cohort. These findings suggest that patients with more recent symptom onset may derive greater benefit from intraoperative endoscopic assistance.

Through this study, the thesis introduces an original concept of preoperative stratification for selecting candidates who may benefit most from endoscopic assistance during microvascular decompression. Although the ALEXA-Y score remains exploratory and requires external validation in larger patient cohorts, the results support the feasibility of developing a predictive instrument that may contribute to the individualization of surgical strategies in neurovascular compression syndromes.

CHAPTER 7: STUDY III - POSTOPERATIVE OUTCOME ASSESSMENT USING THE BNI SCORE AND PGIC SCALE

The third study of the thesis investigated a perspective that has been less extensively addressed in the literature, namely the manner in which patients perceive the real impact of microvascular decompression on their daily lives. Although several studies have evaluated the efficacy and clinical outcomes of microvascular decompression, only a limited number have specifically analyzed the concordance between different postoperative outcome assessment instruments used concurrently[90].

In this context, evaluating outcomes using a single scoring system may be restrictive, which highlights the relevance of employing complementary instruments aimed not only at symptom improvement, but also at the patient's overall perception of life changes following surgery. In this study, postoperative outcomes after microvascular decompression were assessed using the modified Barrow Neurological Institute pain intensity score (BNI) and the Patient Global Impression of Change (PGIC) scale, with the aim of exploring the relationship between these two instruments in order to achieve a more comprehensive and patient-centered evaluation of surgical outcomes.

The study hypothesis was that the BNI score and PGIC scale are significantly correlated, although not perfectly concordant, reflecting two complementary dimensions of postoperative outcome: pain control and the patient's global perception of clinical improvement. The primary objective of this study was to evaluate the relationship between the BNI score and the PGIC scale in patients who underwent microvascular decompression.

The analysis included the entire cohort of 40 patients treated by microvascular decompression for trigeminal neuralgia, hemifacial spasm, and glossopharyngeal neuralgia. The results demonstrated a high rate of postoperative improvement, with the majority of patients achieving excellent pain control and reporting a favorable overall perception of clinical evolution at the latest follow-up evaluation.

The study demonstrated a significant correlation between the BNI score and the PGIC scale (Spearman's $\rho = 0.546$; $p = 0.0012$), suggesting that better pain control is associated with a more favorable global perception of postoperative outcome. However, concordance between the two instruments was only moderate (Cohen's kappa = 0.52), indicating that they evaluate complementary dimensions of recovery. The BNI score primarily reflects pain control and therapeutic requirements, whereas the PGIC scale captures the patient's subjective perception of overall clinical change following surgery.

Comparative analysis showed that the use of QEVO endoscopic assistance was associated with superior pain control outcomes, with all patients operated using endoscopic assistance achieving a BNI I score at follow-up (100%), compared with 73.3% in the non-QEVO group ($p = 0.038$). In contrast, the proportion of patients with a PGIC score of 1 did not differ significantly between groups (90.5% versus 81.3%; $p = 0.634$), suggesting that the patient's global perception of improvement may also be influenced by factors beyond strict pain control alone.

Postoperative outcomes were generally independent of age, symptom duration, and history of previous interventions, suggesting that clinical evolution may depend more on anatomical and technical factors than on simple clinical variables.

Through this study, the thesis supports the utility of the combined use of the BNI score and the PGIC scale for postoperative evaluation following microvascular decompression. The integration of these two instruments allows for a more comprehensive and nuanced assessment of therapeutic success, incorporating both objective symptom control and the patient's subjective experience of recovery.

CHAPTER 8: STUDY IV - APPLICATIONS OF ENDOSCOPIC ASSISTANCE IN THREE SELECTED CASES OF MICROVASCULAR DECOMPRESSION

To highlight the practical applicability of endoscopic assistance in microvascular decompression, the thesis includes the presentation of three representative clinical cases, selected based on their anatomical and intraoperative particularities. These cases illustrate situations in which endoscopic assistance contributed to the optimization of the surgical strategy. In addition, the contribution of three-dimensional reconstruction of the neurovascular conflict using the 3D Slicer software is emphasized, as well as the utility of intraoperative neuromonitoring in a case of glossopharyngeal neuralgia, a pathology rarely encountered in neurosurgical practice.

Each case is presented by highlighting the relevant clinical, imaging, and intraoperative findings, as well as the impact of these adjunctive technologies on the surgical outcome.

The first case describes a patient with trigeminal neuralgia caused by vertebrobasilar dolichoectasia, in association with a neurovascular conflict involving the superior cerebellar artery. The complex vascular anatomy, characterized by tortuous vessels and displacement of the trigeminal nerve, represented a major technical challenge. Endoscopic assistance enabled extended exploration of the neurovascular conflict, reduced the need for cerebellar retraction, and facilitated verification of the correct positioning of the Teflon material.

Relevance of the case within this doctoral thesis: In the setting of complex vascular anatomy, endoscopic assistance facilitated comprehensive evaluation of the neurovascular relationships and optimization of the microvascular decompression strategy.

The second case presents a patient with recurrent trigeminal neuralgia following a previous microvascular decompression. Revision surgery highlighted the challenges generated by postoperative anatomical alterations and the presence of previously placed Teflon material. Endoscopic micro-inspection enabled identification of a residual neurovascular conflict between the trigeminal nerve and the superior cerebellar artery, suggestive of either incomplete initial decompression or migration of the interposition material. Final endoscopic reinspection confirmed complete resolution of the conflict following Teflon repositioning, and the postoperative course was favorable, with complete remission of pain symptoms.

Relevance of the case within this doctoral thesis: The presented case highlights how endoscopic micro-inspection can be integrated as an adjunctive method for intraoperative verification of microvascular decompression, particularly in revision procedures, where postoperative anatomical changes may limit the accuracy of conventional microscopic evaluation and hinder complete identification of neurovascular conflicts.

The third case illustrates the management of glossopharyngeal neuralgia, a pathology rarely encountered in neurosurgical practice. Preoperative MRI examination suggested only subtle evidence of a neurovascular conflict, without clear identification of the vascular structure involved. Intraoperatively, both arachnoid adhesions and a minimal conflict between the glossopharyngeal nerve and a branch of the anterior inferior cerebellar artery were identified. Endoscopic assistance enabled detailed exploration of the root entry zone of cranial nerve IX and confirmation of the absence of additional neurovascular conflicts. Intraoperative neuromonitoring of cranial nerves

VII, VIII, IX, and X contributed to increased surgical safety and reduction of the risk of postoperative neurological deficits. Subsequently, three-dimensional reconstruction performed using 3D Slicer confirmed the concordance between the three-dimensional imaging findings and the intraoperative observations regarding the minimal neurovascular conflict identified.

Relevance of the case within this doctoral thesis: This case highlights the diagnostic and intraoperative challenges associated with glossopharyngeal neuralgia in the absence of an evident major neurovascular conflict on imaging studies. In this context, intraoperative endoscopic assistance enabled extended evaluation of the root entry zone and confirmation of the vascular structure involved.

This chapter highlights that endoscopic micro-inspection plays a complementary role to conventional microscopy by facilitating identification of subtle neurovascular conflicts, comprehensive evaluation of the root entry zone of the cranial nerves, and confirmation of the correct positioning of the interposition material. Furthermore, its association with three-dimensional reconstruction and intraoperative neuromonitoring may improve understanding of individual anatomy and enhance surgical safety, particularly in complex or rare cases.

The conclusions of the study support the concept that the use of endoscopic assistance during microvascular decompression may provide important benefits in selected cases by optimizing intraoperative visualization, identifying neurovascular conflicts that are difficult to observe microscopically, and verifying the effectiveness of the performed decompression.

CHAPTER 9: CONCLUSIONS AND PERSONAL CONTRIBUTIONS

Final conclusions

Following the studies conducted within this doctoral thesis, several conclusions can be drawn, providing an integrated perspective on the role of microvascular decompression and endoscopic assistance in the treatment of cranial nerve neurovascular compression syndromes.

This research confirms the effectiveness of microvascular decompression as the surgical treatment of choice for classical trigeminal neuralgia and primary hemifacial spasm. The success of the procedure depends fundamentally on accurate identification of the neurovascular conflict, the anatomical particularities of each case, and the experience of the surgical team.

The obtained results highlight the existence of intraoperative situations in which additional visualization is required, particularly in cases involving complex anatomy, subtle neurovascular conflicts, or revision surgery. In such situations, endoscopic assistance may increase surgical accuracy by expanding the field of visualization and facilitating identification of neurovascular conflicts that are difficult to access through conventional microscopy alone.

The first study of the thesis aimed to compare the outcomes obtained in patients treated with microvascular decompression with and without endoscopic assistance. Comparative analysis demonstrated that the use of endoscopic micro-inspection with the QEVO instrument may contribute to the identification of additional conflicts and optimization of decompression, being associated with favorable functional outcomes and a lower recurrence rate.

Based on the observations derived from the first study, the second study aimed to outline an exploratory model for estimating the potential benefit of endoscopic assistance. In this context, the ALEXA-Y pilot score was proposed, based on the analysis of perioperative variables associated with "high-impact endoscopic yield." The results suggest the existence of factors with potential predictive value; however, the model requires external validation before any possible clinical application.

The third study analyzed the relationship between objective assessment of pain control and the patient's overall perception of postoperative outcome. The correlation between the Barrow Neurological Institute (BNI) scale and the Patient Global Impression of Change (PGIC) demonstrated a significant but moderate association, suggesting that the two instruments capture complementary dimensions of surgical outcome. These findings support the need for a multidimensional evaluation of outcomes following microvascular decompression, integrating both objective clinical parameters and the patient's subjective perception.

An important contribution of the thesis is represented by the analysis of complex clinical cases of endoscopy-assisted microvascular decompression. In these situations, the anatomical particularities highlighted the utility of a combined microscopic and endoscopic surgical strategy. Three-dimensional reconstruction was used as a complementary tool for the analysis of neurovascular relationships within the cerebellopontine angle. Furthermore, in the case of glossopharyngeal neuralgia, the use of intraoperative neuromonitoring contributed to increased surgical safety and prevention of postoperative neurological complications.

Overall, the results of this thesis support the integration of technological advances into contemporary neurosurgical practice and confirm the adjunctive role of endoscopic assistance in microvascular decompression. The obtained data do not demonstrate an absolute superiority of the endoscopy-assisted technique over the standard microscopic approach, but rather emphasize its complementary value, particularly in selected cases involving complex anatomy or neurovascular conflicts that are difficult to identify microscopically.

In conclusion, this thesis demonstrates the effectiveness of microvascular decompression as the surgical treatment of choice for cranial nerve neurovascular compression syndromes, while also confirming the complementary role of endoscopic assistance and the importance of integrated, multidimensional evaluation of clinical outcomes in optimizing the management of these patients.

Personal Contributions

The personal contributions began with the development of the research plan, based on a critical analysis of the literature, an approach that enabled the establishment of an integrated perspective on microvascular decompression. In this context, a synthesis was performed of the essential factors involved in preventing therapeutic failure in neurovascular compression syndromes, including establishment of the correct etiology and accurate diagnosis, selection of the optimal therapeutic approach, mastery of intraoperative microsurgical techniques, and integration of adjunctive technologies with the potential to optimize the surgical procedure.

Subsequently, based on the original studies conducted, an integrated analysis of clinical, imaging, intraoperative, and postoperative data was performed, with particular emphasis on the evaluation of functional outcomes and the role of endoscopic assistance during microvascular decompression. In addition, the roles of three-dimensional reconstruction of preoperative imaging and intraoperative neuromonitoring were specifically evaluated. This approach enabled correlation of objective outcomes with patient-reported perception and integration of these findings into a unified analytical framework.

Based on the correlation of clinical and perioperative data, an exploratory model for estimating the benefit of endoscopic assistance (the ALEXA-Y score) was proposed as an original contribution, with potential utility in preliminary patient stratification. The L component ("Length of symptoms" $\leq$ 24 months) demonstrated the most stable predictive signal within the analyzed cohort.

In the absence of standardized therapeutic protocols, the management of these patients remains dependent on individual anatomical and clinical particularities, highlighting the importance of selecting a surgical strategy tailored to each patient in order to achieve optimal outcomes.

The personal contributions and **original elements of the thesis** may be summarized as follows:

1. This research represents **the first analysis performed on a national cohort** of patients undergoing **microvascular decompression**. The patients were consecutively treated between January 2020 and November 2025 at the "Bagdasar-Arseni" Clinical Emergency Hospital in Bucharest. The research generated original data on the effectiveness of microvascular decompression in Romanian patients. (Chapters 5 - 8)
2. **Comparative evaluation of microvascular decompression performed with and without endoscopic assistance** (QEVO), through a systematic analysis of the impact of intraoperative endoscopic micro-inspection technology on the quality of decompression and clinical outcomes, in a field where comparative data in the literature remain limited. (Chapters 5 - 7)
3. **Original contribution:** development of the **ALEXA-Y score**, an exploratory pilot scoring system derived from the analysis of the studied cohort, designed to identify predictive factors associated with *high-impact endoscopic yield* during microvascular decompression, defined as cases in which endoscopic assistance either modifies the intraoperative surgical strategy or reveals previously undetected neurovascular conflicts. The L component (Length of symptoms ≤ 24 months) represented the variable with the most stable predictive signal within the analyzed cohort. At present, no similar score or proposal estimating the impact of endoscopic assistance for case selection has been published in the literature, making this score an original contribution of the thesis. Although external validation in larger cohorts is required, the score demonstrates potential future clinical applicability and may contribute to the standardization of selection criteria and therapeutic decision-making. (Chapter 6)
4. **Introduction of a standardized approach to postoperative outcome** assessment that **combines the BNI and PGIC scales**, integrating objective pain control with the patient's

global perception of recovery, and providing a complementary, multidimensional evaluation of surgical results through analysis of the relationship between the two instruments. (Chapter 7)

5. **Characterization of the impact of adjunctive intraoperative technologies (QEVO endoscopic assistance, three-dimensional reconstruction of the neurovascular conflict, and neuromonitoring)** in optimizing identification of neurovascular conflicts, particularly in complex, recurrent, or anatomically atypical cases, demonstrating their role in increasing the accuracy of microvascular decompression. (Chapter 8)

REFERENCES

1. Haller S, Etienne L, Kövari E, Varoquaux AD, Urbach H, Becker M. Imaging of Neurovascular Compression Syndromes: Trigeminal Neuralgia, Hemifacial Spasm, Vestibular Paroxysmia, and Glossopharyngeal Neuralgia. AJNR Am J Neuroradiol. 2016;37(8):1384-92.
2. Wang Y, Sun K, Zhang W, Zhang H, Wang C. Pain and Psychological Distress: Effect of Microvascular Decompression on Sleep Disorders and Obsessions in Trigeminal Neuralgia. J Neurol Surg B Skull Base. 2021;82(Suppl 3):e285-e94.
3. Kim YG, Chang WS, Jung HH, Chang JW. The long-term effects of microvascular decompression on social phobia and health-related quality of life in patients with hemifacial spasm: a 3-year prospective study. Acta Neurochir (Wien). 2019;161(10):2035-42.
4. Shi X, Zhang X, Xu L, Xu Z. Neurovascular compression syndrome:Trigeminal neuralgia, hemifacial spasm, vestibular paroxysmia, glossopharyngeal neuralgia, four case reports and review of literature. Clinical Neurology and Neurosurgery. 2022;221:107401.
5. Adams H, Pendleton C, Latimer K, Cohen-Gadol AA, Carson BS, Quinones-Hinojosa A. Harvey Cushing's case series of trigeminal neuralgia at the Johns Hopkins Hospital: a surgeon's quest to advance the treatment of the 'suicide disease'. Acta Neurochirurgica. 2011;153(5):1043-50.
6. Dandy WE. Concerning the cause of trigeminal neuralgia. American Journal of Surgery. 1934;24:447-55.
7. Gardner WJ, Miklos MV. Response of trigeminal neuralgia to decompression of sensory root; discussion of cause of trigeminal neuralgia. J Am Med Assoc. 1959;170(15):1773-6.
8. Kaufmann AM, Price AV. A history of the Jannetta procedure. J Neurosurg. 2020;132(2):639-46.
9. Rand RW. Gardner neurovascular decompression of the trigeminal and facial nerves for tic douloureux and hemifacial spasm. Surg Neurol. 1981;16(5):329-32.
10. Okon, II, Menon SS, Osama M, Aiman M, Paleare LFF, Eliseo DL, 3rd, et al. Microvascular decompression: a contemporary update. BMC Surg. 2025;25(1):20.
11. Bhatoe HS. The neurovascular syndromes: A review of pathophysiology - Lessons learnt from Prof. Chandy's paper published in 1989. Neurol India. 2019;67(2):377-88.
12. Jannetta PJ. Neurovascular compression in cranial nerve and systemic disease. Ann Surg. 1980;192(4):518-25.
13. Skinner HA. SOME HISTOLOGIC FEATURES OF THE CRANIAL NERVES. Journal of Nervous and Mental Disease. 1931;25:356-72.
14. Guclu B, Sindou M, Meyronet D, Streichenberger N, Simon E, Mertens P. Cranial nerve vascular compression syndromes of the trigeminal, facial and vago-glossopharyngeal nerves: comparative anatomical study of the central myelin portion and transitional zone; correlations with incidences of corresponding hyperactive dysfunctional syndromes. Acta Neurochir (Wien). 2011;153(12):2365-75.
15. Chen GQ, Wang XS, Wang L, Zheng JP. Arterial compression of nerve is the primary cause of trigeminal neuralgia. Neurol Sci. 2014;35(1):61-6.
16. Tsunoda S, Inoue T, Segawa M, Akabane A. Vein-related Trigeminal Neuralgia: How to Determine the Treatment Method of the Causative Vein: A Technical Note. Neurol Med Chir (Tokyo). 2022;62(2):105-9.
17. Basamh M, Sinning N, Kehler U. Individual variations of the superior petrosal vein complex and their microsurgical relevance in 50 cases of trigeminal microvascular decompression. Acta Neurochir (Wien). 2020;162(1):197-209.

18. Hong W, Zheng X, Wu Z, Li X, Wang X, Li Y, et al. Clinical features and surgical treatment of trigeminal neuralgia caused solely by venous compression. Acta Neurochir (Wien). 2011;153(5):1037-42.
19. Szmyd B, Sołek J, Błaszczyk M, Jankowski J, Liberski PP, Jaskólski DJ, et al. The Underlying Pathogenesis of Neurovascular Compression Syndromes: A Systematic Review. Front Mol Neurosci. 2022;15:923089.
20. Traylor KS, Sekula RF, Eubanks K, Muthiah N, Chang YF, Hughes MA. Prevalence and severity of neurovascular compression in hemifacial spasm patients. Brain. 2021;144(5):1482-7.
21. Kulkarni A. Complex Neurovascular Syndromes: Is the Compressing Vessel Alone the Culprit? J Neurosci Rural Pract. 2022;13(2):283-9.
22. Burchiel KJ. Trigeminal Neuralgia: New Evidence for Origins and Surgical Treatment. Neurosurgery. 2016;63:52-5.
23. Panchagnula S, Sularz AK, Kahle KT. Familial Trigeminal Neuralgia Cases Implicate Genetic Factors in Disease Pathogenesis. JAMA Neurol. 2019;76(1):9-10.
24. Di Stefano G, Yuan JH, Cruccu G, Waxman SG, Dib-Hajj SD, Truini A. Familial trigeminal neuralgia - a systematic clinical study with a genomic screen of the neuronal electrogenisome. Cephalalgia. 2020;40(8):767-77.
25. Lagalla G, Logullo F, Di Bella P, Haghighipour R, Provinciali L. Familial hemifacial spasm and determinants of late onset. Neurol Sci. 2010;31(1):17-22.
26. Coad JE, Wirtschafter JD, Haines SJ, Heros RC, Perrone T. Familial hemifacial spasm associated with arterial compression of the facial nerve. Case report. J Neurosurg. 1991;74(2):290-6.
27. Xu F, Gu P, Yuan H, Jiang L, Xie Y, Shi Q, et al. Analysis of risk factors related to the progression rate of hemifacial spasm. Frontiers in Neurology. 2024;Volume 15 - 2024.
28. Han IB, Kim NK, Huh R, Shin DA, Moon JY, Park HM, et al. The role of genetic factors in the development of hemifacial spasm: preliminary results. Acta Neurochir Suppl. 2008;101:107-10.
29. Society IH. ICHD-3, Trigeminal neuralgia Website: International Headache Society; 2026 [cited 2026 22.01.2026]. Available from: https://ichd-3.org/13-painful-cranial-neuropathies-and-other-facial-pains/13-1-trigeminal-neuralgia/13-1-1-classical-trigeminal-neuralgia/.
30. Cruccu G, Finnerup NB, Jensen TS, Scholz J, Sindou M, Svensson P, et al. Trigeminal neuralgia. New classification and diagnostic grading for practice and research. 2016;87(2):220-8.
31. The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia. 2013;33(9):629-808.
32. Chaudhry N, Srivastava A, Joshi L. Hemifacial spasm: The past, present and future. J Neurol Sci. 2015;356(1-2):27-31.
33. Colosimo C, Bologna M, Lamberti S, Avanzino L, Marinelli L, Fabbrini G, et al. A comparative study of primary and secondary hemifacial spasm. Arch Neurol. 2006;63(3):441-4.
34. Shi X, Zhang X, Xu L, Xu Z. Neurovascular compression syndrome:Trigeminal neuralgia, hemifacial spasm, vestibular paroxysmia, glossopharyngeal neuralgia, four case reports and review of literature. Clin Neurol Neurosurg. 2022;221:107401.
35. Henssen D, van Grinsven M, Vissers K, van Goethem J. Magnetic resonance imaging in the diagnosis of trigeminal neuralgia: a systematic review of the imaging protocol and diagnostic accuracy. European Radiology. 2025.

36. Liang C, Yang L, Reichardt W, Zhang B, Li R. Different MRI-based methods for the diagnosis of neurovascular compression in trigeminal neuralgia or hemifacial spasm: A network meta-analysis. J Clin Neurosci. 2023;108:19-24.
37. Tai AX, Nayar VV. Update on Trigeminal Neuralgia. Curr Treat Options Neurol. 2019;21(9):42.
38. Bendtsen L, Zakrzewska JM, Abbott J, Braschinsky M, Di Stefano G, Donnet A, et al. European Academy of Neurology guideline on trigeminal neuralgia. Eur J Neurol. 2019;26(6):831-49.
39. Radoš I. TREATMENT OPTIONS FOR TRIGEMINAL NEURALGIA. Acta Clin Croat. 2022;61(Suppl 2):96-102.
40. Ji Y, Wang J. Comparison of microvascular decompression and percutaneous balloon compression efficacy in patients with V2 idiopathic trigeminal neuralgia. Frontiers in Neurology. 2024;Volume 15 - 2024.
41. Van Kleef M, Mekhail N, Van Zundert J. Evidence-Based Guidelines for Interventional Pain Medicine according to Clinical Diagnoses. Pain Practice. 2009;9(4):247-51.
42. Zakrzewska JM, Lopez BC. Quality of Reporting in Evaluations of Surgical Treatment of Trigeminal Neuralgia: Recommendations for Future Reports. Neurosurgery. 2003;53(1):110-22.
43. Linskey ME, Ratanatharathorn V, Peñagaricano J. A prospective cohort study of microvascular decompression and Gamma Knife surgery in patients with trigeminal neuralgia. Journal of Neurosurgery SUP. 2008;109(Supplement):160-72.
44. Wang DD, Raygor KP, Cage TA, Ward MM, Westcott S, Barbaro NM, et al. Prospective comparison of long-term pain relief rates after first-time microvascular decompression and stereotactic radiosurgery for trigeminal neuralgia. Journal of Neurosurgery. 2018;128(1):68-77.
45. Dai ZF, Huang QL, Liu HP, Zhang W. Efficacy of stereotactic gamma knife surgery and microvascular decompression in the treatment of primary trigeminal neuralgia: a retrospective study of 220 cases from a single center. J Pain Res. 2016;9:535-42.
46. Wang B, Wei X, Qi H, Bao X, Hu M, Ma J. Efficacy and safety of botulinum neurotoxin in the treatment of hemifacial spasms: a systematic review and meta-analysis. BMC Neurol. 2024;24(1):420.
47. Frei K, Truong DD, Dressler D. Botulinum toxin therapy of hemifacial spasm: comparing different therapeutic preparations. Eur J Neurol. 2006;13 Suppl 1:30-5.
48. Helal A, Graffeo CS, Meyer FB, Pollock BE, Link MJ. Predicting long-term outcomes after microvascular decompression for hemifacial spasm according to lateral spread response and immediate postoperative outcomes: a cohort study. Journal of Neurosurgery. 2024;140(6):1664-71.
49. Sindou M, Mercier P. Microvascular decompression for hemifacial spasm : Surgical techniques and intraoperative monitoring. Neurochirurgie. 2018;64(2):133-43.
50. Holste K, Chan AY, Rolston JD, Englot DJ. Pain Outcomes Following Microvascular Decompression for Drug-Resistant Trigeminal Neuralgia: A Systematic Review and Meta-Analysis. Neurosurgery. 2020;86(2):182-90.
51. Thomas KL, Vilensky JA. The anatomy of vascular compression in trigeminal neuralgia. Clin Anat. 2014;27(1):89-93.
52. Li Y, Yang L, Ni J, Dou Z. Microvascular decompression and radiofrequency for the treatment of trigeminal neuralgia: a meta-analysis. J Pain Res. 2019;12:1937-45.

53. Pătrășcan AM, Brehar FM, Gorgan RM. Pivotal Factors for Minimizing the Risks of Therapeutic Failure in Trigeminal Neuralgia and Hemifacial Spasm. Current Pain and Headache Reports. 2026;30(1):27.
54. Cohen-Gadol AA. Microvascular decompression surgery for trigeminal neuralgia and hemifacial spasm: naunces of the technique based on experiences with 100 patients and review of the literature. Clin Neurol Neurosurg. 2011;113(10):844-53.
55. Ravina K, Strickland BA, Rennert RC, Bakhsheshian J, Russin JJ, Giannotta SL. Revision Microvascular Decompression for Trigeminal Neuralgia and Hemifacial Spasm: Factors Associated with Surgical Failure. J Neurol Surg B Skull Base. 2019;80(1):31-9.
56. Xu R, Xie ME, Jackson CM. Trigeminal Neuralgia: Current Approaches and Emerging Interventions. J Pain Res. 2021;14:3437-63.
57. Liu MX, Xia L, Zhong J, Li B, Dou NN, Li ST. What Should We Do for Those Hemifacial Spasm Patients Without Efficacy Following Microvascular Decompression: Expectation of Delayed Relief or Early Reoperation? World Neurosurg. 2018;110:e897-e900.
58. Fukushima T. [Posterior cranial fossa neurovascular decompression (Jannetta method) for trigeminal neuralgia and facial spasm]. No Shinkei Geka. 1982;10(12):1257-61.
59. Meybodi AT, Habibi Z, Miri M, Tabatabaie SA. Microvascular decompression for trigeminal neuralgia using the 'Stitched Sling Retraction' technique in recurrent cases after previous microvascular decompression. Acta Neurochir (Wien). 2014;156(6):1181-7; discussion 7.
60. Abi-Aad KR, Turcotte E, Patra DP, Welz ME, Maiti T, Hess R, et al. Vascular Transposition of the Superior Cerebellar Artery Using a Fenestrated Clip and Fibrin Glue in Trigeminal Neuralgia: 2-Dimensional Operative Video. Oper Neurosurg. 2020;19(1):E50-e1.
61. Shulev YA, Gordienko KS, Trashin AV, Pechiborshch DA, Rzayev DA. Venous compression as a cause of trigeminal neuralgia. Zh Vopr Neirokhir Im N N Burdenko. 2016;80(4):21-30.
62. Kasuya H, Tani S, Kubota Y, Yokosako S, Ohbuchi H, Arai N, et al. Characteristics and management of the offending veins in microvascular decompression surgery for trigeminal neuralgia. Neurosurgical Review. 2021;44(4):2337-47.
63. Inoue T, Shitara S, Goto Y, Prasetya M, Fukushima T. Petrosal Vein Involvement in Neurovascular Conflict in Trigeminal Neuralgia: Surgical Technique and Clinical Outcomes. Oper Neurosurg. 2021;20(4):E264-e71.
64. Wu M, Fu X, Ji Y, Ding W, Deng D, Wang Y, et al. Microvascular Decompression for Classical Trigeminal Neuralgia Caused by Venous Compression: Novel Anatomic Classifications and Surgical Strategy. World Neurosurg. 2018;113:e707-e13.
65. Eghlimi RA, Meyer JH, Bendok BR, Zimmerman RS. Commentary: Microvascular Decompression for Treatment of Simultaneous Arterial and Venous Conflict Causing Trigeminal Neuralgia: 2-Dimensional Operative Video. Oper Neurosurg. 2023;25(6):e380-e1.
66. Soni P, Potter T, Soni PP, Estemalik E, Recinos PF, Kshettry VR. Outcomes of microvascular decompression for trigeminal neuralgia with purely venous compression: A systematic review and meta-analysis. Clinical Neurology and Neurosurgery. 2020;198:106230.
67. Segura-Lozano MA, Carranza-Rentería O, Velázquez-Delgado G, Munguía-Rodríguez AG. Histochemical Analysis of Altered Arachnoid Tissue in Patients With Paroxysmal Trigeminal Neuralgia With Concomitant Continuous Pain. Cureus. 2024;16(6):e61502.

68. Yue Y, Zhao ZR, Liu DC, Liu HJ, Lu DL, Zhang H, et al. Life-threatening complications after microvascular decompression procedure: Lessons from a consecutive series of 596 patients. J Clin Neurosci. 2021;86:64-70.
69. Fayed ZY, Afify H. Long-term follow-up of microvascular decompression for management of trigeminal neuralgia. Egyptian Journal of Neurosurgery. 2022;37(1):30.
70. Tomlinson SB, Hendricks BK, Cohen-Gadol A. Single-Surgeon in Vivo Experience with the Zeiss QEVO Microinspection Tool: An Analysis of Its Use for Extending the Reach of Operative Visualization. World Neurosurg. 2021;147:268-72.
71. Pătrășcan AM, Brehar FM, Gorgan RM, Prună VM. The Added Value of Endoscopic Micro-Inspection in Microvascular Decompression for Trigeminal Neuralgia and Hemifacial Spasm: Literature Review and Single-Center Experience. Neurology International. 2026;18(4):66.
72. Schebesch K-M, Doenitz C, Haj A, Höhne J, Schmidt N. Application of the Endoscopic Micro-Inspection Tool QEVO® in the Surgical Treatment of Anterior Circulation Aneurysms—A Technical Note and Case Series. Frontiers in Surgery. 2020;7.
73. Schebesch KM, Brawanski A, Tamm ER, Kühnel TS, Höhne J. QEVO(®) - A new digital endoscopic microinspection tool - A cadaveric study and first clinical experiences (case series). Surg Neurol Int. 2019;10:46.
74. Fouda MA, Jeelani Y, Gokoglu A, Iyer RR, Cohen AR. Endoscope-assisted microsurgical retrosigmoid approach to the lateral posterior fossa: Cadaveric model and a review of literature. Surg Neurol Int. 2021;12:416.
75. Yadav YR, Parihar V, Ratre S. Endoscopic Microvascular Decompression for Trigeminal Neuralgia: Is It What We Should Aim for? World Neurosurg. 2018;114:436-7.
76. Jiang H, Zou D, Wang P, Zeng L, Liu J, Tang C, et al. Case report: Fully endoscopic microvascular decompression for trigeminal neuralgia. Front Neurol. 2022;13:1090478.
77. Ji HK, Lee MH, Lee T-K. Robotic surgery for microvascular decompression in hemifacial spasm: a feasibility study. Neurofunction. 2024;20(1):28-33.
78. Simioni V, Capone JG, Sette E, Granieri E, Farneti M, Cavallo MA, et al. Intraoperative monitoring of sensory part of the trigeminal nerve using blink reflex during microvascular decompression for trigeminal neuralgia. Acta Neurochir (Wien). 2018;160(1):165-9.
79. Legninda Sop FY, D'Ercole M, Izzo A, Rapisarda A, Ioannoni E, Caricato A, et al. The Impact of Neuronavigation on the Surgical Outcome of Microvascular Decompression for Trigeminal Neuralgia. World Neurosurg. 2021;149:80-5.
80. Abdulrauf SI, Urquiaga JF, Patel R, Albers JA, Sampat VB, Baumer M, et al. Awake Microvascular Decompression for Trigeminal Neuralgia: Concept and Initial Results. World Neurosurg. 2018;113:e309-e13.
81. Fareed A, Iftikhar Z, Haider R, Shah SI, Ennabe M, Alan A, et al. Awake neurosurgery: Advancements in microvascular decompression for trigeminal neuralgia. Surg Neurol Int. 2024;15:215.
82. Murcia D, D'Souza S, Abozeid M, Thompson JA, Djoyum TD, Ormond DR. Investigation of Asleep versus Awake Motor Mapping in Resective Brain Surgery. World Neurosurg. 2022;157:e129-e36.
83. Al-Adli NN, Young JS, Sibih YE, Berger MS. Technical Aspects of Motor and Language Mapping in Glioma Patients. Cancers (Basel). 2023;15(7).
84. Ratha V, Roopesh Kumar VR, Subramaniam S, Kumar S, Sankaran V, Suresh Bapu KR. Awake microvascular decompression with fat-teflon sandwich technique: Clinical implications of a novel approach for cranial nerve neuralgias. J Clin Neurosci. 2019;64:77-82.

85. Burgos-Sosa E, Mendizabal-Guerra R, Nieto-Velazquez NG, Ayala-Arcipreste A. Microvascular decompression for primary trigeminal neuralgia with the 3/4 circumferential expanded polytetrafluoroethylene (ePTFE) sleeve technique. Surg Neurol Int. 2024;15:336.
86. Lucas JT, Jr., Nida AM, Isom S, Marshall K, Bourland JD, Laxton AW, et al. Predictive nomogram for the durability of pain relief from gamma knife radiation surgery in the treatment of trigeminal neuralgia. Int J Radiat Oncol Biol Phys. 2014;89(1):120-6.
87. Karam SD, Tai A, Snider JW, Bhatia S, Bedrick EJ, Rashid A, et al. Refractory trigeminal neuralgia treatment outcomes following CyberKnife radiosurgery. Radiat Oncol. 2014;9:257.
88. Faizo E, Kurdi M, Hafiz B, Alzahrani W, Alajmi N, Althaqafi B, et al. Patient satisfaction and pain relief following radiofrequency rhizotomy for trigeminal neuralgia: a prospective cohort study. Frontiers in Pain Research. 2025;Volume 6 - 2025.
89. Ferguson L, Scheman J. Patient global impression of change scores within the context of a chronic pain rehabilitation program. The Journal of Pain. 2009;10(4):S73.
90. Granzer-Corno L, Rana R, Dick BD, Sankar T. Different Scale, Different Pain? Discordant Pain Measurements After Surgery for Trigeminal Neuralgia. World Neurosurg. 2025;194:123481.

PUBLISHED SCIENTIFIC PAPERS

Scientific papers published in Web of Science-indexed journals (Impact Factor journals)

1. **Pătrășcan, A.M**., Brehar, F.M. & Gorgan, R.M. *Pivotal Factors for Minimizing the Risks of Therapeutic Failure in Trigeminal Neuralgia and Hemifacial Spasm*. Current Pain and Headache Reports, Volume 30, Article number 27 (2026). IF 3.5/2024, Review article (Chapter 2 of the thesis, pp. 26–33)

https://link.springer.com/article/10.1007/s11916-025-01449-1
https://doi.org/10.1007/s11916-025-01449-1

2. **Pătrășcan, A. M**., Brehar, F. M., Gorgan, R. M., & Prună, V. M. *The Added Value of Endoscopic Micro-Inspection in Microvascular Decompression for Trigeminal Neuralgia and Hemifacial Spasm: Literature Review and Single-Center Experience*. Neurology International, Volume 18(4), Article number 66 (2026). IF 3/2024, Original Research (Chapter 5 of the thesis, pp. 42-63)

https://www.mdpi.com/2035-8377/18/4/66
https://doi.org/10.3390/neurolint18040066

3. **Pătrășcan, A.M**., Brehar, F.M., Gorgan, R.M. *ALEXA-Y: A Proposed Pilot Score Framework for Predicting High-Impact Endoscopic Yield in Microvascular Decompression for Trigeminal Neuralgia and Hemifacial Spasm*. Balneo and PRM Research Journal. 2026;17(2); Accepted for publication (June 2026 issue). IF 1.1/2024, Original Research (Chapter 6 of the thesis, pp. 66-87)