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OUTCOME COMPARISON OF CAROTID ENDARTERECTOMY AND CAROTID ARTERY STENTING IN PATIENTS WITH EXTRACRANIAL CAROTID ARTERY STENOSIS: ONE-HOSPITAL-BASED RETROSPECTIVE STUDY

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Abstract

Introduction: *Extracranial carotid artery stenosis is a significant risk factor for ischemic stroke, necessitating effective management strategies to mitigate potential complications.*

This retrospective study aims to compare the short-term (30-day) and long-term outcomes (1-year and 5-year) of carotid endarterectomy and carotid artery stenting in patients treated for extracranial carotid artery stenosis at National Scientific Center of Surgery named after A.N. Syzganov.

Material and methods: *A retrospective review of medical records from spanning from January 2018 to December 2023 was conducted. Patients diagnosed with extracranial carotid artery stenosis who underwent either carotid endarterectomy or carotid artery stenting were included in the study. Data collection focused on demographic characteristics, comorbidities, procedural details, and outcomes including perioperative complications, 30-day mortality, and long-term follow-up data such as restenosis rates and stroke recurrence.*

Results: *A total of 237 patients met the inclusion criteria, with 32% undergoing carotid endarterectomy and 68% receiving carotid artery stenting. During the study, four periprocedural strokes occurred: three in the carotid artery stenting group and one in the carotid endarterectomy group ($p<0.005$). Additionally, the carotid artery stenting group experienced one case of transient ischemic attack, while the carotid endarterectomy group had one case of thrombosis. There was one death in the carotid artery stenting group during the perioperative period. Over a follow-up period of less than one year and less than five years, 42 deaths were recorded, with mortality rates of 13.1% for carotid endarterectomy and 19.8% for carotid artery stenting ($p<0.005$). The carotid artery stenting group also had one periprocedural myocardial infarction, and both groups had one case of periprocedural hemorrhage each. Cardiac arrhythmias were identified as the primary cause of death among these cases.*

Conclusion: *In conclusion, this retrospective study provides important insights into the short-term and long-term outcomes of carotid endarterectomy versus carotid artery stenting for extracranial carotid artery stenosis. Both procedures demonstrate efficacy in preventing stroke, yet differences in outcomes warrant careful consideration in clinical decision-making.*

Keywords: *carotid endarterectomy, carotid artery stenting, extracranial carotid artery stenosis, stroke.*

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Introduction

Stroke is a serious global disease with a high degree of disability and high incidence [*Krishnamurthi R et al., 2017; Kyu H et al., 2018*]. Globally, stroke is the second leading cause of mortality, responsible for 11.6% of all deaths in 2019. Ischemic stroke, the most common type, accounted for 62.4% of all stroke cases worldwide in 2019. [*Murray C et al., 2020; Feigin V et al., 2021, Ding Q, 2022*]. Over the past three decades, the disease profile in 80% of developing nations has shifted from infectious diseases to non-communicable diseases, with stroke emerging as one of the most prevalent and debilitating conditions, ranking third in terms of disability-adjusted life years [*Kyu H et al., 2018; Johnson C et al., 2019; Phipps M et al., 2020*]. In 2019, approximately 77.19 million people worldwide suffered from ischemic stroke, resulting in 63.48 million disability-adjusted life years lost and 3.29 million deaths attributed to this condition. From 1990 to 2019, age-standardized rates of incidence, mortality, and disability-adjusted life years associated with ischemic stroke declined in both genders [*Benjamin E et al., 2020; Martinez R et al., 2020*].

Global forecasts indicate that among individuals aged 25 and older, the lifetime risks of experiencing any type of stroke and specifically ischemic stroke are estimated at 24.9% and 18.3%, respectively [*Pu L et al., 2024; Feigin V et al., 2018*]. The World Health Organization has recommended a range of primary healthcare strategies targeting behavioral and lifestyle factors such as hypertension, smoking, and poor diet to prevent and manage noncommunicable diseases like stroke [*Stanaway J et al., 2017; Vos T et al., 2019; Roth G et al., 2017*]. A key objective of one of the United Nations' Sustainable Development Goals is to reduce premature deaths from noncommunicable diseases by one-third by 2030, focusing on promoting mental health and well-being [*NCD Countdown 2030 collaborators, 2020*]. However, the feasibility of achieving reductions in mortality rates and disability-adjusted life years attributable to ischemic stroke globally by 2030 remains uncertain. Projections of these statistics on a global scale are essential for assessing the burden of ischemic stroke and its long-term consequences. Such projections would significantly aid in evaluating the effectiveness of current prevention efforts, guiding healthcare policies, and informing targeted investments in preventive measures at the national level. Forecasting global trends in ischemic stroke is critical for informed decision-making and strategic planning in public health.

Extracranial carotid artery stenosis is a critical precursor to ischemic stroke, necessitating timely and effective intervention to reduce associated morbidity and mortality [*Naylor A et al., 2018; AbuRahma A et al., 2022*]. When the plaque causes a stenosis of 50% or more of the lumen of the carotid artery, it results in a hemodynamically significant arterial stenosis syndrome. Atherosclerotic lesions of the extracranial carotid arteries are the third leading cause of ischemic stroke in the general population and the second most common non-traumatic cause among adults under 45 years of age [*Ooi Y, Gonzalez N, 2015; Bonati L et al., 2022; Saduakas A et al., 2023*]. The treatment and diagnosis of this condition are currently at a turning point [*Abbott A et al., 2015; Homssi M et al., 2023*]. However, approximately 15% of strokes are still secondary to carotid artery stenosis, which can be detected using effective imaging techniques [*Zhu Z, Yu W, 2019; Kedev S, 2023*].

Carotid endarterectomy and carotid artery stenting are established treatments aimed at restoring blood flow and preventing stroke. Both procedures have evolved with advancements in technology and surgical techniques, yet debate persists regarding their comparative effectiveness and safety. This retrospective study seeks to contribute to this discourse by analyzing short-term and long-term outcomes of carotid endarterectomy versus carotid artery stenting in a single hospital setting.

Material and methods

Data were retrospectively collected from electronic medical records of patients who underwent carotid endarterectomy or carotid artery stenting for extracranial carotid artery stenosis between January 2018 and December at National Scientific Center of Surgery. Baseline patient demographics, comorbidities, procedural details, and outcomes were analyzed. Short-term outcomes, including perioperative complications and mortality within 30 days of the procedure, were assessed. Long-term outcomes, such as stroke recurrence, cardio-

vascular events, and overall survival rates, were evaluated at 1-year and 5-year follow-ups. Both carotid endarterectomy and carotid artery stenting were performed for patients with 50-99% carotid artery stenosis, while asymptomatic patients with 70-99% stenosis were also enrolled in the study. Before both procedures, all patients underwent duplex ultrasonography. Following the identification of hemodynamically significant stenosis on duplex ultrasonography, patients underwent diagnostic carotid angiograms as well magnetic resonance imaging or computed tomography scans to assess their anatomy and determine their suitability for either carotid endarterectomy or carotid artery stenting.

The patients were categorized into two groups based on their surgical treatment method: group 1 underwent carotid endarterectomy, while group 2 underwent carotid artery stenting. The observation period included assessments at 30-days post-surgery, followed by subsequent follow-up intervals every 6 months up to 5 years.

The primary objectives of the study were to evaluate rates of transient ischemic attack, myocardial infarction, stroke, and all-cause mortality. These outcomes were combined into a composite measure. All-cause mortality was defined as death from any cause.

Statistical analysis: The data was analyzed using the free version of the JamoviTM program and "Microsoft Excel" (2019). The quantitative indicators were summarized using the arithmetic mean (M) and standard deviation (±SD). The data were presented as M±SD. Independent t-test used to determine the significance of the difference between the means. Qualitative variables were described using absolute (n) and relative (%) values. The threshold for statistical significance was a $p \leq 0.05$.

Results and discussion

A total of 237 patients met the inclusion criteria, with 32% undergoing carotid endarterectomy and 68% undergoing carotid artery stenting. Baseline characteristics, including age, gender distribution, and comorbidities (e.g., hypertension, diabetes), were comparable between the two groups. Patients undergoing carotid endarterectomy had an average age of 70.8 ± 5.9 years, with 77.6% of them being male. In contrast, patients undergoing carotid artery stenting had an average age of 60.9 ± 7.4 years, and similarly, 77.6% of them were male. The average body mass index levels in group 2 were significantly higher compared to those in group 1 (25.8 ± 3.82 vs. 27.7 ± 4.49, respectively; ($p<0.05$) (Table 1). Among the patients with extracranial carotid artery stenosis, the distribution of associated conditions was as follows: 6 patients experienced transient ischemic attack, 54 patients had a history of stroke, 215 patients had hypertension, 59 patients had diabetes mellitus, and 255 patients had ischemic heart disease (Table 1).

The study analyzed the outcomes of patient

Table 1

Patient features for carotid endarterectomy and carotid artery stenting

Variables	Carotid endarterectomy (n=76)	Carotid artery stenting (n=161)	p value < 0.05
Age, mean ± SD	70.8±5.9	60.9±7.4	0.085
Body mass index	25.8±3.82	27.7±4.49	0.001
Male	59 (77.6%)	125 (77.6%)	0.999
Female	17 (22.4%)	40 (22.4%)	0.999
Transient ischemic attack	3 (3.9%)	3 (1.8%)	0.343
Stroke	13 (17.1%)	41 (25.4%)	0.153
Diabetes mellitus	14 (18.4%)	45 (27.5%)	0.114
Hypertension	70 (92.1%)	145 (90%)	0.149
Previous Myocardial infarction	20 (26.3%)	56 (34.7%)	0.194
Ischemic heart disease	71 (93.4%)	155 (93.4%)	0.332
Smoking	31 (40.7%)	52 (32.2%)	0.203
Alcohol	38 (50%)	56 (34.7%)	0.025
Arterial fibrillation	1 (1.3%)	1 (0.6%)	0.495
Coronary artery bypass graft	3 (3.9%)	4 (2.4)	0.272
Coronography	1 (1.3%)	1 (0.6%)	0.495

Notes: *Data was shown by mean and standard deviation. Independent t-test was applied, p value <0.05*

TABLE 2

Comparison of treatment outcomes between the two groups

Variables	Carotid end-arterectomy (n=76)	Carotid artery stenting (n=161)	p value < 0.05
Peri-procedural death	1 (1.3%)	0	0.272
Peri-procedural Myocardial infarction	0	1 (0.6%)	0.495
Peri-procedural stroke	1 (1.3%)	3 (1.8%)	0.272
Peri-procedural hemorrhage	1 (1.3%)	1 (0.6%)	0.789
Transient ischemic attack within 30 days	0	1 (0.6%)	0.495
Restenosis	1 (1.3%)	0	0.272
Shunt thrombosis	0	1 (0.6%)	0.495
Stroke recurrence	1 (1.3%)	1 (0.6%)	0.789
Mortality rate (1-year and 5-year)	10 (13.1%)	32 (19.8%)	0.208

***NOTES**: Data was shown by mean and standard deviation. Independent t-test was applied, p value <0.05.*

treatment during two distinct periods: the initial 30-day postoperative period and the long-term 5-year follow-up period.

Short-term outcomes revealed that the peri-procedural stroke rate was 1.3 % in group 1and 1.8% in group 2 (p=0.272). Additionally, there was one case of periprocedural myocardial infarction (0.6%) in group 2, one instance of peri-procedural hemorrhage in group 1, and incidences of transient ischemic attack reported in group 2 (Table 2).

Over the long-term follow-up, both groups showed comparable rates of stroke recurrence: 1.3% in group 1 and 0.6% in group 2. In group 1, one case of restenosis was reported (Table 2).

Regarding complications leading to mortality, in the long-term period, 10 patients (13.1%) in group 1and 32 patients (19.8%) in group 2 died. The statistical analysis (p value = 0.208) indicates that there was no significant difference in mortality rates between the two groups over the long term (Table 2).

These findings underscore the comparative effectiveness and risks associated with carotid endarterectomy and carotid artery stenting in managing carotid artery disease, considering both stroke recurrence and mortality outcomes over an extended follow-up period.

The findings of this study suggest that both carotid endarterectomy and carotid artery stenting are effective in reducing the risk of stroke in patients with extracranial carotid artery stenosis. The choice between carotid endarterectomy and carotid artery stenting should be tailored based on patient-specific factors, including anatomical considerations, procedural risks, and patient preferences.

Carotid endarterectomy has traditionally been considered the gold standard treatment for carotid artery stenosis, especially in patients with high-grade stenosis or anatomical complexities. However, carotid artery stenting offers a less invasive alternative with comparable long-term outcomes, particularly in patients at higher surgical risk or those with unfavorable neck anatomy.

CONCLUSION

In conclusion, this single-hospital retrospective study provides valuable insights into the comparative outcomes of carotid endarterectomy and carotid artery stenting for extracranial carotid artery stenosis. Both procedures demonstrate favorable short-term and long-term outcomes in terms of stroke prevention and overall survival. Further prospective studies are needed to validate these findings and refine treatment algorithms to optimize outcomes for patients with carotid artery disease.

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