Carotid Endarterectomy in Octogenarians: Mortality, Stroke, and Restenosis

Jovan Petrovic MD[1], Slobodan Pesic MD[2], Bojan Vucurevic MD[1], Draginja Petkovic MD[3], Mihailo Neskovic MD[2,4], Petar Dabic PhD[1], Slobodan Tanaskovic PhD[2,4], Predrag Gajin PhD[2,4], Nenad Ilijevski PhD[2,4]

[1] Department of Cardiology and Internal Medicine, Vascular Surgery Clinic, Institute for Cardiovascular Diseases "Dedinje", Belgrade, Serbia
[2] Vascular Surgery Clinic, Institute for Cardiovascular Diseases "Dedinje", Belgrade, Serbia
[3] Department of Neuroangiology, Vascular Surgery Clinic, Institute for Cardiovascular Diseases "Dedinje", Belgrade, Serbia
[4] Faculty of Medicine, University of Belgrade, Belgrade, Serbia

Abstract:

Introduction: Carotid endarterectomy (CEA) is a proven surgical intervention for stroke prevention in patients with carotid artery stenosis. However, octogenarians are often considered a "high-risk" group for late stroke prevention, and current guidelines suggest best medical treatment in many cases. This study aims to evaluate whether age ≥80 years is associated with increased morbidity and mortality following CEA.

Methods: A retrospective analysis was conducted on 158 consecutive patients (≥80 years) who underwent elective CEA between 2018 and 2023 at a tertiary vascular centre. Patient data, including demographics, clinical presentation, perioperative outcomes, and 6-month follow-up results, were collected. Comparisons were made between octogenarians and a control group of 1,908 patients younger than 80 years. The primary outcome was technical and clinical success, and secondary outcomes included mortality, stroke, and significant restenosis (>50%). Statistical analyses were performed using parametric and nonparametric methods.

Results: No significant differences were found between the groups in terms of sex, functional status, or most risk factors, except for smoking (p<0.001) and atrial fibrillation (p=0.010), which were more prevalent in non-octogenarians and octogenarians, respectively. Perioperative complications (3.8% vs. 4.5%, p=0.699) and in-hospital mortality (0.6% vs. 0.5%, p=0.602) were similar between groups. However, during a 6-month follow-up, octogenarians had a higher rate of cardiac-related mortality (2.0% vs. 0.2%, p=0.012), while stroke rates were comparable (0.6% vs. 1.0%, p=1.000). Restenosis occurred in 7.0% of octogenarians and 8.0% of non-octogenarians (p=0.750).

Conclusion: CEA is a viable option for stroke prevention in carefully selected octogenarian patients, though cardiovascular comorbidities must be closely managed to improve long-term outcomes.

INTRODUCTION

Carotid endarterectomy (CEA) is an effective surgical intervention for reducing the risk of stroke in patients with symptomatic carotid artery stenosis[1]. However, the European Society of Vascular Surgery (ESVS) identifies octogenarians as a "high-risk" group, suggesting they may not fully benefit from late stroke prevention, and recommends the best medical treatment alone in most cases[2,3]. Furthermore, most carotid trials have excluded patients aged ≥80 years[2]. While there is limited evidence supporting the best medical treatment alone for this population, a recent meta-analysis suggests that although stroke risk increases with age on medical therapy, selective urgent intervention in symptomatic elderly patients is advisable[4,5]. Current guidelines suggest that for patients > 75 years with at least one feature that puts them at high risk of stroke on best medical therapy interventional treatment might be helpful[3,6]. There is an ongoing debate whether this data remains relevant today because these recommendations are based on the results of large randomized controlled trials that recruited patients between 1983 and 2003 when fewer patients were on statin therapy and more of them smoked[7,8]. This study aimed to assess whether age ≥80 years is associated with increased morbidity and mortality in patients undergoing CEA.

Author for correspondence:

Jovan Petrovic

Department of Cardiology and Internal Medicine, Vascular Surgery Clinic, Institute for Cardiovascular Diseases "Dedinje", Belgrade, Serbia
E-mail: jovanpetrovic1997@gmail.com
doi: 10.59037/n0j9ec07
ISSN 2732-7175 / 2024 Hellenic Society of Vascular and Endovascular Surgery Published by Rotonda Publications

METHODS

We conducted a retrospective analysis of 158 consecutive patients who underwent elective carotid surgery at a tertiary vascular centre between 2018 and 2023. We obtained data from available medical records. All patients provided informed consent, and the Ethical Committee of the Institution approved this study. The data included 1) basic demographic data, 2) clinical presentation and course of the disease, 3)

preoperative and postoperative therapy, 4) type of procedure, 5) primary outcome classified through technical and clinical success, and 6) mortality and stroke; secondary outcome was defended as significant restenosis (>50%). We analysed outcomes intrahospital and at 6 months (short-term). Risk factors-related data included 1) ischemic heart disease (IHD), 2) heart failure (HF), 3) hypertension (HTA) defined as office systolic blood pressure values >140 mmHg and/or diastolic blood pressure values >90 mmHg, 4) diabetes mellitus (DM) defined as a non-fasting, venous plasma glucose concentration of >11.1 mmol/L or a fasting venous plasma glucose concentration >7 mmol/L, 5) chronic obstructive pulmonary disease (COPD) defined as postbronchodilator-forced expiratory volume in one second and forced vital capacity ratio of <0.7, 6) chronic kidney disease (CKD) defined as the presence of abnormality in the kidney structure or function with an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m2, persisting for >3 months and 7) atrial fibrillation (AF). We also used functional status score (FSS) to assess the patients. We compared the results of the octogenarian group with those of 1908 patients younger than 80 years of age who were surgically treated for carotid disease during the same period.

Statistical analysis

We analyzed the data by parametric or nonparametric methods. Observed characteristics were expressed as mean values, standard deviation, median, and interquartile range (IQR). The Mann-Whitney U test was used for continuous nonparametric data, and continuous parametric data were analyzed using Student's t-test. Categorical data were analyzed using the Chi-square test and Fisher exact test, to determine the statistically significant difference. Significance was set at a 2-sided p<0.05. IBM SPSS Statistics 26 (Armonk, New York, USA) was used for the analysis.

RESULTS

Demographic and clinical characteristics of the two groups are presented in Table 1. There was no significant difference between the groups in terms of sex and most risk factors, except for smoking, which was more common in the control group (p<0.001), and atrial fibrillation (AF), which was more prevalent in the octogenarian patients (p=0.010). Notably, the majority of octogenarian patients with atrial fibrillation (16 patients, or 76.2%) were on direct oral anticoagulants (DOACs), with the remainder on vitamin K antagonists (VKAs). In the control group, 77 patients with AF (53.5%) received DOACs, while the rest were on VKAs. No significant difference was observed in anticoagulation therapy between the two groups (p=0.090). The frequency of contralateral CEA and carotid artery stenting was similar in both groups. Additionally, no difference was observed between the groups regarding the functional status score (FSS).

On admission, the majority of patients in both groups were asymptomatic (66.5% vs 67.3%, p=0.552). The remaining patients presented with a transient ischemic attack (TIA) (19.6% vs 16%), amaurosis fugax (10.8% vs 13.6%), or stroke (3.2% vs 3.1%). Notably, crescendo TIA was observed in 1.3% of octogenarians and 1% of the control group (p=0.683). All symptomatic patients matched the treated carotid artery. The median degree of stenosis did not differ significantly between the two groups (p=0.731).

Perioperative complications are given in Table 2. No dif-

Table 1. Demographic characteristics of the octogenarian group and control group

Factor	Octogenarian N=158	Control N=1908	p
Male sex, n (%)	107 (67.7)	1168 (61.2)	0.124
BMI, median (IQR)	25.5 (4.3)	26.2 (4.8)	0.138
Functional status - severe dysfunction, n (%)	1 (0.6)	9 (0.5)	0.619
DM, n (%)	49 (31)	600 (31.4)	0.910
CKD, n (%)	15 (9.5)	109 (5.7)	0.055
Dialysis, n (%)	0 (0.0)	3 (0.2)	1.000
Smoking, n (%)	53 (33.5)	990 (51.9)	0.000
IHD, n (%)	19 (12.0)	269 (14.1)	0.470
Previous MI, n (%)	15 (9.5)	211 (11.1)	0.545
Previous myocardial revascularisation, n (%)	28 (17.7)	275 (14.4)	0.259
CHF, n (%)	19 (12.0)	173 (9.1)	0.218
AF, n (%)	21 (13.3)	144 (7.5)	0.010
COPD, n (%)	13 (8.2)	118 (6.2)	0.311
HTA, n (%)	145 (91.8)	1664 (87.2)	0.095
Previous stroke, n (%)	40 (25.3)	405 (21.2)	0.229
Previous contralateral CEA/CAS, n (%)	12 (7.6)	181 (9.5)	0.602

BMI - body mass index; DM - diabetes mellitus; CKD - chronic kidney disease; IHD - ischemic heart disease; MI - myocardial infarction; CHF - congestive heart failure; AF - atrial fibrillation, COPD - chronic obstructive pulmonary disease; HTA - hypertension; CEA - carotid endarterectomy; CAS - carotid artery stenting

Table 2. Perioperative complications in the octogenarian group and control group

Complication	Octogenarian N=158	Control N=1908	p
Bleeding, n (%)	3 (1.9)	31 (1.6)	0.741
Haematoma, n (%)	0 (0.0)	4 (0.2)	1.000
Thrombosis, n (%)	1 (0.6)	4 (0.2)	0.328
Cranial nerve injury, n (%)	0 (0.0)	4 (0.2)	1.000
Hyperperfusion syndrome, n (%)	0 (0.0)	6 (0.3)	1.000
MI, n (%)	0 (0.0)	3 (0.2)	1.000
Intraoperative TIA/stroke, n (%)	0 (0.0)	8 (0.4)	1.000
Stroke within 72h, n (%)	1 (0.6)	17 (0.9)	1.000
TIA within 72h, n (%)	0 (0.0)	10 (0.5)	1.000
Death, n (%)	1 (0.6)	10 (0.5)	0.584

MI - myocardial infarction; TIA - transient ischemic attack

ference was observed between the two groups about cumulative complications (3.8% vs 4.5%; p=0.699). The median length of hospital stay did not differ significantly between the two groups (4 vs 4 days, p=0.063). Furthermore, the average clamping time did not differ between the groups (18.3 ± 5.6 vs 19.3 ± 11.9 minutes, p=0.418).

During hospitalization, one patient (0.6%) in the octogenarian group died due to a stroke. This patient initially presented with amaurosis fugax. In the control group, 10 deaths (0.5%) were recorded; 6 of these (0.3%) were attributed to neurological events. Notably, all six patients who died from stroke in the control group had initially presented with symptoms, while of the remaining deaths, one patient (0.05%) was asymptomatic, and three (0.2%) had symptomatic presentations. Statistical analysis revealed no significant difference in in-hospital mortality rates between the two groups (p=0.602).

All patients received single antiplatelet therapy after the procedure, in line with guideline recommendations. Patients with atrial fibrillation were discharged on dual therapy (antiplatelet plus anticoagulation). The only exceptions were patients with recent coronary stents (<6 months), who were also discharged on dual therapy with a recommendation to transition to monotherapy six months post-stenting. Notably, patients with both a high bleeding risk and recent coronary stents were transitioned to monotherapy within 1-3 months after stenting. All patients were discharged with statin therapy.

During a 6-month follow-up after carotid endarterectomy, 3 (2.0%) deaths were observed in the octogenarian group while in the control group, 4 (0.2%) deaths were observed (p=0.012). All deaths were reported as cardiac. One (0.6%) stroke was reported in the octogenarian group, while in the control group, 17 (1.0%) strokes were observed (p=1.000). After six months significant restenosis (>50%) was observed in 11 (7.0%) of octogenarian patients and 153 (8.0%) non-octogenarian patients (p=0.750).

DISCUSSION

The short-term outcomes following CEA between octogenarian and non-octogenarian patients provide critical insights into the procedure's efficacy and safety across different age groups. The study's findings reveal that while some differences in outcomes exist, particularly concerning cardiac-related mortality, the overall results suggest that CEA remains a viable intervention in elderly patients.

The demographic and clinical characteristics of the two groups showed several noteworthy patterns. Importantly, there was no significant difference in sex distribution or most risk factors between octogenarians and non-octogenarians. However, smoking was significantly more common in the non-octogenarian group (p<0.001), while AF was more prevalent in the octogenarian group (p=0.010). The higher prevalence of AF in older patients is consistent with the known increase in AF incidence with age and highlights the importance of considering this arrhythmia when planning perioperative management and postoperative monitoring in octogenarians[9].

On admission, the majority of patients in both groups were asymptomatic, and the presentation with TIA, amaurosis fugax, or stroke did not differ significantly between the groups. Notably, crescendo TIA, a marker of high stroke risk, was rare and comparably distributed between the groups.

Perioperative complications were similar between octogenarians and non-octogenarians, with no significant difference in cumulative complication rates. The median length of hospital stay and average clamping time were comparable, suggesting that advanced age did not significantly prolong the operative process or recovery. The in-hospital mortality rate was low in both groups, with no significant difference observed. This finding is particularly encouraging, as it suggests that with modern surgical techniques and perioperative care, CEA can be performed safely in octogenarians, resulting in low immediate postoperative mortality rates comparable to those in younger patients.

The 6-month follow-up outcomes highlighted some differences between the groups, particularly in mortality rates. The octogenarian group experienced a higher rate of cardiac-related deaths (2.0% vs 0.2%, p=0.012), suggesting that age-related cardiovascular comorbidities contribute significantly to

postoperative mortality in this population. This finding underscores the need for comprehensive cardiovascular evaluation and management in elderly patients undergoing CEA, both preoperatively and during follow-up[10].

Interestingly, the stroke rates at 6 months were low and did not differ significantly between the groups (0.6% in octogenarians vs 1.0% in non-octogenarians; p=1.000). This low incidence of stroke across both age groups reinforces the effectiveness of CEA in preventing cerebrovascular events, even in older patients. The comparable stroke rates also suggest that, despite the higher prevalence of AF and other risk factors in octogenarians, these patients can still achieve favourable neurological outcomes post-CEA.

Restenosis rates were also similar between the two groups, with significant restenosis observed in 7.0% of octogenarians and 8.0% of non-octogenarians. The comparable rates of restenosis indicate that age alone does not appear to influence the likelihood of restenosis significantly within the 6 months following CEA[11]. This finding suggests that regular follow-up and ultrasound monitoring should be equally emphasized in both elderly and younger patients to detect and manage restenosis effectively.

The findings from this study suggest that CEA is a safe and effective procedure for preventing stroke in both octogenarian and non-octogenarian patients, with relatively low perioperative and postoperative complication rates. However, the higher cardiac-related mortality observed in the octogenarian group during the 6-month follow-up highlights the need for enhanced cardiovascular care in this population. These results advocate for a patient-centred approach where the decision to perform CEA in elderly patients is based on chronological age and a comprehensive assessment of overall health, functional status, and cardiovascular risk.

This finding is further supported by a recent paper from Chang et al. that showed lower than previously reported, but significant stroke prevention that expands beyond 8 years from CEA in all age groups[12]. Furthermore, the lower adherence to statins is highlighted across the patient population which magnifies risk of stroke in elderly patients[13,14].

The similar rates of stroke and restenosis between the groups suggest that the benefits of CEA extend well into advanced age, provided that patients are carefully selected and monitored. This reinforces the procedure's role as a crucial intervention in preventing major strokes, which can carry devastating consequences, especially in the elderly. Future research should continue to explore the long-term outcomes of CEA in octogenarians, with a focus on optimizing perioperative care and postoperative follow-up to reduce further the risks associated with the procedure in this growing patient population.

CONCLUSION

Carotid endarterectomy is a safe and effective procedure for stroke prevention in octogenarians, with perioperative complication and in-hospital mortality rates comparable to those in younger patients. Although octogenarians demonstrated a higher rate of cardiac-related mortality at 6-month follow-up, the overall stroke and restenosis rates were similar across age groups. These findings suggest that age alone should not preclude CEA in elderly patients and that CEA can be a viable option for selected octogenarians with a life expectancy of more than three years as part of stroke prevention strategies

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