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Outcomes of carotid endarterectomy in symptomatic octogenarian patients

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ABSTRACT

Introduction: Carotid endarterectomy (CEA) is the standard treatment for symptomatic carotid artery stenosis (ipsilateral cerebral ischemic symptoms in the last 3months - SCS) in patients suitable for open surgery. Given the increasing age of the general population, this treatment is performed in octogenarian patients with increasing frequency. However, this population was not included in the historical randomized controlled trials and there is a lack of available data on perioperative complications, specifically the severity of possible postoperative stroke. The aim of this study is to report the outcomes of CEA for SCS in octogenarians and to evaluate the characteristics of postoperative stroke, in comparison to non-octogenarians.

Methods: This is a retrospective analysis of patients treated with CEA from 2012 to 2023 for SCS. Patients were divided according to their age in non-octogenarian (<80year-old) and octogenarian (≥80 year-old) and compared according to type of preoperative symptoms and timing of intervention. The primary endpoints of this study were to analyze the postoperative stroke and death rate and to assess the severity of postoperative stroke in octogenarian and non-octogenarian patients using the National Institute of Health Institute of Stroke Scale (NIHSS) classification. Follow-up was performed with yearly clinical visit.

Results: A total of 664 symptomatic patients were treated by CEA, 157(24 %) were octogenarian (mean age 84 ± 4) and had similar preoperative characteristics of non-octogenarian except for the distribution of preoperative neurological type of symptoms: transient ischemic attack (TIA) 51 %vs42 %,$P = .05$, amaurosis fugax (AF) 14 % vs5 %,$P = .001$; stroke 36 %vs53 %,$P = .01$. The timing between symptoms and surgery was similar between the octogenarian and non-octogenarian patients 10 ± 8vs8 ± 7 days($P = .22$). The overall postoperative rate of stroke and death was 3.1 %, similar between octogenarian and non-octogenarian: 3.7 %vs.3.1 %,$P = .39$. The type of preoperative symptoms did not affect the outcome between older and younger patients: TIA 3.4 %vs.3.3 %,$P = .63$; AF 0 %vs0 %,$P = .1.0$ and stroke 3.5 %vs.3.3 %,$P = 1.0$. In octogenarian patients stroke and death rate was similar independently on the timing of CEA performance: 3.9 %, if performed within 48h, 3.7 % between 2days and 14 days and 3.4 % after 2 weeks, $P = .72$. Postoperative stroke rate was similar in the two groups: 15(2.9 %) in non-octogenarians and 5(3 %) in octogenarian patients ($P = .1$); but moderate/severe stroke (NIHSS ≥ 5) was more frequent in octogenarian patients: 2 % vs 0.4 %, $P = .05$ The mean follow-up was 68±14 months and at 5-year the ipsilateral stroke free survival was 97.6 % ± 4 % with no differences between octogenarian and non-octogenarian: 95.2 % ± 6 %vs98.1 % ± 3 %,$P = .32$.

Conclusion: SCS octogenarian submitted to CEA have a low rate of perioperative and follow-up events, comparable with non-octogenarian. The timing and the type of symptoms do not seem to affect the CEA outcome. However, when a postoperative stroke occurs in the older patients, its severity is greater.

Introduction

Carotid endarterectomy (CEA) is recognized by current international guidelines as the treatment of choice in the prevention of cerebrovascular events in patients with symptomatic carotid artery stenosis (SCS).[1,2] While the efficacy and safety of CEA in younger and middle-aged patients are well-documented in historical randomized trials,[3–5] its application in the octogenarian population has become a

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subject of increasing interest and debate within the medical community.

With the aging population steadily growing in many parts of the world, a substantial number of octogenarians are now being diagnosed with symptomatic carotid artery stenosis, i.e. a cerebral ischemic ipsilateral event in the previous 3 months.[6]

The decision to perform CEA to this particular group of patients, however, requires a delicate balance between the potential benefits of the surgery and the risks associated with advanced age, comorbidities, and frailty.

Octogenarians often present with more comorbidities and reduced physiological reserves compared to their younger counterparts, therefore their surgical outcomes may differ.[7] Specifically, the incidence and severity of postoperative stroke in octogenarian patients following CEA remain underexplored, with limited data available to guide clinical decision-making in this age group.[8]

The aim of the present study is to offer valuable insights into the decision-making process for both clinicians and patients, reporting the outcomes of CEA for symptomatic carotid artery stenosis in octogenarians.

Methods

Study design and patients' selection

This is a multi-center, observational study without fundings from any organization and approved by the Local Review Board (Ethical Committee protocol code CE-AVEC n° 3686).

All patients underwent CEA for SCS between 2012 and 2023 in two large community hospitals, were prospectively collected and retrospectively analyzed. According to their age, patients were divided into two groups: non-octogenarian (<80 years old) and octogenarian (≥ 80 years old).

Each patient signed a dedicated informed consent for CEA and their anonymous data analysis for retrospective clinical studies as previously reported.[9–11] According with the European General Data Protection Regulation, all cases were deidentified with a coding number and clustered in an electronic database.

All patients were preoperatively evaluated by an in-hospital neurologist and preoperative neurological symptoms were categorized according to the current guidelines and modified Rankin scale (mRS)[12] in: transient ischemic attack (TIA)/Amaurosis fugax (AF), minor stroke (mRS: 0-2), Moderate severe stroke (mRS: 3-4), crescendo TIA (cTIA) / stroke in evolution (Se). mRS grades stroke-related disability as 0 (none), 1 (not significant), 2 to 3 (moderate), 4 to 5 (severe), and 6 (dead). All patients were treated with dual antiplatelet therapy from the day of the neurological event until the day of revascularization; thereafter, single antiplatelet therapy was continued. The timing of CEA was defined with the neurologist according to the ABCD2 score,[13] the clinical condition and logistic issues. The main timing target was to operate the patients within 2 weeks from the index event, except for moderate /severe stroke that are procrastinated up to neurological symptoms stabilization. For patients referring from other hospitals or with neurological symptoms with an uncertain timing onset, CEA was performed in the earliest possible time.

Surgical technique

Carotid endarterectomies are routinely performed under general anesthesia, through a longitudinal skin incision. Near-infrared spectroscopy (NIRS) is employed for cerebral monitoring throughout the surgery to ascertain optimal brain function. The use of routine shunting is preferred, with the choice between a rectus shunt (Flexcel™, LeMaitre) or an Inhara-Pruitt shunt (Pruitt F3®, LeMaitre), depending on the surgeon's preference.

Endarterectomy patch closure, with either Dacron or bovine pericardium is performed routinely. To ensure successful outcomes, completion intra-operative duplex ultrasound control is also consistently performed.

Study endpoints and follow-up

The incidence of postoperative (<30-day) and follow-up (≥30-day) stroke and death rates, taking into consideration type of symptom and timing of intervention, was assessed as primary endpoints; secondary endpoint was defined by the severity of postoperative stroke according to the NIHSS classification.[14] All patients were entered into a dedicated CEA follow-up protocol after the procedure. Follow-up was performed with yearly Doppler Ultrasound and clinical valuation.

Statistical analysis

Continuous variables were described with mean and standard deviation (SD) for normal distribution and were compared by unpaired Student' t test. The differences between percentages were assessed using Fisher's test or Chi-square test, when appropriate. Multivariate analysis was performed to investigate the influence of different risk factors on post CEA stroke and death by binary logistic regression including in the model timing of surgery and type of symptoms, as the categories of reference were considered the factors with lower risk at the univariable analysis. Risk factors were reported as odds ratio (OR) and 95 % of confidence interval (CI). A value of $p \leq .05$ (two-tailed) was considered to be significant. The statistical tests were performed using SPSS® 28.0 for Windows® (SPSS, Chicago, Il, USA).

Results

Patients selection and characteristics

A total of 664 patients with SCS underwent carotid endarterectomy during the study period. Among these patients, 24 % (157) were octogenarians, with a mean age of 84 ± 4 years. The patients' demographic characteristics, cardiovascular risk factors, and preoperative comorbidities are summarized in Table 1.

The nature and distribution of preoperative neurological symptoms differed significantly between octogenarians and non-octogenarians. Transient ischemic attacks (TIA) and amaurosis fugax (AF) were more frequent in the octogenarian group compared to the younger cohort. On the other hand, non-octogenarians exhibited a higher incidence of preoperative stroke. These differences are outlined in Table 2.

The interval between the onset of neurological symptoms and the carotid endarterectomy was comparable between the two groups. On average, octogenarians underwent surgery 10 ± 8 days after the onset of symptoms, while non-octogenarians had a slightly shorter interval of 8 ± 7 days, ($P = .22$).

Study endpoints and follow-up

The overall postoperative rate of stroke and death following CEA was

Table 1
Patients' demographic characteristics and cardiovascular risk factors.

	< 80-yo (N)	≥ 80-yo (N)	P
Male Sex	210	119	1.0
Arterial Hypertension	269	153	.73
Dyslipidaemia	219	132	.35
Type 2 diabetes mellitus	79	40	.50
Smoke habit (present or past)	12	13	.16
Coronary Artery Disease	82	44	.90
Chronic Obstructive Pulmonary Disease	82	44	.90
Atrial fibrillation	20	10	1.0
Mean age (years-old)	69(±5)	84(±4)	

Table 2
Distribution of preoperative type of symptoms in octogenarians and non-octogenarians.

	<80 yo (%)	≥80 yo (%)	p
TIA	42	51	.05
AF	5	14	.001
Stroke	53	36	.01

TIA: Transient Ischemic Attack; AF: Amaurosis Fugax.

3.1 %, similar between octogenarian and non-octogenarian patients. Specifically, 3.7 % of octogenarians experienced either a stroke or death after the procedure, compared to 3.1 % of non-octogenarians, ($P = .39$).

When the patients were stratified according to their preoperative neurological symptoms, the postoperative outcomes remained comparable between the older and the younger groups. For patients who had experienced a TIA prior to surgery, the stroke and death rate was 3.4 % in octogenarians, compared to 3.3 % in non-octogenarians ($P = .63$). Among patients presenting with AF, there were no postoperative strokes or deaths in either group ($P = 1.0$). In patients who had suffered a stroke as the index symptom, the rates of stroke or death after surgery were also similar: 3.5 % in octogenarians and 3.3 % in non-octogenarians ($P = 1.0$).

Similarly, the timing of the surgical procedure following the onset of symptoms did not significantly influence the rate of stroke or death. For octogenarian patients who underwent CEA within the first 48 hours after symptoms onset, the stroke and death rate was 3.9 %. This was comparable to octogenarians who had surgery between 2 and 14 days after symptom onset (3.7 %) and those who had the procedure more than 2 weeks later (3.4 %), $P = .72$.

The overall postoperative stroke rate across the entire patient cohort was 3 % (20 cases), with similar rates between octogenarian (3.1 %) and non-octogenarian (2.9 %) patients ($P = .1$). While the overall stroke rate was low, moderate to severe strokes occurred in 5 patients. A higher proportion of these moderate to severe strokes occurred in octogenarians, with 3 cases (2 %) in the older group compared and 2 cases (0.4 %) in the younger group ($P = .05$).

With a mean follow-up of 68 ± 14 months, freedom from ipsilateral stroke was 97.6 % ± 4 %, with no significant differences between octogenarians and non-octogenarians. In octogenarians, the ipsilateral stroke-free survival rate was 95.2 % ± 6 %, compared to 98.1 % ± 3 % in younger patients ($P = .32$).

Discussion

The life expectancy of the population is steadily increasing worldwide, leading to a growing number of octogenarian patients seeking physician assistance. As a result, more patients over the age of 80 are being evaluated and deemed eligible for CEA, a surgical procedure that continues to be the first-line treatment for SCS.

Given the physiological changes associated with aging, including the possible presence of multiple comorbidities, octogenarians may present different risks and challenges when undergoing surgical interventions. Therefore, this study seeks to evaluate the outcomes of CEA specifically in octogenarian patients, with the aim of providing valuable data to guide clinical decision-making for this subset of patients.

The postoperative and long-term follow-up data of this study reveal that age does not significantly increase the risk of adverse events, with low rates of postoperative stroke and death in both octogenarian and non-octogenarian populations (3.1 %). These findings are consistent with previous literature[15–17] suggesting that age alone should not preclude older individuals from undergoing CEA.

One of the most important findings of this analysis is that the timing of surgical intervention after symptoms onset did not significantly influence the postoperative outcomes in octogenarians, whether the procedure was performed within 48 hours (3.9 %), between 2 and 14 days (3.7 %), or after 2 weeks (3.4 %). Nevertheless, it is also interesting to see that stroke and death rates seems to be lower if the surgical repair is not executed too expeditiously, i.e. in the first 48 hours after symptoms onset. This is particularly relevant due to the possible consequences of any complication in a frail individual with decreased physiological reserve or other comorbidities.[18,19]

The type of preoperative neurological symptoms also did not appear to clearly affect the postoperative outcomes. Both octogenarians and non-octogenarians showed similar rates of postoperative stroke and death, underscoring that older patients should not be excluded from CEA based on the type of preoperative symptoms alone. Previous research already showed that neither preoperative symptoms nor timing of intervention affect post-operative stroke and death rate.[20]

Despite these findings, a specific feature of our results is related to the severity of postoperative strokes in the octogenarians. Although the overall incidence of postoperative stroke was similar between the two age groups (3.1 % vs 2.9 %), octogenarians were found to have a higher proportion of moderate to severe strokes compared to younger patients (2 % vs 0.4 %). This suggests that while CEA remains generally safe also in elderly individuals, older patients may be prone to more severe consequences in case of neurological complications, probably due to their reduced physiological reserve. These potential risks should be taken into account and tailored postoperative strategies should be undertaken to mitigate their impact.

Long-term follow-up data further support the effectiveness of CEA in octogenarians, with ipsilateral stroke-free survival rates exceeding 95 % in both age groups. Given the increasing life expectancy in the general population, the ability of CEA to offer long-term stroke prevention in octogenarians further indicates that even elderly patients can benefit from CEA for SCS

Limitations

While this study provides valuable insights into the outcomes of CEA in octogenarians, it is important to acknowledge some limitations. First of all, this study is based on retrospective data, which may introduce selection bias in patient management and outcomes. Additionally, although the study population is sizable, the number of octogenarian patients with postoperative moderate-to-severe stroke is low, indicating that these results should be interpreted with caution and, therefore, further prospective, randomized controlled trials involving octogenarians are needed to validate our results.

Conclusions

Carotid endarterectomy appears to be a safe and effective treatment option for symptomatic carotid artery stenosis in octogenarian patients, with perioperative and follow-up outcomes comparable to those of younger patients. These findings indicate that in octogenarians, the timing of surgical intervention and the type of preoperative symptoms, do not significantly influence the outcomes.

However, although the overall incidence of stroke is comparable, there is an increase severity of postoperative strokes in octogenarian patients. This suggests a greater frailty of these patients and the need of dedicated postoperative cares.

CRediT authorship contribution statement

Marcello Lodato: Writing – original draft, Data curation, Conceptualization. **Rodolfo Pini:** Writing – review & editing, Formal analysis, Data curation. **Gianluca Faggioli:** Writing – review & editing, Validation, Supervision. **Cristina Rocchi:** Data curation. **Enrico Gallitto:** Validation. **Andrea Vacirca:** Validation. **Mauro Gargiulo:** Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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