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Original Article

Association between plaque length and residual lesions after eversion carotid endarterectomy

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Abstract

Aim: Residual carotid artery lesions following eversion endarterectomy may predispose patients to restenosis and adverse clinical outcomes. This study investigated the influence of preoperative atherosclerotic plaque length and composition on the development of residual lesions after eversion endarterectomy.

Material and Methods: A retrospective analysis was conducted on patients who underwent eversion endarterectomy between January 2021 and October 2022 and had available carotid computed tomography angiography (CTA) scans both preoperatively and within 3 months postoperatively. Preoperative CTA was assessed for stenosis severity and plaque length, while postoperative CTA was reviewed for residual lesions. Resected plaque specimens were subjected to routine histopathological evaluation to determine plaque composition.

Results: A total of 42 patients (mean age, 71.3 ± 8.4 yr) were included in the study. Postoperative residual lesions were identified in six patients (14.3%). Histological analysis showed no statistically significant association between plaque composition and the presence of residual lesions. However, increased preoperative plaque length was significantly associated with residual lesions (odds ratio [OR], 1.171; 95% confidence interval [95% CI], 1.028–1.333; p = 0.0017). Receiver operating characteristic curve analysis identified a cutoff plaque length of 22.5 mm (area under the curve, 0.769; 95% CI, 0.541–0.996; p = 0.037) for predicting residual lesions.

Conclusion: Longer preoperative plaque length on carotid CTA was significantly associated with the presence of residual lesions following eversion endarterectomy. This finding suggests that increased plaque length may reflect more extensive atherosclerotic involvement of the carotid artery, potentially contributing to suboptimal surgical outcomes.

Keywords: Atherosclerotic plaque, carotid artery disease, eversion carotid endarterectomy, plaque length, residual lesion

INTRODUCTION

Atherosclerotic disease involving the carotid arteries is a major cause of ischemic stroke, primarily due to thromboembolism or acute vessel occlusion following thrombus propagation [1]. Carotid endarterectomy (CEA), a surgical technique developed more than five decades ago, remains the standard treatment for removing atherosclerotic stenosis from the carotid arteries [2].

Carotid endarterectomy has demonstrated safety and efficacy in treating both symptomatic and asymptomatic carotid artery stenosis. However, postoperative restenosis continues to pose a significant clinical challenge. Numerous studies have examined systemic and technical risk factors for restenosis, highlighting the potential role of various atherosclerotic plaque characteristics in its development [3].

Emerging evidence suggests that residual lesions of the carotid artery following endarterectomy may serve as precursors to

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restenosis and cerebrovascular adverse events [4-6]. Reported incidences of residual lesions detected via computed tomography angiography (CTA) after surgery are notably high, reaching up to 89.2% in some cohorts [7]. Although the clinical impact of these residual lesions on long-term outcomes remains uncertain, a better understanding of their nature may help mitigate the risk of restenosis and postoperative complications.

Eversion CEA is a widely used surgical variant that involves transection of the internal carotid artery (ICA) at the bifurcation, blunt dissection and removal of the atherosclerotic plaque, and reimplantation of the artery at its origin. This technique has been associated with a reduced risk of long-term restenosis, possibly due to the formation of a natural anastomosis at the carotid stump [8].

However, limited data exist on the relationship between atherosclerotic plaque characteristics and the development of residual lesions following eversion endarterectomy. Therefore, this retrospective study aimed to (a) identify the presence of residual lesions after eversion CEA and (b) assess the impact of preoperative plaque length and histopathological plaque composition on the occurrence of these lesions.

MATERIAL AND METHODS

This retrospective study consecutively enrolled patients who underwent eversion CEA at a tertiary care hospital between January 2021 and October 2022. The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Ethical approval was obtained from the Aydın Adnan Menderes University Non-Interventional Clinical Research Ethics Committee (Decision No: 2, Protocol No: 2022/202, Date: 08 December 2022).

The primary endpoint was the presence of postoperative residual lesions detected on CTA. Surgical indications included asymptomatic carotid artery stenosis of 60%–99% or symptomatic stenosis > 50% [9]. Patients were eligible for inclusion if they had both preoperative and postoperative CTA within 3 months of surgery [7,10]. CTA images were evaluated to assess preoperative stenosis severity, plaque length, and the presence of postoperative residual lesions. Patients monitored using only duplex ultrasound were excluded to avoid interobserver variability in detecting residual lesions. Atherosclerotic plaques excised during surgery were routinely submitted for histopathological evaluation.

Surgical Technique

All procedures were performed under general anesthesia by the same surgical team; none were performed under local or regional anesthesia. Intraoperative neuromonitoring, including near-infrared spectroscopy (NIRS), was not routinely used. Shunting was not routinely performed. The carotid bifurcation was exposed, and the internal, external, and common carotid arteries were encircled with vascular tapes. Anticoagulation was achieved using a 5.000-IU intravenous heparin bolus. Activated clotting time was measured 3 min post-injection, and additional heparin was administered as needed.

Arterial clamping was performed in the following sequence: internal, common, and external carotid arteries. The ICA was transected at its origin, and the atherosclerotic plaque was circumferentially dissected and removed via eversion. Backbleeding was permitted by temporarily releasing the ICA clamp to flush out debris. If plaque extended into the proximal common carotid artery, an additional endarterectomy was performed. The ICA was then reimplanted at its origin using 6-0 polypropylene running sutures. The duration of carotid clamping was recorded for each case. Postoperative complications, including hematoma, surgical revision, cranial nerve injury, stroke, and transient ischemic attack (TIA), were documented.

Radiological Assessment

All CTA examinations were performed using a 128-detector, 160-slice CT scanner (Prime Aquilion, Toshiba Medical Systems, Otawara, Japan). Each scan included six series across axial, sagittal, and coronal planes with a slice thickness of 3 mm, acquired before and after administration of intravenous contrast. A 70- to 100-mL bolus of nonionic iodinated contrast agent (300 mg/mL) was injected into the antecubital vein at 4 mL/s using an automated injector. Image analysis was conducted using the vessel analysis tool on a Sectra workstation (version 25.2; Sectra AB, Linköping, Sweden). Two radiologists reviewed all images by consensus.

Preoperative plaque length was measured using semiautomated curved centerline tracking from the aortic arch to the ICA apex, followed by multiplanar reconstruction in the sagittal plane. The maximum craniocaudal length of the plaque was recorded.

The degree of stenosis was calculated using axial CTA images based on the luminal cross-sectional area at the narrowest point and at a nearby healthy segment. The stenosis percentage was determined using the formula: (1 – [narrowest luminal area/poststenotic luminal area]) × 100 [11].

Postoperative CTA images were assessed for residual lesions, including residual plaque, intimal defects, and arterial irregularities such as folding, kinking, or angulation. When residual plaque was detected, its longest dimension was measured in all three planes to ensure accuracy.

Histological Evaluation

Plaque specimens were fixed in 10% formalin, dehydrated, and embedded in paraffin. Hematoxylin and eosin (H&E)–stained slides were prepared using standard techniques. Histological features evaluated included inflammation, calcification, neovascularization, fatty changes, fibrous cap formation, and intraplaque hemorrhage. Each feature was scored as absent (0) or present (1).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was used to assess normality of continuous variables, and the normality assumption was evaluated accordingly. The independent samples t-test was used for normally distributed variables, and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate.

Univariate logistic regression was conducted to identify factors associated with the presence of residual lesions. The diagnostic performance of preoperative plaque length for predicting residual lesions was assessed using receiver operating characteristic (ROC) curve analysis. Continuous variables are presented as mean ± standard deviation (SD) or as median (range), and categorical variables are reported as frequency (percentage). A p-value < 0.05 was considered statistically significant.

RESULTS

The study included 42 patients: 33 males (78.6%) and nine females (21.4%), with a mean age of 71.31 ± 8.43 years. Symptomatic carotid artery stenosis was observed in 23 patients (54.8%). Postoperative CTA revealed residual lesions in six patients (14.3%). The characteristics of these residual lesions and their associated degrees of stenosis are detailed in Table 1, and corresponding sagittal CTA images are presented in Figure 1.

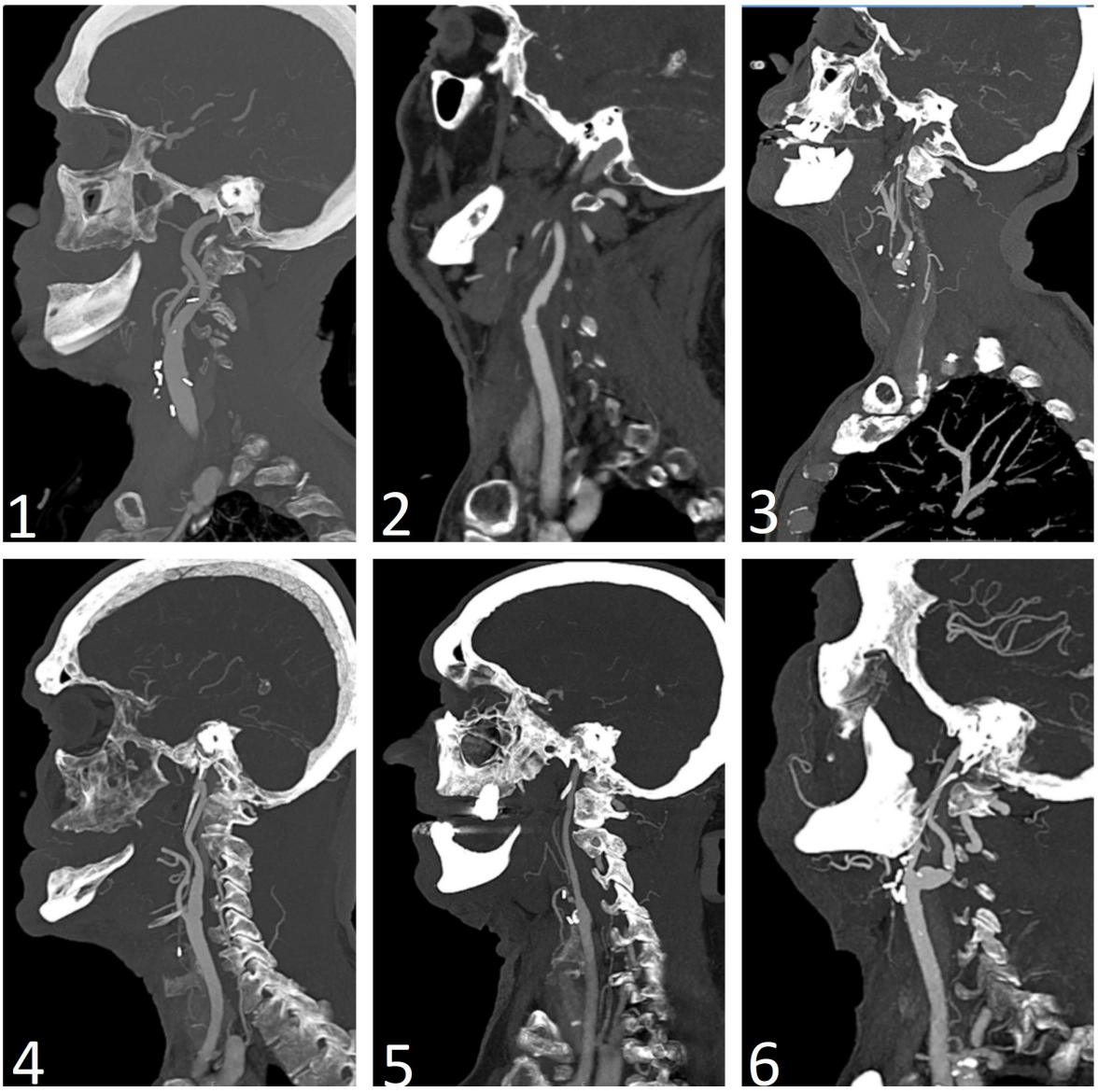

Figure 1. CTA images (sagittal section) of postoperative residual lesions (Cases 1-6 in sequence)

Table 1. Types of residual lesions detected on radiological assessment

Type of residual lesion	Postoperative plaque length	Postoperative stenosis
Case 1- Residual plaque in the bulb and proximal internal carotid artery	10 mm	0%
Case 2- Intimal folding in the posterior wall of the anastomosis	6 mm	0%
Case 3- Total occlusion of the common carotid artery	47 mm	100%
Case 4- Residual plaque in the proximal internal carotid artery	7 mm	0%
Case 5- Residual plaque in the bulb and distal common carotid artery	12 mm	7.5%
Case 6- Residual plaque in the bulb and proximal internal carotid artery	6 mm	46%

Patients were categorized into two groups based on the presence of postoperative residual lesions: lesion (+) for those with residual findings and lesion (−) for those without. Table 2 summarizes the demographic data and comorbidity profiles for both groups.

The mean carotid clamp time was 19.8 ± 1.16 min. A statistically significant difference in clamp duration was noted between the groups (p = 0.002). No in-hospital mortality occurred. Four patients (9.5%) experienced postoperative stroke or TIA: three in the lesion (+) group and one in the lesion (−) group. Postoperative complications in the lesion (−) group included hematoma (n = 2) and cranial nerve injury (n = 2). One patient in the lesion (+) group required surgical revision due to acute common carotid artery occlusion. However, the overall incidence of complications did not differ significantly between the groups (p>0.05).

The mean atherosclerotic plaque length was 19.24 ± 8.61 mm, and the mean degree of stenosis was 78.45 ± 10.38 across the study cohort. Plaque length was significantly longer in the lesion (+) group (29.00 ± 12.60 mm) than in the lesion (−) group (17.62 ± 6.71 mm; p = 0.002). The degree of stenosis, however, did not differ significantly between the groups.

Table 2. Demographic and clinical characteristics of patients

Variable	Total (n = 42)	Residual lesion		
		(+) (n = 6)	(-) (n = 36)	p-value
Age (mean ± SD)	71.31 ± 8.43	71.44 ± 8.77	70.50 ± 6.26	0.803*
Gender n, (%)				
Male	33 (78.6)	6 (100)	27 (75)	0.312+
Female	9 (21.4)	0 (0)	9 (25)	
Diabetes mellitus n, (%)	12 (28.6)	1 (16.7)	11 (30.6)	0.439#
Hypertension n, (%)	34 (81)	6 (100)	28 (85.7)	0.256#
Coronary artery disease n, (%)	15 (35.7)	4 (66.7)	11 (30.6)	0.108#
Chronic kidney disease n, (%)	1 (2.4)	0 (0)	1 (2.8)	0.857#
Chronic obstructive pulmonary disease n, (%)	4 (9.5)	2 (33.3)	2 (5.6)	0.091#
Peripheral artery disease n, (%)	4 (9.5)	2 (33.3)	2 (5.6)	0.091#
Smoking n, (%)	18 (42.9)	4 (66.7)	14 (38.9)	0.375+
Acetylsalicylic acid n, (%)	32 (76.2)	5 (83.3)	27 (75)	0.557#
Clopidogrel n, (%)	32 (76.2)	4 (66.7)	29 (77.8)	0.443#
Vitamin K Antagonist n, (%)	1 (2.4)	0 (0)	1 (2.8)	0.857#
Novel oral anticoagulants n, (%)	5 (11.9)	1 (16.7)	4 (11.1)	0.557+
Symptomatic n, (%)	23 (54.8)	3 (50)	20 (55.6)	1.000+
Contralateral Carotid Artery Stenosis	25 (59.5)	4 (66.7)	21 (58.3)	1.000+
Contralateral Carotid Artery Occlusion n, (%)	3 (7.1)	0 (0)	3 (8.3)	0.622#

*: Student's t-test; #: Chi-square test; +: Fisher's exact test

Histopathological analysis of the plaque specimens revealed fatty changes in 54.8% (n = 23), fibrous formation in 47.6% (n = 20), calcification in 78.6% (n = 33), inflammation in 21.4% (n = 9), neovascularization in 16.7% (n = 7), and intraplaque hemorrhage in 14.3% (n = 6). Representative histological features are shown in Figure 2, and the complete distribution is presented in Table 3. No statistically significant differences in histological features were observed between the two groups.

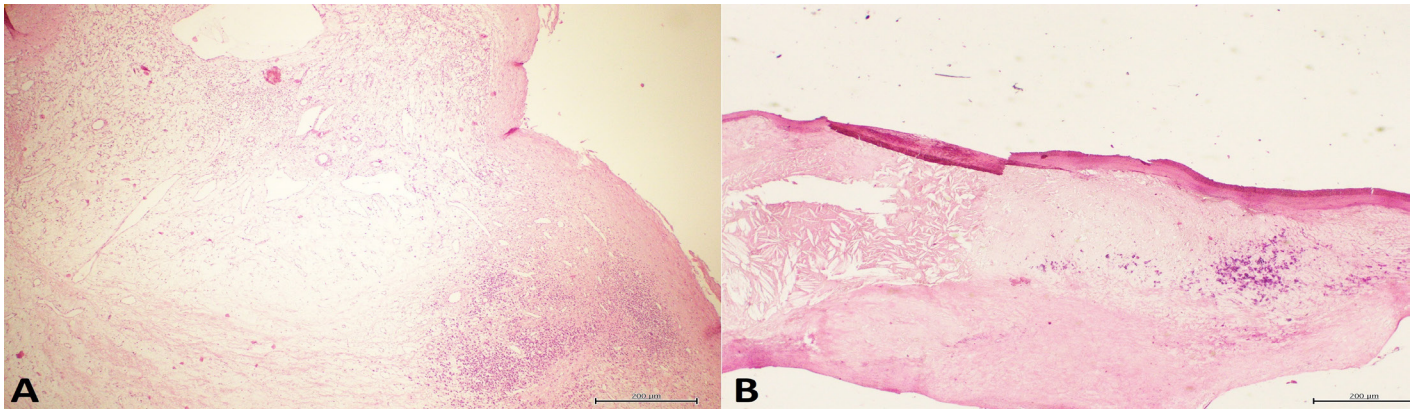

Figure 2. Examples of histological sections of carotid plaques: A) Neovascularization and inflammation within the plaque, B) Cholesterol clefts and focal calcification within the plaque

Table 3. Histological examination of plaque content in groups

Histopathological features	Residual Lesion		Total (n = 42)	p value
	(-) (n = 36)	(+) (n = 6)		
Fatty changes				
Negative	15 (41.7)	4 (66.7)	19 (45.2)	0.384[f]
Positive	21 (58.3)	2 (33.3)	23 (54.8)	
Fibrous formations				
Negative	20 (55.6)	2 (33.3)	22 (52.4)	0.400[f]
Positive	16 (44.4)	4 (66.7)	20 (47.6)	
Calcification				
Negative	8 (22.2)	1 (16.7)	9 (21.4)	1.000[f]
Positive	28 (77.8)	5 (83.3)	33 (78.6)	
Inflammation				
Negative	29 (80.6)	4 (66.7)	33 (78.6)	0.593[f]
Positive	7 (19.4)	2 (33.3)	9 (21.4)	
Neovascularization				
Negative	31 (86.1)	4 (66.7)	35 (83.3)	0.257[f]
Positive	5 (13.9)	2 (33.3)	7 (16.7)	
Intraplaque hemorrhage				
Negative	31 (86.1)	5 (83.3)	36 (85.7)	1.000[f]
Positive	5 (13.9)	1 (16.7)	6 (14.3)	

f: Fisher's exact test; values are presented as n (%)

Univariate logistic regression analysis was performed to evaluate predictors of residual lesions. Among all variables assessed—including degree of stenosis, plaque length, and histological features—only preoperative plaque length significantly predicted residual lesion presence (odds ratio [OR]: 1.171; 95% CI, 1.028–1.333; p = 0.0017). ROC curve analysis determined

that a plaque length of 22.5 mm predicted residual lesions with a sensitivity of 66.7% and a specificity of 72.2% (AUC: 0.769; 95% CI, 0.541–0.996; p = 0.037; Figure 3).

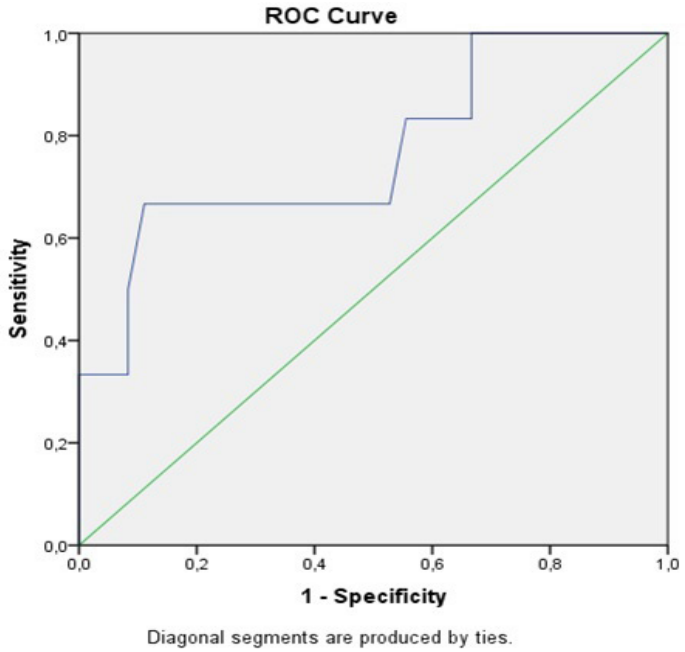

Figure 3. The ROC curve showing the role of the preoperative atherosclerotic plaque length in predicting postoperative residual lesions

DISCUSSION

This study aimed to evaluate the presence of residual lesions following eversion CEA and investigate whether specific characteristics of atherosclerotic plaques were associated with these lesions. Our findings indicate that the length of the atherosclerotic plaque, as measured on preoperative CTA, was significantly associated with the presence of postoperative residual lesions. In contrast, neither the degree of preoperative stenosis nor the histological composition of the plaque appeared to influence the development of residual lesions.

In our clinical practice, eversion carotid endarterectomy is routinely preferred as the primary surgical technique. The National Guideline for Peripheral Arterial and Venous Diseases states that eversion endarterectomy may be selected at the discretion of the surgical team and is recommended as a Class I recommendation. The guideline also highlights several technical advantages of the eversion technique, including reduced need for shunt use, shorter clamping time, and the ability to correct arterial elongation [12]. Reported rates of residual lesions after CEA vary depending on imaging modality, timing of postoperative evaluation, and surgical technique. Previous studies have reported residual lesion rates of 17%–21%, often associated with increased postoperative complications, especially in patients who underwent primary suture closure of the carotid artery [13,14]. In a study by van der Kolk et al. [7], postoperative CTA performed 1–3 months after surgery revealed residual defects in 58 of 65 patients, most of whom had undergone patch closure. However, the study found no significant association between these residual lesions and postoperative ischemic events.

Green et al. [15] assessed residual lesions using intraoperative duplex ultrasound in patients undergoing CEA via patch or eversion techniques and reported that only 2 of 107 patients who underwent eversion CEA required surgical revision due to residual lesions. In our study, postoperative CTA was performed within 3 months of surgery in 42 patients who exclusively underwent eversion CEA. The incidence of residual lesions in our cohort was 14.3%. However, this finding should be interpreted cautiously, given the retrospective design of our study.

Despite the small sample size, we observed no significant difference in the incidence of neurological complications or severe postoperative stenosis (>50%) between patients with and without residual lesions. Although the overall rate of postoperative stroke or TIA may appear relatively high, this study did not include all patients who underwent CEA during the study period. In routine practice, most patients are followed up with duplex ultrasound, and only symptomatic cases typically undergo urgent CTA for more detailed assessment of the carotid and cerebral vasculature.

The most commonly observed residual lesion (in four cases) involved persistent plaque at the carotid bulb and bifurcation. In one case, intimal folding was noted at the ICA anastomosis site. Although these residual lesions did not cause significant stenosis, one patient developed common carotid artery occlusion and suffered an early postoperative stroke. This patient had the longest preoperative plaque (49 mm) among those with residual lesions. During reoperation, a clamp injury and severe intimal defect of the common carotid artery were identified, necessitating thrombectomy and prosthetic graft interposition to restore arterial flow.

Extensive atherosclerotic involvement of the common carotid artery may pose technical challenges during eversion CEA. Inadequate plaque removal at the proximal endarterectomy site, particularly in cases with diffuse plaque, may contribute to residual lesions [8,15]. Supporting this hypothesis, we found that most residual lesions were located near the distal stump of the common carotid artery, where the ICA is transected during the eversion technique. Furthermore, our data indicate that longer preoperative plaque length is significantly associated with the presence of residual lesions after eversion CEA.

Although certain plaque characteristics are more common in symptomatic carotid disease, their predictive value for residual lesions or restenosis post-CEA remains unclear [16,17]. Zhou et al. [3] conducted a systematic review and concluded that heavily calcified plaques were associated with an increased risk of restenosis within 6 months after CEA. In our study, we performed

histological analysis of plaque specimens removed during eversion CEA. Fatty changes and calcification were the most frequently observed features. However, none of the evaluated histological characteristics were significantly associated with postoperative residual lesions. This finding suggests that plaque composition may not significantly affect the completeness of plaque removal in eversion CEA, although it may influence subsequent myointimal changes.

Limitations

This study has several limitations. First, it has a retrospective design and represents a single-center cohort with a relatively limited number of patients. In addition, patient selection was restricted to individuals who had both preoperative and postoperative carotid computed tomography angiography (CTA) within the first three months after surgery. Although duplex ultrasonography is commonly used in routine clinical follow-up, only patients with available CTA imaging were included in order to ensure a more standardized, observer-independent radiological assessment. Nevertheless, this selection may have influenced the observed prevalence of residual lesions. In addition, postoperative CTA may have been obtained more frequently in patients who developed neurological symptoms during follow-up, which could have contributed to the relatively higher rate of postoperative stroke or TIA observed in this cohort.

CONCLUSION

This study demonstrated a significant association between increased atherosclerotic plaque length and the presence of postoperative residual lesions following eversion CEA. A longer plaque length may reflect more diffuse atherosclerotic involvement of the carotid artery, potentially complicating complete plaque removal during surgery. Our findings suggest that a preoperative plaque length > 22.5 mm may predict residual lesions. Although such lesions rarely lead to early postoperative complications, their long-term clinical relevance remains unclear. Further prospective, randomized studies are warranted to elucidate the implications of residual lesions on late postoperative outcomes. Despite these limitations, the limited available data on residual lesions after eversion carotid endarterectomy indicate that the findings of the present study may contribute to the existing literature.

Ethics Committee Approval: It was received from the Aydın Adnan Menderes University Non-Interventional Clinical Research Ethics Committee (Date: 08 December 2022, Decision No: 2, Protocol No: 2022/202,).

Patient Consent for Publication: This study was conducted in accordance with the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent forms were waived. Confidentiality of personal data was meticulously protected, and patient identities were anonymized.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Ballotta E, Angelini A, Mazzalai F, Piatto G, Toniato A, Baracchini C. Carotid endarterectomy for symptomatic low-grade carotid stenosis. J Vasc Surg. 2014;59:25-31.
2. Padayachee TS, Arnold JA, Thomas N, Aukett M, Colchester AC, Taylor PR. Correlation of intra-operative duplex findings during carotid endarterectomy with neurological events and recurrent stenosis at one year. Eur J Vasc Endovasc Surg. 2002;24:435-9.
3. Carnicelli AP, Stone JJ, Doyle A, Chowdhry AK, Mix D, Ellis J, et al. Cross-sectional area for the calculation of carotid artery stenosis on computed tomographic angiography. J Vasc Surg. 2013;58:659-65.
4. Naylor R, Rantner B, Ancetti S, de Borst GJ, De Carlo M, Halliday A, et al. Editor's Choice - European Society for Vascular Surgery (ESVS) 2023 Clinical Practice Guidelines on the Management of Atherosclerotic Carotid and Vertebral Artery Disease. Eur J Vasc Endovasc Surg. 2023;65:7-111.
5. Davidovic LB, Tomic IZ. Eversion carotid endarterectomy : a short review. J Korean Neurosurg Soc. 2020;63:373-9.
6. Green RM, Greenberg R, Illig K, Shortell C, Ouriel K. Eversion endarterectomy of the carotid artery: technical considerations and recurrent stenoses. J Vasc Surg. 2000;32:1052-61.
7. Jackson MR, D'Addio VJ, Gillespie DL, O'Donnell SD. The fate of residual defects following carotid endarterectomy detected by early postoperative duplex ultrasound. Am J Surg. 1996;172:184-7.
8. Howard DP, van Lammeren GW, Redgrave JN, Moll FL, de Vries JP, de Kleijn DP, et al. Histological features of carotid plaque in patients with ocular ischemia versus cerebral events. Stroke. 2013;44:734-9.
9. Donaldson MC, Ivarsson BL, Mannick JA, Whittemore AD. Impact of completion angiography on operative conduct and results of carotid endarterectomy. Ann Surg. 1993;217:682-7.
10. Mechtouff L, Rascle L, Crespy V, Canet-Soulas E, Nighoghossian N, Millon A. A narrative review of the pathophysiology of ischemic stroke in carotid plaques: a distinction versus a compromise between hemodynamic and embolic mechanism. Ann Transl Med. 2021;9:1208.
11. van der Kolk AG, de Borst GJ, Jongen LM, den Hartog AG, Moll FL, Mali WP, et al. Prevalence and clinical consequences of carotid artery residual defects following endarterectomy: a prospective CT angiography evaluation study. Eur J Vasc Endovasc Surg. 2011;42:144-52.

12. Bozkurt K. Periferik Arter Ve Ven Hastalıkları, Ulusal Tedavi Klavuzu 2021.1st. ed. vol1.2021. p. 100-34.

13. Sadideen H, Taylor PR, Padayachee TS. Restenosis after carotid endarterectomy. Int J Clin Pract. 2006;60:1625-30.

14. Liapis CD, Paraskevas KI. Role of residual defects following carotid endarterectomy in the occurrence of cerebrovascular symptoms. Vasc Endovascular Surg. 2006;40:119-23.

15. Xin WQ, Li MQ, Li K, Li QF, Zhao Y, Wang WH, et al. Systematic and comprehensive comparison of incidence of restenosis between carotid endarterectomy and carotid artery stenting in patients with atherosclerotic carotid stenosis. World Neurosurg. 2019;125:74-86.

16. Zhou F, Hua Y, Ji X, Jia L. A systemic review into carotid plaque features as predictors of restenosis after carotid endarterectomy. J Vasc Surg. 2021;73:2179-88.e4.

17. Kazantsev AN, Korotkikh AV, Unguryan VM, Belov YV. Update in Carotid Disease. Curr Probl Cardiol. 2023;48:101676.