Echolucent or predominantly echolucent femoral plaques predict early restenosis after eversion carotid endarterectomy

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Objective: **Although the association between vulnerable lesions and cardiovascular events is well established, little is known about their relationship to postsurgery restenosis. To address this issue, we initiated a prospective, nonrandomized study to examine the femoral plaques on both sides in patients who were undergoing eversion carotid endarterectomy (CEA) and were longitudinally followed-up for early restenosis development.**

Methods: **The final analysis enrolled 321 patients (189 women) with a median age of 67.0 years (interquartile range, 59.0-73.0 years), who underwent eversion CEA (2005 to 2007). Using duplex ultrasound scanning, we evaluated 321 common femoral atherosclerotic lesions on the day before CEA. A quantitative scale was used to grade the size of plaques as grade 1, one or more small plaques (<20 mm^2); grade 2, moderate to large plaques; and grade 3, plaques giving flow disturbances. The plaque morphology in terms of echogenicity was graded as echolucent, 1; predominantly echolucent, 2; predominantly echogenic, 3; echogenic 4; or calcified, 5. The plaque surface was categorized as smooth, irregular, or ulcerated. The patients underwent carotid duplex ultrasound imaging at 6 weeks and at 6, 12, and 24 months after CEA. Mann-Whitney *U* test, χ^2 test, and multivariate logistic regression were used for statistical evaluation.**

Results: **Internal carotid artery restenosis of ≥50% was detected in 33 patients (10.28%) in the operated region. Neither the size (grade 1, *P* = .793; grade 2, *P* = .540; grade 3, *P* = .395) nor the surface characteristics of the femoral plaques (smooth, *P* = .278; irregular, *P* = .281; ulcerated, *P* = .934) were significantly different between the patients with and without carotid restenosis. Echolucent-predominantly echolucent femoral lesions were an independent predictor of recurrent carotid stenosis (adjusted odds ratio, 5.63; 95% confidence interval, 2.14-10.89; *P* < .001).**

Conclusion: **Ultrasound evaluation of femoral plaque morphology before CEA can be useful for identifying patients at higher risk for carotid restenosis. (J Vasc Surg 2010;51:345-50.)**

Eversion endarterectomy of the carotid artery (CEA) is a generally accepted elective surgical method in both symptomatic and asymptomatic patients with significant internal carotid artery (ICA) stenosis. Despite of the best surgical care, recurrent stenosis has been reported to occur in 1% to 36% of patients.[1] Stoney and String[2] were the first to classify carotid restenoses into two distinct types: lesions occurring ≤2 years after CEA were attributed to intimal hyperplasia and thereafter, to recurrent atherosclerosis.

Multiple inflammatory mediators, including growth factors and cytokines, have been postulated to play different roles to trigger the neointimal response.[3] Similarly, inflammation is involved in all stages of the atherosclerotic process, from the initiation of the fatty streak to the final stage of plaque rupture.[4] Histologic findings have revealed that high-risk vulnerable lesions have a thin fibrous cap, a large lipid pool, and a macrophage dense inflammation on or beneath their surface.[5,6] Ultrasound (US) images show these rupture-prone plaques are predominantly echolucent and heterogeneous, as well as ulcerated.[7]

Previous work has shown that the presence of femoral atherosclerotic lesions has a predictive value for future cardiovascular events. Moreover, the size and echogenicity of the plaques were important determinants of the vascular risk.[8] Novo et al[9] reported a significantly higher prevalence of femoral lesions in patients with restenosis after percutaneous coronary interventions than in those without recurrent lumen narrowing. A 2009 study by Sirico et al[10] demonstrated that in patients with peripheral artery disease, the presence of echolucent femoral plaques was associated with a greater prevalence of echolucent carotid lesions. Much less is known about the femoral plaques in relation to recurrent carotid stenosis. The primary aim of the present study was to investigate the putative role of femoral plaque size and lesion characteristics on US imaging in patients who were undergoing carotid eversion endarterectomy and were longitudinally followed-up for early ICA restenosis development.

PATIENTS AND METHODS

This prospective study enrolled 402 consecutive patients scheduled for CEA between June 1, 2005, and

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March 31, 2007. All patients were treated at the Cardiovascular Surgery Department of Semmelweis University, Budapest, Hungary. None of these patients had prior ipsilateral CEA or stent implantation. The study was performed in accordance with the Declaration of Helsinki and was approved by the local Ethics Committee. All participants provided informed consent.

Patient data. At baseline, clinical history and physical examination were evaluated with special attention to cardiovascular risk factors to determine their relationship with occurrence of carotid restenosis: age, gender, body mass index (BMI), history of smoking, and presence of hypertension, diabetes mellitus, and hyperlipidemia. The risk factors were assessed by a review of medical records combined with a patient questionnaire.

- The BMI was calculated as kg/m^2.
- Smoking habit was coded as smokers and nonsmokers. Current cigarette smoking was defined as a daily intake of more than five cigarettes. Nonsmokers included those who had never smoked, former smokers who had quit smoking for ≥1 year before the study, and those whose daily intake was less than five cigarettes.
- Hypertension was diagnosed in patients with resting blood pressure values >140/90 mm Hg measured repetitively (at least twice) and was assumed to be present in patients taking antihypertensive drugs.
- Diabetes was defined as self-reported history of diabetes mellitus, use of antidiabetic drugs, or a fasting blood glucose >5.8 mmol/L, oral glucose tolerance test results suggestive of disease, or glycated hemoglobin A_{1C} level >6.2%.
- Hyperlipidemia was defined as any or all of an elevation of fasting triglycerides >1.7 mmol/L, total cholesterol >5.0 mmol/L, or low-density lipoprotein cholesterol >3.0 mmol/L, and was considered to be present in patients receiving lipid-lowering medication.

Neurologic events were also documented and categorized as transient ischemic attack (TIA), minor stroke, and major stroke. A TIA was termed any neurologic deficit that resolved ≤24 hours without evidence of any residual neurologic damage thereafter. A minor stroke was classified as a new neurologic event that resulted in a slight impairment of neurologic function that either resolved completely ≤7 days or caused an increase in the National Institute of Health Stroke Scale (NIHSS) of <4. A new neurologic deficit that persisted >7 days or increased the NIHSS by ≥4 was defined as a major stroke.[11] Current use of statin and antiplatelet (acetylsalicylic acid, dipyridamole, clopidogrel) therapy was recorded for each patient.

Baseline US evaluation. Each patient had femoral US examination the day before surgery at our department. B-mode and color Doppler measurements were performed using a SSA-700A US machine (Aplio; Toshiba Medical Systems, Tustin, Calif) equipped with a linear array broadband 7-4-MHz transducer. All femoral duplex US (DUS) scans were performed and analyzed by the same senior vascular radiologist. The common femoral artery (CFA) was scanned bilaterally distal to the inguinal ligament along a section approximately 4 cm proximal and 1 cm distal to the flow divider (the site where the artery divides into the superficial and profound femoral arteries) to assess the occurrence of plaques.

Femoral plaque was defined as a focal widening >50% relative to the adjacent segment, as recommended by the US Task Force on noninvasive atherosclerosis measurement.[12] Each plaque was measured in its own longitudinal view in which the plaque was biggest. A cursor on the screen was used to trace the perimeter of the plaque, and intrinsic software of the DUS scanner was used to compute the cross-sectional area of the plaque. The cross-sectional areas of all CFA plaques were then summed to give the total plaque area. The plaques were categorized as grade 1, one or more small plaques (total plaque area $<20\ mm^2$); grade 2, moderate to large plaques; and grade 3, plaques causing flow disturbances.[13] This analysis included plaques in the near wall as well as the far wall of the vessel. When the plaque size was different between the two sides, the higher grade was considered for further evaluation.

The plaque morphology in terms of echogenicity was visually judged and graded from 1 to 5 as echolucent, 1; predominantly echolucent, 2; predominantly echogenic, 3; echogenic, 4; or calcified, 5.[14] Echogenicity was standardized against three reference structures: flowing blood for echolucent, iliopsoas muscle for isoechogenic, and the bright far wall media-adventitia interface for echogenic plaques.[15] Calcified plaques had zones of acoustic shadowing that obscured the deeper part of the arterial wall as well as the vessel lumen. The plaque surface was categorized as smooth, irregular, or ulcerated. The height variations of the surface were determined by using the software incorporated in the US machine. The surface was regarded as irregular in the case of height variations of between 0.4 and 2 mm on the contour of the plaque.

Ulceration was defined as a recess that was at ≥2 mm deep and 2 mm long and had an area of reversed flow within the recess or a zone of low flow signal at the level of the recess.[16] In patients with multiple plaques, only the thickest was selected for analysis.

The US images were sent to a PACS (Picture Archiving Communication System) workstation, and 50 randomly chosen plaques were re-evaluated by the same radiologist at the end of the study. The intraobserver reproducibility for plaque size and morphology (echogenicity, surface characteristics) was good ($\kappa = .81$, $\kappa = .79$, $\kappa = .71$, respectively).

Eversion CEA. The criteria to perform CEA were based on the recommendations by the American Heart Association.[17] The procedures were performed with the patient under deep general anesthesia by four experienced vascular surgeons. After systemic heparinization, the distal internal, common, and external carotid arteries were clamped. The ICA was transected obliquely from the common carotid artery (CCA). The ICA wall was everted over the atheromatous core until a distal end point was directly visualized. After the ICA had been completely endarterectomized, significant disease in the common and external

carotid arteries were removed. The ICA was then reanastomosed to the CCA. All patients were prescribed an acetylsalicylic acid regimen (325 mg daily) ≤24 hours postoperatively, which was continued indefinitely.

Follow-up. Follow-up visits were scheduled at 6 weeks, and at 6, 12, and 24 months after CEA. Outpatient carotid DUS scans were performed by another experienced radiologist who was unaware of the results of CFA plaque characterization. The common, internal, and external carotid arteries on both sides were examined in the standard fashion. Representative values of peak systolic velocity (PSV) and end-diastolic velocity (EDV) were measured. The PSV of the ICA was the primary parameter for the grading of ICA restenosis. If the degree of recurrent ICA stenosis was indeterminate according to the PSVs, then additional parameters, including the ICA/CCA PSV ratio and the ICA EDV were considered. A 50% to 69% ICA restenosis was diagnosed when ICA PSV was 125 to 230 cm/s. Additional criteria included an ICA/CCA PSV ratio of 2.0 to 4.0 and ICA EDV of 40 to 100 cm/s. A ≥70% ICA restenosis was diagnosed when the ICA PSV was >230 cm/s. Additional criteria included an ICA/CCA PSV ratio >4.0 and ICA EDV >100 cm/s. These criteria had been established according to the Society of Radiologists in Ultrasound Consensus Conference and were internally verified.[18]

Statistical analysis. Statistical analyses were performed using Statistica 8.0 software (StatSoft Inc, Tulsa, Okla). Categoric variables were expressed as numbers and percentages and were compared between groups using the χ^2 test. Continuous variables were assessed for normality by using the Shapiro-Wilk test. Because continuous variables exhibited a non-Gaussian distribution, they were expressed as medians and interquartile ranges (IQR) and were compared using the nonparametric Mann-Whitney *U* test. All analyses were two-tailed and values of $P \leq .05$ were considered as statistically significant.

To identify the independent predictors of early carotid restenosis, multivariate logistic regression was done with adjustment for age, gender, BMI, and follow-up time. The dependent variable was ≥50% ICA restenosis. In case of combined variables, patients who fulfilled the criteria of both single variables were compared with those who did not have the combined characteristics. All variables with a value of $P \leq .05$ in the univariate analysis were tested. Intraobserver reproducibility was calculated using the Cohen κ statistic.

RESULTS

Nine of the 402 patients (2.24%) did not undergo follow-up because of all-cause mortality, including stroke in three patients, acute myocardial infarction in four, and cancer in two. No plaques were found in the CFAs in 18 patients (4.48%) and they were excluded from the study because the inclusion criterion for this investigation was the presence of femoral plaque. Unilateral or bilateral femoral artery reconstruction was done in 13 patients (3.23%). Patients with unilateral femoral artery reconstruction were also excluded under the assumption that the revascularized artery had the higher plaque grade. The evaluation of the CFA lesions was impossible because of the marked acoustic shadow in 15 patients (3.73%). Bilateral femoral occlusive disease was present in eight patients (1.99%). Four patients (0.99%) were followed-up at other hospitals, and 14 (3.48%) were lost to follow-up.

The final analysis therefore included 321 patients (189 women) with 321 arteries. Their median age was 67.0 years (IQR, 59.0-73.0 years). Their median BMI was 25.0 kg/m^2 (IQR, 21.0-26.0 kg/m^2). Risk factors included smoking in 258 patients (80.37%), hypertension in 197 (61.37%), diabetes mellitus in 78 (24.30%), and hyperlipidemia in 127 (39.56%). Preoperatively, 95 patients (29.60%) were asymptomatic, 194 (60.44%) had TIA, 26 (8.10%) had minor stroke, and 6 (1.87%) had major stroke. Statin usage in 135 patients (42.06%) and antiplatelet therapy in 220 patients (68.54%) was recorded.

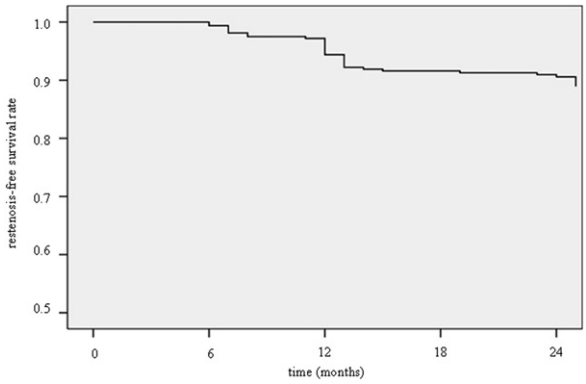
Follow-up period. The median follow-up time was 24.3 months (IQR, 22.9-25.4 months). Five (3 minor strokes, 2 major strokes) nonfatal perioperative strokes (1.56%) occurred. Cardiogenic embolization caused minor strokes in two additional patients ≤2 years after CEA. Nonfatal acute myocardial infarction was recorded in five patients (1.56%).

All patients underwent US examinations preoperatively and at 24 months. The cutoff point for the definition of residual stenosis was 5.79 weeks (IQR, 4.86-6.95 weeks). Residual lesions (<50%) were found in 12 patients (3.74%), but they remained stable during the rest of the follow-up. ICA restenosis of ≥50% was detected in 33 patients (10.28%), among them 17 (5.30%) had severe recurrent stenosis (≥70%) in the operated region. Restenosis was detected at 6.13 months (IQR, 5.60-6.67 months) after CEA in eight patients, at 12.00 months (IQR, 11.42-12.65 months) in 19 patients, and in six patients thereafter (Fig). Eleven patients with significant recurrent lumen narrowing were assigned for carotid stenting, the other patients continued to receive medical treatment.

Baseline characteristics of the patients with and without carotid restenosis. Hyperlipidemia was more common in patients with recurrent carotid stenosis ($P < .001$). In case of preoperative symptoms (TIA, stroke) the statistical analysis did not reveal a significant difference between patients with ($P = .723$) and without ($P = .859$) carotid restenosis. No significant difference was found in statin treatment between the groups of patients with and without restenosis, as well as for antiplatelet usage ($P = .964$, $P = .584$, respectively; Table I).

Presurgical femoral plaque size in patients with and without recurrent carotid lumen narrowing. Plaques in the CFA were grade 1 in 91 patients (28.35%), grade 2 in 111 patients (34.58%), and grade 3 in 119 patients (37.07%). The femoral plaque size did not differ significantly between the groups (grade 1, $P = .793$; grade 2, $P = .540$; and grade 3, $P = .395$, respectively; Table II).

Echogenicity and surface characteristics of the femoral plaques before surgery in patients with and with-



	Follow-up			
	6 weeks	6 months	12 months	24 months
Patency	100%	99.07%	94.08%	89.63%
Standard error	-	0.54%	1.32%	1.75%
Total number of patients	266	266	280	321
Number of patients with restenosis (≥50%)	0	8	27	33

Fig. Kaplan-Meier curve shows the incidence of restenosis after eversion carotid endarterectomy.

Table I. Baseline characteristics of the patients with and without carotid restenosis

Characteristics	*Restenosis (n = 33)*	*No restenosis (n = 288)*	P
Age, median (IQR), y	67 (58-73)	67 (60-73)	.883
Female gender, No. (%)	18 (54.55)	171 (59.38)	.593
BMI, median (IQR), kg/m^2	24 (21-25)	25 (21-26)	.200
Smoking, No. (%)	25 (75.76)	233 (80.90)	.481
Hypertension, No. (%)	19 (57.58)	178 (61.81)	.636
Diabetes mellitus, No. (%)	7 (21.21)	71 (24.65)	.662
Hyperlipidemia, No. (%)	25 (75.76)	102 (35.42)	<.001[a]
Pre-op TIA, No. (%)	19 (57.58)	175 (60.76)	.723
Pre-op stroke, No. (%)	3 (9.09)	29 (10.07)	.859
Statin use, No. (%)	14 (42.42)	121 (42.01)	.964
Antiplatelet use, No. (%)	24 (72.73)	196 (68.06)	.584

BMI, Body mass index; *IQR,* interquartile range; *TIA,* transient ischemic attack.
[a]Statistically significant.

Table II. Presurgical femoral plaque size in patients with and without recurrent carotid lumen narrowing

Plaque size	*Restenosis (n = 33)*	*No restenosis (n = 288)*	P
Grade 1, No. (%)	10 (30.30)	81 (28.13)	.793
Grade 2, No. (%)	13 (39.39)	98 (34.03)	.540
Grade 3, No. (%)	10 (30.30)	109 (37.85)	.395

out carotid restenosis. The incidence of predominantly echolucent CFA plaques was significantly higher in patients with documented restenosis during the follow-up period ($P < .001$). There were no significant differences in surface characteristics of the femoral lesions between the patients with and without recurrent lumen narrowing (smooth, $P = .278$; irregular, $P = .281$; ulcerated, $P = .934$, respectively; Table III).

Table III. Echogenicity and surface characteristics of the femoral plaques before surgery in patients with and without carotid restenosis

Plaque characteristics	*Restenosis (n = 33)*	*No restenosis (n = 288)*	P
Echogenicity, No. (%)			
Echolucent	1 (3.03)	9 (3.13)	.976
Predominantly echolucent	12 (36.36)	41 (14.24)	<.001[a]
Predominantly echogenic	9 (27.27)	102 (35.42)	.352
Echogenic	10 (30.30)	108 (37.50)	.417
Calcified	1 (3.03)	28 (9.72)	.204
Surface, No. (%)			
Smooth	19 (57.58)	193 (67.01)	.278
Irregular	13 (39.39)	87 (30.21)	.281
Ulcerated	1 (3.03)	8 (2.78)	.934

[a]Statistically significant.

Predictors of early restenosis after eversion CEA. The univariate analysis showed that hyperlipidemia was the only cardiovascular risk factor associated with an increased incidence of ICA restenosis during the follow-up (odds ratio [OR], 3.24; 95% confidence interval [CI], 1.72-6.11; $P < .001$). In this analysis, patients with echolucent or predominantly echolucent CFA lesions were merged into one group, and those with echogenic or predominantly echogenic or calcified plaques formed another group. We also merged patients with irregular or ulcerated plaque surface into one group. The reason for this regrouping was that only a few plaques were classified as echolucent, calcified, or ulcerated. Patients with echolucent-predominantly echolucent femoral plaques had a higher risk of ICA restenosis compared with those with echogenic-predominantly echogenic or calcified CFA lesions (OR, 4.99; 95% CI, 2.12-9.69; $P < .001$). Irregular femoral plaques only in combination with echolucency were predictors of early carotid restenosis development (OR, 3.09; 95% CI, 2.13-7.05; $P = .034$). None of the other US features of the CFA plaques showed a relationship with recurrent ICA lumen narrowing (Table IV). The multivariate logistic regression analysis tested all variables with a value of $P \leq .05$ in the univariate analysis, and all parameters remained statistically significant in the multivariate logistic regression model (Table V).

DISCUSSION

DUS imaging is a reliable and noninvasive method of assessing the atherosclerotic plaque morphology and determining the degree of stenosis. Computer-assisted off-line classification of the plaque echogenicity is an objective technology with excellent reproducibility.[16] However, these measurements require separate equipment and are time-consuming; therefore, it is difficult to apply them in everyday clinical practice. In our study the plaque structure

Table IV. Univariate analysis of predictors of early restenosis after eversion carotid endarterectomy

	Univariate logistic regression analysis	
Variables	*OR (95% CI)*	P
Age ≥70 years	2.41 (0.72 to 8.43)	.145
Female gender	1.59 (0.71 to 3.18)	.317
Body mass index ≥25 kg/m^2	1.61 (0.95 to 2.72)	.921
Smoking	1.96 (1.79 to 2.50)	.552
Hypertension	1.01 (0.95 to 1.09)	.344
Diabetes mellitus	0.91 (0.37 to 2.41)	.873
Hyperlipidemia	3.24 (1.72 to 6.11)	<.001[a]
Preoperative TIA, stroke	1.39 (0.49 to 3.65)	.501
Preoperative statin use	–2.24 (–12.97 to 8.81)	.773
Preoperative antiplatelet use	3.01 (–3.72 to 9.06)	.385
CFA plaque characteristics		
Grade 3	3.01 (–1.59 to 7.89)	.234
Irregular-ulcerated surface	1.92 (0.83 to 4.22)	.109
Echolucent-predominantly echolucent	4.99 (2.12 to 9.69)	<.001[a]
Grade 3 CFA plaque	2.72 (0.88 to 8.34)	.113
Irregular-ulcerated	3.09 (2.13 to 7.05)	.034[a]

CFA, common femoral artery; *CI,* confidence interval; *OR,* odds ratio; *TIA,* transient ischemic attack.
[a]Statistically significant.

Table V. Multivariate analysis of predictors of early restenosis after eversion carotid endarterectomy

	Multivariate logistic regression analysis (R^2 = *.152)*	
Variables	*OR (95% CI)*	P
Hyperlipidemia	3.37 (1.77-6.42)	<.001[a]
Echolucent-predominantly echolucent CFA plaque	5.63 (2.14-10.89)	<.001[a]
Irregular-ulcerated	2.42 (1.17-6.03)	.029[a]

CFA, Common femoral artery; *CI,* confidence interval; *OR,* odds ratio.
[a]Statistically significant.

was visually judged. The visual analysis, even if considered to be subjective, was found to be a valuable method for plaque characterization.[19]

This study included one of the largest series of patients in whom the femoral plaque size and lesion morphology were evaluated. Patients with early carotid restenosis had a significantly higher incidence of predominantly echolucent femoral plaques than those without recurrent lumen narrowing. Moreover, the plaque echogenicity seemed to be superior to the surface characteristics of the atherosclerotic lesions in regard to restenosis development, because irregular femoral lesions only in combination with echolucency were independent predictors of early ICA restenosis development. Vulnerable lesions were reported to develop simultaneously at multiple sites of the vascular bed.[20] In addition, trials with lipid-lowering or anti-inflammatory therapy demonstrated a reduced rate of ischemic vascular events and death, which can scarcely be conceived as a single-plaque phenomenon.[4,21] Thus, echolucent femoral lesions may represent a vulnerable patient.

Because an inflammation phenomenon seems to be the key component in both the development of unstable plaques and in the formation of neointima,[3,4] it may be hypothesized that those systemic inflammatory factors that are involved in the destabilization of atherosclerotic lesions at the same time facilitate the restenotic process. An observation of Liapis et al[22] that the presence of ipsilateral echolucent carotid plaques before surgery is a predictor of restenosis after CEA is in line with our findings. This relationship was thought to be mediated by the remainders of plaques at the CEA site. In a 2008 study, Kitta et al[23] showed a strong association between the presence of echolucent carotid lesions and in-stent restenosis after percutaneous coronary interventions. However, it should be taken into account that the pathogenesis of recurrent stenosis after endarterectomy differs from the in-stent restenotic process in many ways.

Schmidt et al[8] revealed a positive correlation between femoral plaque size and future cardiovascular events in middle-aged men. The association remained present, albeit attenuated, after adjustment for traditional cardiovascular risk factors, including low-density lipoprotein cholesterol and triglyceride levels, systolic blood pressure, and smoking. We could not find a significant correlation between baseline femoral plaque size and recurrent lumen narrowing after CEA. The morphology of coexisting lesions rather than size appears to be important in the development of restenosis.

Previous studies support the notion that inflammation is related not only to lesion structure but also to plaque size.[24,25] According to our observations, we assume, that plaque size, "the amount of atherosclerosis" and echogenicity are influenced by different systemic or local inflammatory factors, or both, and those that are associated with plaque morphology may also be involved in the restenotic process.

Several reports have examined the influence of systemic factors such as age, gender, BMI, smoking, hypertension, diabetes mellitus, and hyperlipidemia on the development of recurrent stenosis after CEA, but none has succeeded in establishing a globally accepted status.[26,27] Our study identified patients with hyperlipidemia as being at particular risk of developing restenosis. In hyperlipidemia, the rate of LDL entry into the intima increases and the LDL undergoes progressive oxidative modification in the subendothelial space. The aggregation of oxidized LDL induces the release of mitogens from platelets, macrophages, and endothelial cells, which stimulate smooth muscle cell proliferation and may lead to neointima formation.[28]

Despite of the results of immunohistochemical and biochemical studies that confirmed the role of oxidized LDL in the restenotic process,[29] the salutary effect of lipid-lowering agents on the incidence of restenosis is controversial. Some investigators have found a statistically significant correlation, while others have not.[27,30] Of note in our study, the diagnosis of hyperlipidemia was determined by an evaluation of available medical records of the patients.

Moreover, we do not know how many patients were on optimal control of their associated risk factors or were treated with statins independently of their serum lipoprotein levels; therefore, definite conclusions about the importance of traditional risk factors on the development of early recurrent lumen narrowing after surgery cannot be drawn from our investigation.

CONCLUSIONS

Patients with echolucent-predominantly echolucent femoral plaques, independently of their size, have an increased risk for recurrent ICA stenosis development compared with those with echogenic-predominantly echogenic or calcified atherosclerotic lesions. However, an important question that may be asked is: If it is possible for us to examine the morphology of the carotid plaques before CEA, do we have to care about the composition of femoral lesions in regard to carotid restenosis? The answer should be yes, but further prospective trials with analysis of both carotid and femoral lesions in the same individuals are needed to reveal whether all patients or only subgroups of patients would benefit from the evaluation of CFA lesions before carotid surgery.

AUTHOR CONTRIBUTIONS

Conception and design: ED, LE, GA, KH
Analysis and interpretation: ED, KH
Data collection: ED, AA, ZJ, KH
Writing the article: ED
Critical revision of the article: K Hirschberg
Final approval of the article: ED, K Hirschberg, AA, ZJ, LE, GA, KH
Statistical analysis: K Hirschberg
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Overall responsibility: ED

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