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Importance of vascular surgeon's experience, surgical volume and patient's risk factors on the results of carotid endarterectomy

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Background. The contribution of vascular surgeon's years of practice and volume to carotid endarterectomy outcomes in a routine practice of a single vascular centre is not well known.

Objective. To investigate the importance of the technical competence of surgeons with increasing experience and procedure volume in the causation of perioperative stroke and death associated with carotid endarterectomy in routine clinical practice of a single centre.

Methods and patients. Mortality and stroke morbidity rates and selection criteria of all the CEAs, performed between 1995 and 2006, were analysed and correlated to the operating vascular surgeon according to his experience in performing carotid endarterectomy and the volume of procedures. Risk factors, comorbidities, indications for carotid surgery, carotid shunting, morbidity and mortality of 790 carotid endarterectomies were prospectively recorded in a database. Univariate and multivariable logistic regression, ROC curves were used to analyse the data.

Results. Among the 790 cases studied the in-hospital mortality was 2.1%, stroke morbidity was 2.4%. There was a significant difference in the incidence of perioperative stroke between the surgeons with experience less than 10 years and the surgeons who practise for more than 20 years (5.6% vs. 1.8%, $p = 0.03$), however, no significant difference was noted in the mortality rate. A greater number of years since the surgeon started CEAs were associated with better outcomes in patients with neurologic symptoms. The postoperative stroke rate was 5.6% for surgeons with <6 CEA volume per year and 1.1% was for surgeons who performed ≥6CEA ($p = 0.015$). Increased surgical volume was associated with better outcomes in patients with stroke, but not in asymptomatic patients. In the multivariate logistic regression combined mortality and stroke was independently predicted by diabetes mellitus (OR 3.51; 95% CI 1.60–7.66, $p = 0.002$), contralateral or v/b stroke (OR 4.14; 95% CI 1.57–10.91, $p = 0.004$), low-volume surgeon (OR 0.32; 95% CI 0.13–0.78, $p = 0.013$). ROC curves analysis showed 0.72 predicting value of these three parameters.

Conclusions. Increasing surgical volume and experience in carotid surgery improve the results of carotid endarterectomy. Significant predictors of bad outcome were diabetes mellitus, contralateral or v/b stroke and low-volume surgeon.

Key words: carotid endarterectomy, indications, risk factors, surgical experience, procedure volume, outcomes

INTRODUCTION

Several randomized prospective clinical trials have clearly affirmed the safety and efficacy of carotid endarterectomy (CEA) and its superiority when compared with the best medical management of patients with both symptomatic and asymptomatic extracranial carotid stenoses (1–4). CEA is a fairly common procedure that requires proficiency, and technical errors of the surgeon may lead to clinically significant complications, such as stroke and death. Poor outcome after CEA has traditionally been related to patient factors and also to hospital and surgeon-associated factors, such as frequency of performance of CEA and specialty training.

There is a commonly held view that better outcomes (e. g. lower mortality and post-operative stroke rates) are associated with hospitals and physicians' volumes of activity. Higher volumes represent better quality (5). Increased surgeon's experience with operation, as measured by annual procedural volume, has been related to the improved outcome, too (6).

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Although the results of the randomized trials clearly showed the safety of CEA, because the procedures were performed in selected high-volume centres by skilled carotid surgeons who underwent a careful vetting process, it has been suggested by some that these results may not truly reflect the outcome of the operation in every day practice (7). Moreover, no consensus exists among vascular surgeons on the minimum caseload necessary to maintain technical competence in the performance of CEA, the preponderance of the data published during the past decade confirms that CEA perioperative major morbidity is the lowest when the operation is performed by higher volume surgeons and in higher volume centers (8–10). What is not clear is whether these observations are influencing practice patterns.

The aim of the present study was to investigate the importance of the technical competence of surgeons with increasing years of experience and the procedure volume in the causation of perioperative stroke and death taking in account patient's risk factors and indications for carotid endarterectomy in routine clinical practise.

MATERIALS AND METHODS

Patient population. Between 1995 and 2006, we prospectively recorded the risk factors, indications, operative details, morbidity and mortality from every patient who underwent carotid endarterectomy in a database. The degree of carotid stenosis was determined on duplex and angiographic findings using NASCET criteria. The indications for carotid surgery were asymptomatic ≥70% or symptomatic >50% stenosis of the internal carotid artery when other causes of stroke were excluded. The patients were examined by a neurologist before and were followed during their hospital course after operation. Almost all the procedures were performed with general anaesthetic techniques, and local anaesthesia was used only in 1.5% cases. The median anaesthetic time was less than 3 hours, implying a median surgical time of 2 hours. Transcranial Doppler technique for intraoperative monitoring was used in 86% cases, the rest patients were shunted routinely. The patients were awakened in the surgical intensive care unit where they spent the first postoperative day. Dupplex ultrasonography and CT were repeated when cerebrovascular events were suspected. All the postoperative in-hospital complications were registered. The primary outcome was in-hospital death and postoperative stroke defined as the onset of a new focal neurological deficit, lasting more than 24 hours and causing permanent disability or death during hospital course.

Results of 790 CEAs were analyzed over recent 12-year time interval (1995–2006) with respect to each surgeon years of experience in performing CEA, averange annual operative experience and with respect to indications for operation.

Surgeons' characteristics. Twelve vascular surgeons with different years of experience in performing CEAs (from 2 to 33 years) comprised the study group. Five surgeons were stable, presented in performing CEAs during each of the 12 years of analysis. The number of operations the surgeons performed over the period under the study varied from 3 to 276. Surgeons were separated into three groups according to the years of experience in carotid surgery: less than 10 years – 7(58%) vascular surgeons with low experience; experience from 10 to 20 years – (25%) surgeons with moderate experience, and over 20 years of experience – 2 (17%) very experienced vascular surgeons. The mean annual caseload of hospital was 66 CEAs (ranging from 43 to 93 CEAs), and the mean surgeon's annual caseload was 6 CEA, with a range of one to 38 procedures per year. Surgeons performing annualy 5 or less, 6 to 10, and more than 10 endarterectomies were arbitrarily categorized as low-volume, moderate-volume and high-volume, respectively.

Patients' characteristics and indications for surgery. The average age of all the patients at the time of operation was 66.3 years. Twenty four percent of operations were performed on women, 67% patients were smokers, 57% patients had arterial hypertension, 14% patients had diabetes mellitus, 11% patients suffered from peripherial occlusive arterial disease, 31% patients had stable angina pectoris, 21% patients had previous myocardial infarction and 11% patients underwent PTA or CABG in the past (Table 1). The indications for operation were TIA (11%), ipsilateral stroke (40%). In this study (Table 2), the definition of asymptomatic stenosis included all nonspecific symptoms (17%), stroke in posterior circulation or contralateral carotid stroke (20%) and total asymptomatic stenosis (12%). Patients were grouped into three groups according to the operating surgeon's years of experience and to the mean annual caseload of CEA.

Statistical analysis was carried out using SPSS 13.0 for Windows program package (SPSS Inc., Chicago, Il, USA). Study

Table 1. **Baseline characteristics of patients**

Patients characteristics	Number	%
Age, mean (range), years	66.3 ± 10.4	44–86
Age ≥75 years	117	15
Male	605	76
Past or present smoker	532	67
Hypertension	454	57
Angina pectoris	249	31
Previous myocardial infarction	169	21
Previous PTA or CABG	88	11
Diabetes mellitus	110	14
PAOD	89	11

PAOD – peripherial arterial occlusive disease.

Table 2. **Indications of carotid endarterectomy**

Indications	Number	%
Transient ischemic attack	108	11
Stroke	295	40
Asymptomatic	97	12
Nonspecific symptoms	136	17
Contralateral or v/b stroke	154	20

end point was postoperative stroke and death. Operative mortality and stroke rates were analyzed separetely and then together as a bad outcome rate. The correlation between surgeon's experience, CEAs caseload and bad outcome rate was assessed by univariate analysis using the Chi-square and Fisher exact tests. The variables that positively associated with postoperative outcomes at $p < 0.05$ were selected for multivariate analysis using forward stepwise logistic regression. Odds ratios (OR) and 95% confidence interval (CI) were calculated. A risk factor was considered statistically significant when $p < 0.05$.

We analyzed the operative death and stroke predicting characteristics by assessing receiver operating characterictics (ROC) curves. The area under the ROC curve shows predicting values. The values more than 0.7 are considered to be useful for predicting bad outcome (11).

RESULTS

Overall, there were 17 deaths and 19 strokes for the combined rate of death and nonfatal stroke of 4.55% (Table 3). Of the 17 deaths (2.1%), there were 9 deaths due to perioperative stroke, three deaths due to myocardial infarction, 4 due to intracranial haemorrhage and one because of thrombembolism arteria pulmonale. The postoperative stroke rate was 2.4%.

All the patients were distributed into three groups according to the operating surgeon's experience. There were no significant differences in patients' average of ages, risk factors, comorbidities and indications for operation (Table 4). CEA was performed by very experienced surgeons in 55% of patients, by moderately experienced surgeons in 34% of patients and by surgeons with low experience in 11% of patients. Observed mortality by surgeon's experience was 1.5% for very experienced surgeons, 2.6% for moderate experienced surgeons, and 3.4% for surgeons with low experience (Fig. 1). Although the mortality rate was twice lower for the very experienced surgeons than for those with low experience, the difference did not reach any statistical significance. The postoperative stroke rate was 1.8% for very experienced surgeons, 2.3% for moderately experienced surgeons, and 5.6% for low-experienced surgeons. The operative stroke rate of surgeons with low experience was significantly higher than that of surgeons with more than 20 years of experience ($p < 0.03$). Overall, the operative results were better for more experienced surgeons than for those with low experience (3.0% vs. 9.0%; $p = 0.017$).

Table 3. **Outcomes of carotidendarterectomy**

Outcomes	Number	%
In-hospital mortality	17	2.15
Nonfatal stroke	19	2.40
Total bad outcomes	36	4.55

There were no significant differences between different surgeon experience and the operative indications (Fig. 2). The combined stroke – mortality rate of patients with symptomatic stroke was 15% operated by inexperienced surgeons, 3% operated by moderately experienced surgeons ($p < 0.03$), and 4% by very experienced surgeons (Fig. 3). Operative results of the patients' group with asymptomatic stenosis did not differ significantly between groups of surgeons with different experience in performing CEAs (3%, 2%, 1%, respectively). Combined stroke-mortality rate of patients undergoing CEAs for contralateral or v/b stroke was 21% when operations were performed by inexperienced surgeons, 13% by moderately experienced surgeons and 3.7% by very experienced surgeons ($p < 0.05$).

Table 4. **Characteristics of patients who underwent carotid endarterectomy grouped by surgeon experience**

Characteristic	<10 years	10–20 years	20> years
Number of patients	89	304	397
Mean age, years	64.6 ± 9.4	65.2 ± 5.7	67.1 ± 5.2
Age ≥75 years,	12%	14%	16%
Female	24%	20%	22%
Arterial hypertension	64%	64%	69%
Current and past smokers	49%	54%	52%
Angina pectoris	28%	29%	32%
Previous myocardial infarction	18%	21%	23%
Previous PTA or CABG	7%	9%	11%
Diabetes mellitus	13%	14%	13%
PAOD	15%	9%	13%
Using shunt	63%	54%	50%
Heterogenous plaque	76%	72%	80%
TIA	15%	13%	13%
Stroke	29%	39%	40%
Asymptomatic	35%	30%	27%
Contralateral or v/b stroke	21%	18%	20%

PAOD – peripherial arterial occlusive disease.

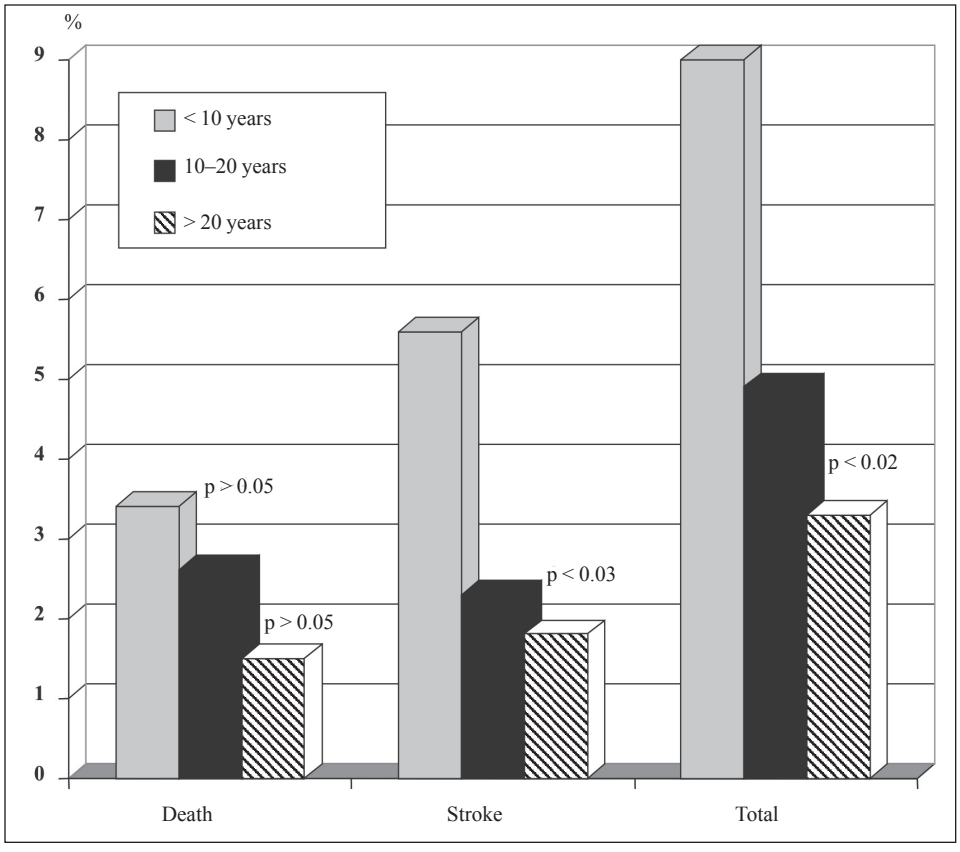

Fig. 1. Surgeon practise in carotid surgery and carotid endarterectomy outcomes

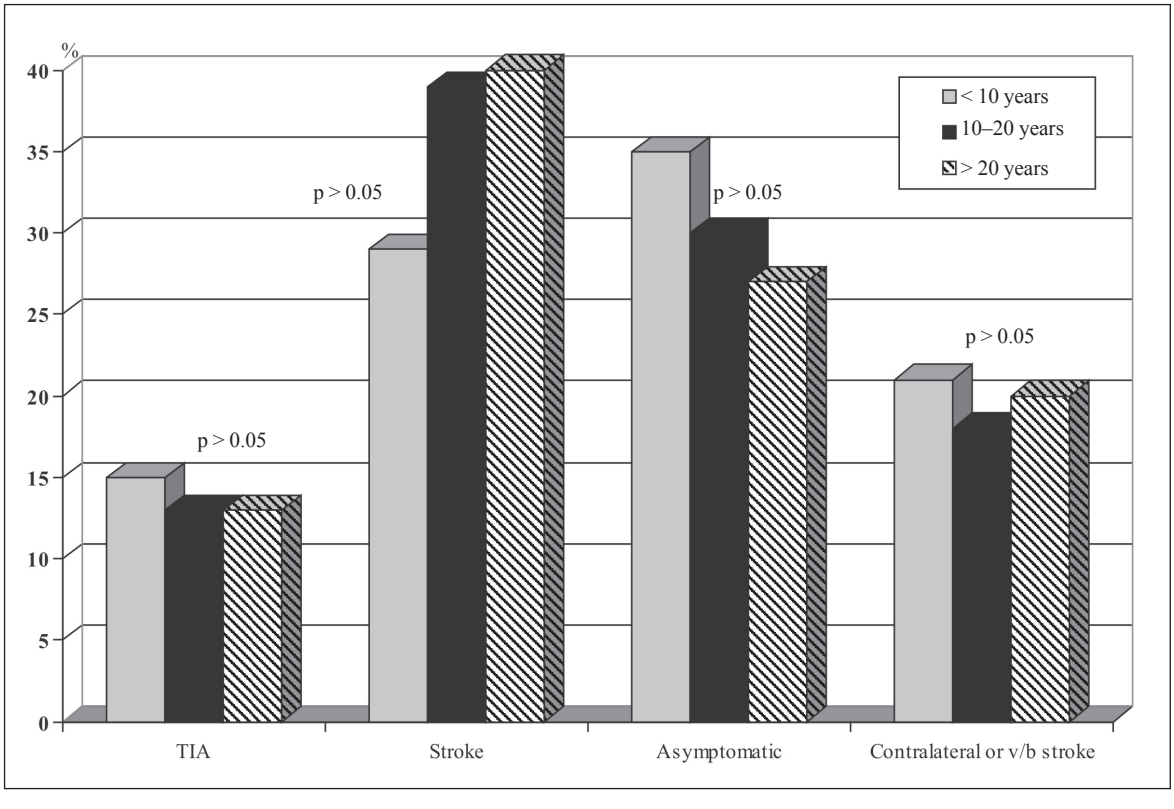

Fig. 2. Indications for carotid endarterectomy grouped by surgeon years of practise

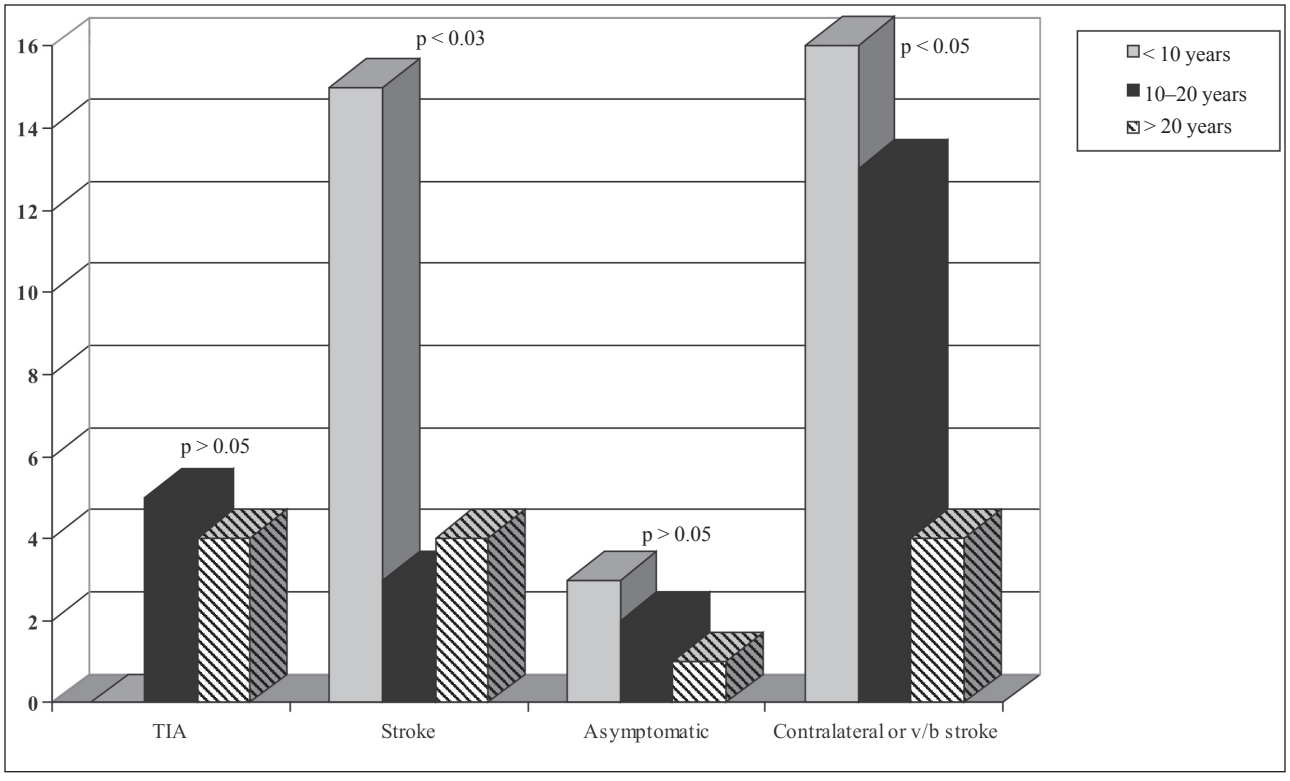

Fig. 3. Mortality and postoperative stroke rates grouped by indications for carotid endarterectomy and surgeon experience

Among the series of 790 CEAs, 89 (11%) were performed by low-volume surgeons, 261 (33%) by moderate volume, and 440 (56%) by high-volume operators. In other words, the patient had a less than one in two chances of undergoing the procedure with high-volume operator but approximately one in nine chances of undergoing the operation with a low-volume surgeon. Then we stratified the patients into three subgroups based on surgeon volume (Table 5). There were no significant differences in

Table 5. **Characteristics of patients who underwent carotid endarterectomy grouped by annual surgeon CEA volume**

Characteristic	Less than 6 CEA	6 to 10 CEA	10 more CEA
Number of patients	89	261	440
Mean age, years	64.6 ± 9.4	65.9 ± 6.4	66.6 ± 5.1
Age ≥75 years %	12	13	15
Female %	24	23	19
Arterial hypertension %	64	66	67
Current and past smokers %	49	57	50
Angina pectoris %	28	31	31
Previous myocardial infarction %	18	26	20
Previous PTA or CABG %	7	9	11
Diabetes mellitus %	13	14	13
PAOD %	15	10	12
Using shunt %*	63*	60*	47
Heterogenous plaque %	76	83	83
TIA %	15	14	12
Stroke %	29*	43	38
Asymptomatic %	35	30	27
Contralateral or v/b stroke %	21	13*	23

PAOD – peripherial arterial occlusive disease.

Shunt using I–III $p < 0.01$; II–III $p < 0.001$.

Stroke I–II $p < 0.03$.

Contralateral or v/b stroke I–II $p < 0.05$, II–III $p < 0.0005$.

patients' mean age, risk factors, comorbidities, only shunt usage differed significantly – 47% was used in high-volume group, 60% in moderate-volume group ($p < 0.001$) and 63% in low-volume group ($p < 0.01$). The observed mortality by surgeon volume (Fig. 4) was 1.8% for high-volume surgeons, 2.3% for moderate-volume surgeons, and 3.4% for low-volume surgeons ($p > 0.05$). The postoperative stroke rate was 2.5% for high-volume surgeons, 1.1% for medium-volume surgeons, and 5.6% for low-volume surgeons ($p = 0.015$). Overall, mortality and stroke morbidity rate was significantly lower in the moderate-volume group compared with the low-volume surgeon group (3.4% vs. 9%, $p = 0.036$).

When stratified by symptomatic vs. asymptomatic status (Fig. 5), the ratio of symptomatic and asymptomatic CEAs (S/A) was 1.0 for high-volume operators, 1.33 for moderate-volume operators and 0.79 for low-volume operators ($p = 0.035$). Among the patients with stroke, 38% patients were operated on by high-volume surgeons, 43% by moderate-volume surgeons, and 29% by low-volume surgeons ($p = 0.026$). There were no significant differences among asymptomatic patients operated by different volume operators. High-volume surgeons performed 23% CEAs with contralateral or v/b stroke, moderate-volume surgeons 13% ($p = 0.0005$), and low volume surgeons 21% ($p = 0.046$).

The combined stroke-mortality rate of patients with symptomatic stroke was 15% operated by low-volume surgeons, 2.7% operated by moderate-volume surgeons ($p = 0.03$) and 4.2% by high-volume surgeons (Fig. 6). Operative results of patients group with nonspecific symptoms and asymptomatic stenosis did not differ significantly between groups of surgeons with different volume (3%, 2.5%, 0.8%, respectivly). Complication rate of patients undergoing CEAs for contralateral or v/b stroke was 16% when operations were performed by low-volume surgeons, 9% by moderate-volume surgeons, and 7.7% by high-volume surgeons ($p > 0.05$).

Using Spearman's coefficient we assessed the correlation between surgeon experience and volume. The surgeon's annual procedural volume was directly associated with surgeon years in carotid surgery ($r^2 = 0.47$, $p = 0.01$) suggesting that both variables are close and important.

Univariate associations between patient, surgeon characteristics and outcomes showed that age, sex, arterial hypertension, smoking, angina pectoris, previous MI, peripheral arterial occlusive disease, symptomatic carotid stenosis and shunting did not appear to influence the rates of death and stroke. Multivariate logistic regression models (Table 6) revealed three independent risk factors for perioperative death and stroke: diabetes mellitus tripled the odds of death and stroke (odds ratio [OR], 3.51: 95% confidence interval [CI] = 1.61–7.67), contralateral or v/b stroke as the indication for surgery contralateral four times increased the odds of death/stroke (OR, 4.14; 95% CI = 1.57–10.91) and low surgeon volume three times increased the risk-adjusted odds of death and stroke (OR, 0.33; 95% CI = 0.13–0.79).

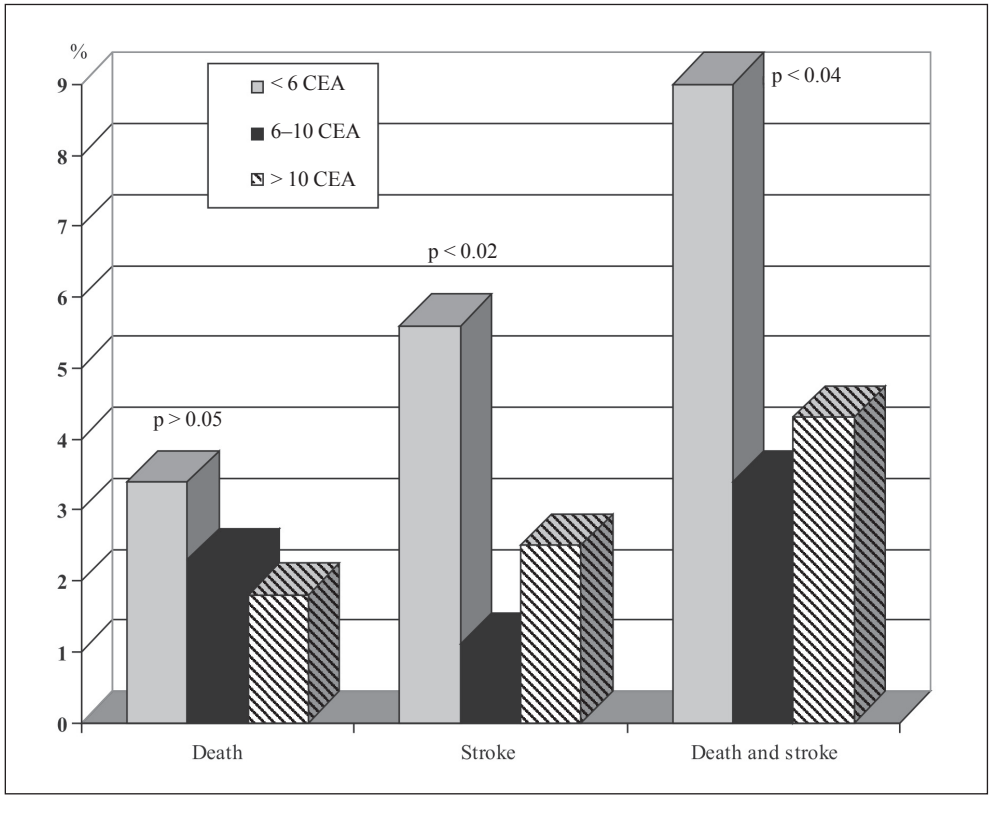

Fig. 4. Surgeon annual volume and carotid endarterectomy outcomes

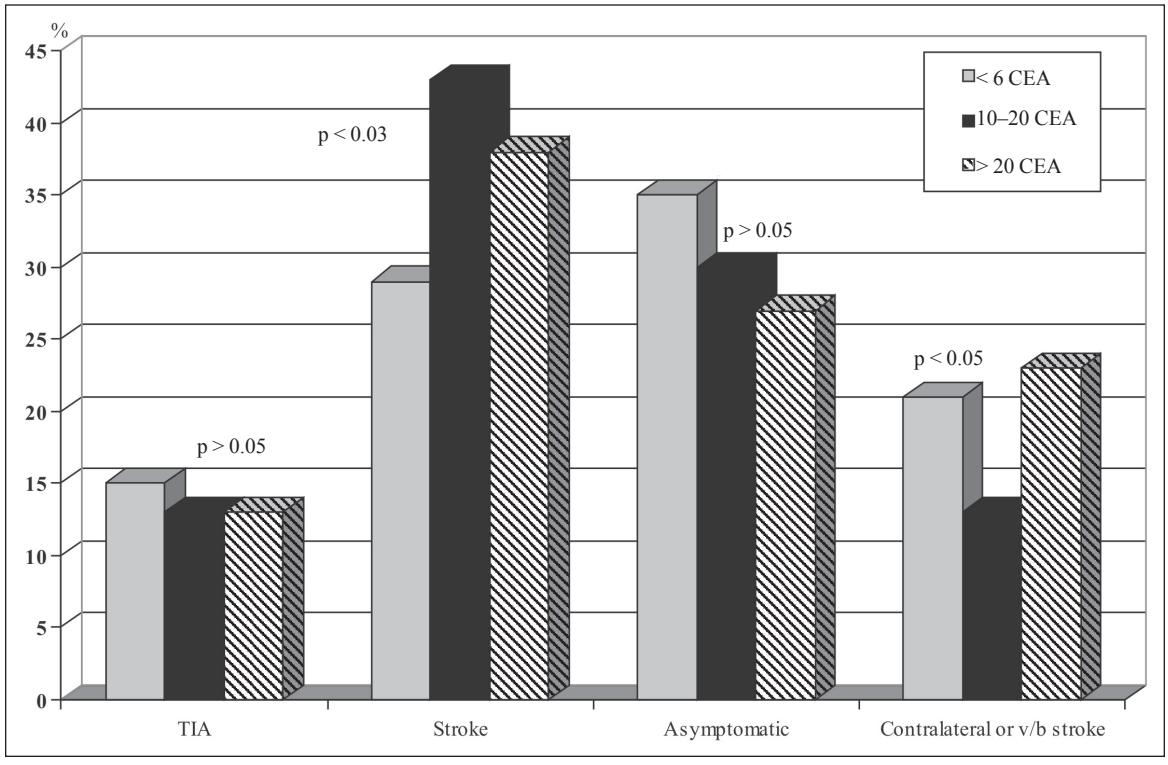

Fig. 5. Indications for carotid endarterectomy grouped by surgeon annual volume

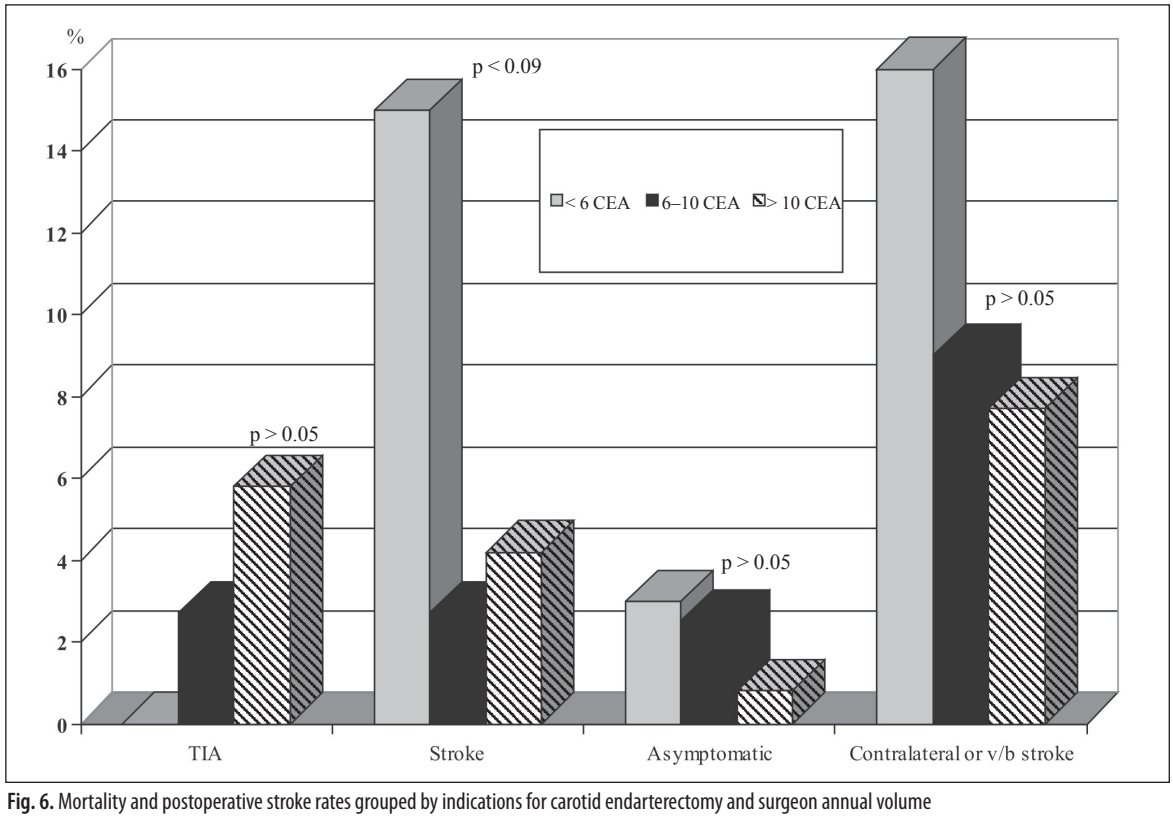

Fig. 6. Mortality and postoperative stroke rates grouped by indications for carotid endarterectomy and surgeon annual volume

Table 6. **Multivariate associations between patient, surgeon characteristics and complication rates**

Death and stroke			
	OR	95% CI	p
Surgeon volume	0.33	0.13–0.79	0.013
Diabetes mellitus	3.51	1.61–7.67	0.002
Contralateral or v/b stroke as indication for surgery	4.14	1.57–10.91	0.004

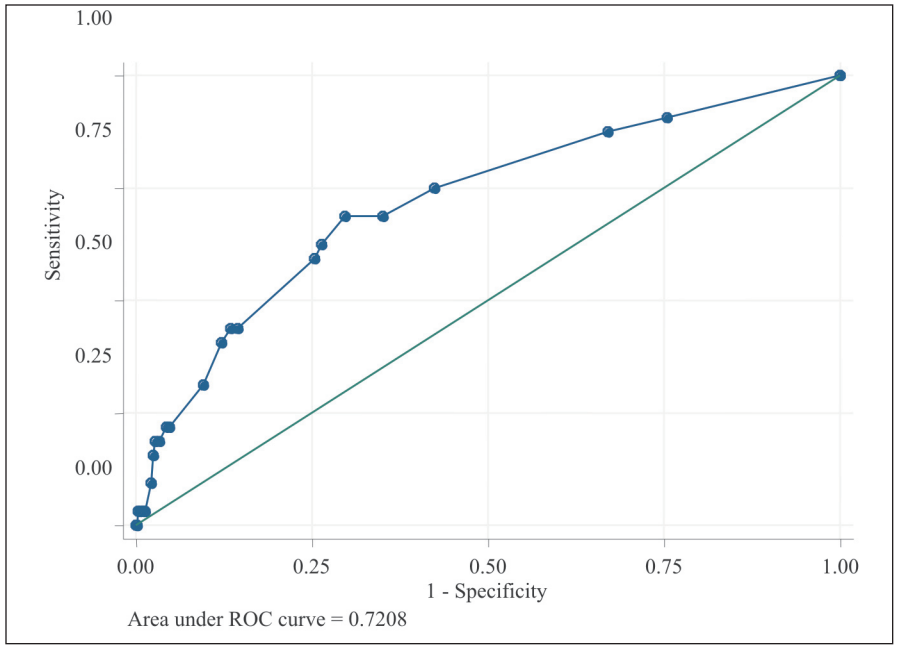

Fig. 7. ROC curve after logistic regression

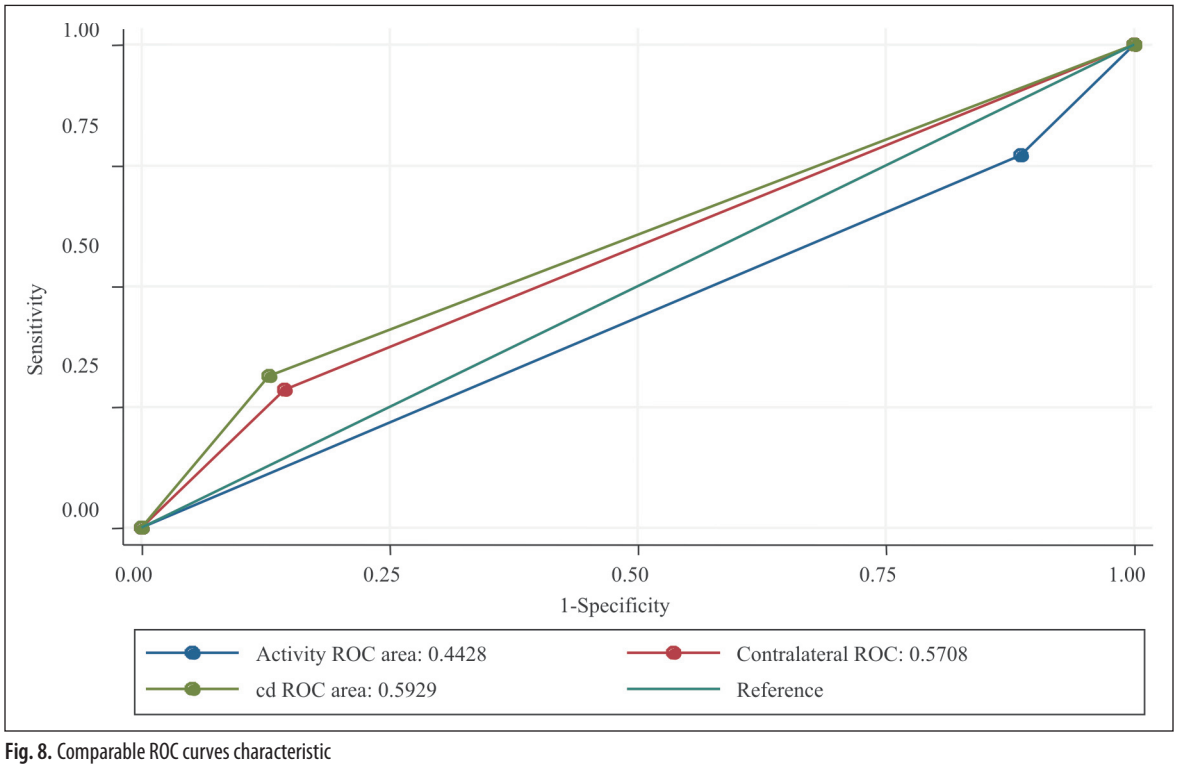

Fig. 8. Comparable ROC curves characteristic

ROC curves analysis (Fig. 7, 8) for mortality and stroke showed predicting value of diabetes mellitus 0.59, contralateral stroke or v/b stroke 0.58, and surgeon volume 0.44 and 0.72, when these three parameters were assessed in common.

DISCUSSION

To realize the benefits of CEA, postoperative mortality and stroke must be minimized (12). A successful outcome after a surgical procedure is a complex interaction between patient characteristics, the surgeon experience and hospital characteristics. The importance of hospital volume has been considered an important variable by independent agencies (8). High-volume hospitals have better outcomes than low-volume hospitals (12).

Our centre represents one of 4 vascular surgery centres performing 60%–70% of all the CEAs in our country. Depending on the different definitions used, our hospital mean caseload of 66 CEAs per year met the criteria of a moderate or even high caseload

institution (5, 8, 12). However, the optimal performance of CEA may depend more on an individual surgeon's performance of the operative procedure than on the ability of hospital, as a whole. In a study comparing two high-volume surgeons practicing at two low-volume hospitals with other vascular surgeons operating at a high-volume hospital demonstrated no difference in morbidity and mortality (13). Gibbs and Guzzetta, in describing the results of CEA at both low- and high-volume hospitals by high-volume surgeons concluded that "individual surgeons, not institutions, determine the efficacy of carotid endarterectomy" (14).

The current study suggests that slightly above half of CEAs in our centre are performed by experienced and high-volume surgeons. We have found that only 11% of procedures are being performed by surgeons who perform few CEAs annually. This finding contrasts with that of Matsen et al where most surgeons who in 1999 performed CEA in New York State fall into low-volume category with 1or 2 CEAs per year (15). Other studies report that between 50% and 60% of CEAs are being performed by high-volume surgeons (16, 17).

In select statewide analyses, surgeon volume has been shown to improve mortality rates (9, 18). Because no consensus exists among vascular surgeons on the minimum caseload necessary to maintain technical competence in the performance of specialized procedures, such as CEA, different definitions of low volume were used among the CEA studies. Segal et al. found that physicians with an annual caseload of 15 or more CEAs had significantly lower mortality rate than physicians performing fewer than 15 CEAs per year (19). Ruby and colleagues reported significant mortality benefits for patients operated on by surgeons performing at least 10 CEAs annually (20). In the State of New York, Hannan and his associates found a significantly lower mortality rate among physicians performing five or more CEAs per year (21). O'Neil et al. reported that the characteristics of surgeons that predicted greater mortality after operation were a surgical volume of only one or two cases over 2 years (22). These results contrast with those of Mattos et al. who found that there was no significant difference in mortality rates between physicians performing more or fewer than 12 CEAs per year (23). Others have documented little or no individual surgeon volume effect on mortality (16, 22, 24).

In the present study high-volume and very experienced surgeons had lower mortality rate than their low-volume and inexperienced counterparts. We noted a stepwise decrease in perioperative mortality from 3.4% to 1.5% with increasing years of practise and operation volume, however, there was no statistical difference in mortality rates between different surgeon level of experience and volume. The possible explanation of the absence of direct relationship between surgeon volume and mortality rates is because some deaths are not related to technical errors made during operation and more depend on patient-related characteristics.

Postoperative ischemic stroke more represents a surgeon's skill, and ischemic stroke continues to be the most frequent cause of post operative neurologic complication after CEA. Only few studies focused on the relationship between surgeon volume and stroke separately. Mattos et al. found statistical differences in postoperative stroke rates between surgeons performing less than 12 CEAs per year and those performing more than 12 procedures per year (23). Edwards et al also found a significant inverse relationship between physician volume and stroke rates (25). Cowan et al using the National Impatient Sample of 35.821 patients who underwent CEA reported that postoperative stroke rate was consistently less with an increase in surgeon volume (17). Our results parallel with the others in demonstrating statistically significant inverse difference between surgeon volume (with the minimum 6 CEAs per year) and stroke rate. In the present study there was also an inverse relationship between surgeon experience and stroke rate. We found a significant decrease in stroke rate for surgeons with increasing experience with a threshold of 10 years of carotid surgery practice. These studies and our observations support the thesis that active surgical practice reduces the risk of perioperative stroke. It may be reasonable to consider that the repetition and familiarity of the procedure by a surgeon frequently performing it may improve outcomes (26).

In a systematic overview of prospective or retrospective volume-outcome studies the weight of evidence is supportive of being an inverse relationship between surgeon's caseload and combined mortality and morbidity (10). Findings in two studies identified a positive volume-outcome relationship for both mortality and stroke at a threshold of 10 CEA per year (27, 28). This finding is supported by Kucey et al. who reported that medium volume (between six and 12 CEAs per year) and high volume (more than 12 CEAs annually) physicians had significantly better outcomes than their low volume (fewer than six per year) counterparts (29). In contrast, Cebul et al. (24) found no differences in outcomes between high and low volume physicians (defined as more or fewer than 21 CEAs per year, respectively). Neither of the two studies, Kempczinski and Mayo, found statistically significant evidence of a positive volume-outcome relationship (16, 30). In the present study we found that high-volume surgeons with prolonged experience have lower combined stroke-mortality rates compared with inexperienced and low-volume surgeons. Our results support the thesis that an inxperienced and low-volume surgeon creates early bad outcomes.

A few previous studies of CEA have assessed time in surgical practice as a morbidity and mortality risk. Surgeons with a greater proportion of their practice in vascular surgery had better outcomes (31). O'Neil et al. found that time in surgical practice was more important than surgical volume as a predictor of patient outcome (22). Another interesting finding in this study contradicting our results was that mortality increased with surgeons in practice for 20 or more years, whereas morbidity was the highest in those recently licensed. Our results suggest that threshold for the safe performance of CEA is not lower than 10 years of practice in carotid surgery. Prolonged carotid surgery practice was directly associated with annual surgeon volume ($r^2 = 0.47$, $p = 0.01$), suggesting positive and significant correlation between them.

In some studies ischemic and valvular heart disease, atrial fibrillation, congestive heart failure, diabetes, gender, age, contralateral stenosis >70%, ipsilateral occlusion and symptomatic status have been found to affect the outcome after CEA (32). Of these factors stroke as indication for surgery, active coronary artery disease and contralateral carotid stenosis >50% are commom with those found in a study by Halm et al. (33). A retrospective analysis of 1370 consecutive CEA confirmed that contralateral occlusion was the only significant predictor of adverse outcome (34). Our study found only two patient-related factors increasing the risk-adjusted odds of complications (diabetes

mellitus and contralateral or v/b stroke as an indication for surgery). Multivariate logistic regression models identified low surgeon volume as significant independent predictor of an adverse outcome.

In most studies there was no information whether patients were symptomatic or asymptomatic. When we stratified patients by symptomatic vs. asymptomatic status, an association was found between the surgeon's experience and outcome rates in patients with stroke. Though low volume surgeons chose to deal with a higher proportion of low risk patients with asymptomatic stenoses, there were statistical differences in the outcome of carotid surgery between patients with stroke operated on by low-volume surgeons and by high-volume operators. This association did not persist for asymptomatic patients. Our results confirm that it is also important to distinguish patients according to the underlying neurologic indication for surgery (nonspecific versus contralateral or v/b stroke).

The mortality and morbidity of CEA have been shown to be related not only to the presence and severity of preoperative neurological deficits, but also to the medical condition of the patient (32–34). As Halm et al. noted, even in the hands of surgeons with excellent overall results, patients with high comorbid illness burden may experience more perioperative complications (35). Our results demonstrate high mortality and morbidity rate in patients with contralateral or v/b stroke operated on even by experienced and high volume surgeons. As Matssen et al. noted, high-risk patients may benefit from a surgeon with yearly volume of at least 75 CEA (36).

We agree that the surgeon's contribution is considered to be the most important of all the factors pertaining to good quality in carotid surgery, however we do not find superiority surgeon volume over patient risk factors. Our results show that surgeon volume together with patient risk factors have predictive value of bad outcomes after CEA.

CONCLUSIONS

Carotid endarterectomy, when performed by experienced vascular surgeon with substantial volume, carries a low risk for perioperative stroke and death in most patients. A cautious exeption is noted in patients with diabetes mellitus and in small subgroup of patients with contralateral carotid or v/b stroke, who demonstrated an elevated death and stroke rate, when they were operated on by low volume and inexperienced surgeon. Risk of perioperative events in asymptomatic patients is less associated with surgeon experience and volume compared with symptomatic patients. In our centre high-risk patients may benefit from a surgeon with experience more than 10 years and annual volume of at least 6 CEA, however, most surgeons who perform CEAs in our hospital do so infrequently. Although our overall operative results are still not optimal, we shoud try to attain that results in every day practice would be in agreement with the results from randomized trials.

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ANGIOCHIRURGO DARBO STAŽO, OPERACIJŲ SKAIČIAUS IR LIGONIO RIZIKOS VEIKSNIŲ REIKŠMĖ VIDINĖS MIEGO ARTERIJOS ENDARTEREKTOMIJOS REZULTATAMS

S a n t r a u k a

Darbo tikslas. Remiantis kraujagyslių chirurgijos centro kasdieninės praktikos duomenimis, nustatyti ryšį tarp angiochirurgo techninių įgūdžių, kurie priklauso nuo darbo stažo ir atliktų operacijų skaičiaus, ir mirties bei insulto po vidinės miego arterijos endarterektomijos.

Metodai ir medžiaga. Analizuota 790 vidinių miego arterijų endarterektomijų, atliktų 1995–2006 metais. Pradinių duomenų bazėje buvo registruoti visų ligonių rizikos veiksniai, gretutiniai susirgimai, indikacijos operacijai, mirties ir naujo insulto atvejai. Duomenys suskirstyti atsižvelgiant į angiochirurgo patirtį miego arterijų chirurgijoje ir atliktų endarterektomijų skaičių. Duomenų analizei naudota vienaveiksmė ir daugiaveiksmė loginė regresija bei ROC kreivės.

Rezultatai. Tarp analizuojamų 790 endarterektomijų mirčių buvo 2,1%, insultu susirgo 2,4% ligonių. Nustatytas statistiškai patikimas operacinių insultų skirtumas tarp chirurgų, kurių darbo stažas nesiekė 10 metų, ir angiochirurgų, kurių darbo stažas viršijo 20 metų (5,6% vs 1,8%; P = 0,03); mirčių statistikoje patikimo skirtumo nerasta. Didesnė darbo patirtis turėjo reikšmę ligonių su neurologiniais simptomais operacijos rezultatams ir neturėjo įtakos nesimptominių ligonių operacijos rezultatams. Kai ligonius operavo chirurgai, kurie atlikdavo mažiau kaip 6 miego arterijos endarterektomijas per metus, insultu po operacijos sirgo 5,6% ligonių, ir 1,1% ligonių, kai operavo chirurgai, kurie atlikdavo 6 ir daugiau endarterektomijų per metus (P = 0,015). Endarterektomijų skaičius turėjo įtakos ligonių su insultu rezultatams ir neturėjo nesimptominių ligonių rezultatams. Cukrinis diabetas (ŠS 3,51; 95% PI 1,60–7,66; P = 0,002), priešingos pusės miego arterijos, arba v/b, insultas (ŠS 4,14; 95% PI 1,57–10,91; P = 0,004) ir mažai operuojantis angiochirurgas (ŠS 0,32; 95% PI 0,13–0,78; P = 0,013), daugiaveiksmės loginės regresijos duomenimis, turėjo didžiausią mirties po operacijos ir insulto prognostinę vertę. ROC kreivių analizė rodo, kad šių trijų parametrų bendra prognostinė vertė yra 0,72.

Išvados. Miego arterijos endarterektomijos rezultatai priklauso nuo angiochirurgo darbo stažo ir operacijų skaičiaus. Nepalankią operacijos baigtį daugiausia lėmė cukrinis diabetas, persirgtas priešingos pusės miego arterijos, arba v/b, insultas ir mažai operuojantis angiochirurgas.

Raktažodžiai: vidinės miego arterijos endarterektomija, indikacijos, rizikos veiksniai, darbo stažas, operacijų skaičius, rezultatai