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Is Carotid Endarterectomy a Trainee Operation?

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Abstract

Background Recent dramatic changes in surgical training resulting from working-hour regulations may lead to lack of competence. Traditionally, carotid surgery has been the domain of specialists. This study was designed to compare the outcome of carotid endarterectomy performed by vascular surgical trainees versus vascular surgeon (VS).

Methods A retrospective study of 1,379 consecutive patients who underwent carotid endarterectomy as the sole procedure under local or general anesthesia (from 1995–2004) was performed. All patients were admitted to the intensive care unit for 24 hours. Trainees performed 475 (34.5%) and vascular specialists performed 904 (65.5%) operations.

Results Patient characteristics with regard to preoperative neurological status were similar. Trainees operated on 61.4% symptomatic patients and VS on 56.8% ($P = 0.09$). Shunt use did not differ (16% trainee vs. 17.8% VS). Clamping time and total operating time were longer among trainees (41.9 vs. 33.5 min, $P < 0.001$; and 121.2 vs. 101.8 min, $P < 0.001$, respectively). Postoperative stroke and death rates (3.2% vs. 3.1% and 0.4% vs. 0.9%, respectively) did not differ. Peripheral nerve complications were more common among trainees (12.2% vs. 6.5%; $P < 0.0001$); 99.6% of these nerve injuries had resolved at 3 months' follow-up.

Conclusions Carotid endarterectomy can be performed safely by a trainee vascular surgeon when assisted and supervised by a specialist vascular surgeon.

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Introduction

It has been shown that experience plays an important role in the outcome in surgery. Several studies have demonstrated that the results of operations are better in large-volume centers as well as in the hands of more experienced surgeons [1]. The same is true for carotid endarterectomy (CEA) [2, 3]. Recent dramatic changes in surgical training resulting from working-hour regulations may lead to a decrease in the level of competence among young surgeons. Less clinical experience, less manual training, increasing number of endovascular procedures, and consequently a decrease of operative case volume during training may necessitate the need for other solutions, such as using surgical simulators in training. The benefits of these devices have been clearly shown in laparoscopic surgery [4] and are being studied in vascular surgery as well [5].

Traditionally, carotid surgery has been the domain of specialists rather than trainees. The volume of carotid surgery may diminish as a result of carotid stenting. Surgeons have to produce excellent results to defend their impact in the management of carotid disease [6–8]. These circumstances do not support extensive practical training; however, it seems clear that carotid surgery will not disappear completely. This study was designed to clarify whether CEA can be encouraged as a safe trainee operation.

Materials and methods

The hospital records of 1,379 consecutive patients who underwent carotid endarterectomy as sole procedure in two vascular centers (Department of Cardiovascular Surgery at Giessen University, and Department of Vascular Surgery at Staedtisches Klinikum Dessau in Germany) from January 1995 to December 2004 were collected retrospectively. Indication for surgery was >80% asymptomatic (41.4%) and >70% (58.6%) symptomatic carotid stenosis. Hospital volume was approximately 60 to 80 operations per year in both teaching hospitals. The diagnosis had been made by duplex scan in all cases and confirmed by angiography or magnetic resonance imaging.

Patients were divided into two groups based on the experience of the operating surgeon: trainee vs. vascular specialist. All operations performed by a trainee were supervised by a vascular specialist. All the attending specialists had more than 5 years of experience in educational function. The trainees were certified general surgeons in vascular fellowship (as stipulated by the German specifications for vascular surgical training). Before the first operation, the trainees had assisted 25 carotid endarterectomies performed by a specialist. Knowledge of anatomy and theory of carotid surgery were provided. The final responsibility for the outcome was carried by the attending surgeon.

Comparisons were made with respect to preoperative risk factors, intraoperative events, and postoperative complications. Total operating time and clamping time of the carotid artery were recorded.

Postoperatively, major stroke was defined as neurologic deficit lasting more than 30 days and leading to handicap. Minor stroke was defined as any focal deficit leaving no handicap. Particular attention was paid to analyzing postoperative cranial nerve injuries. All patients were preoperatively and postoperatively examined by an independent neurologist. All patients with new central neurologic deficits underwent computed tomography.

The operation was performed by using local or general anesthesia. For local anesthesia, 0.75% rocuronium bromide and additional xylocaine was used, supplemented by the surgeon as needed (1–5 ml), combined with intravenous sedatives and anxiolytics as suggested by the anesthetist. At the time of carotid clamping, neurology was tested by the patient's ability to squeeze a duck making a sound. Shunting was performed if the response was deemed inappropriate.

For general anesthesia, the patients were intubated. Etomidate and propofol were used for anesthesia with remifentanyl infusion. SSEP (somato-sensoric evoked potentials) monitoring was routinely used. Carotid shunting was performed if SSEP showed slowing of 50% response. CEA was performed conventionally, using patch closure in all cases.

All patients were admitted to an intensive care unit (ICU) routinely for 24 hours. Blood pressure was recorded directly by using a needle in the radial artery.

Statistical analysis was performed by using SPSS 15.0 software (SPSS Inc., Chicago, IL). The two groups were compared by univariate analysis with χ^2 test for categorical items or *t*-test for parametric data, respectively. All P values are shown in the tables. The results are considered significant at $P < 0.05$.

Results

During the study period, a total of 1,379 carotid endarterectomies were performed: 475 (34.5%) by a trainee (T) and 904 (65.5%) by a consultant vascular surgeon (VS).

Patient characteristics are shown in Table 1. There were no differences in patient characteristics with regard to preoperative neurological status. Trainees operated on 39.2% asymptomatic patients and VS on 43.2% ($P = 0.09$).

Anatomically, there were no significant differences between the two groups. Trainees operated on 13.5% patients with contralateral occlusion and VS on 13.4% ($P = 0.96$). There was a significant difference in the distribution of the 24 redo operations; all except one was operated on by a VS ($P < 0.01$).

There were more smokers in the trainee group (43.2% vs. 34.5%; $P = 0.001$), whereas more patients suffered from hypertension in the VS group (85.4% vs. 77.8%; $P < 0.001$).

Other preoperative factors, such as age and sex, as well as comorbidities, such as peripheral arterial occlusive disease, hyperlipidemia, coronary artery disease, diabetes, or renal disease, showed no significant differences. Operative variables between the groups are shown in Table 2.

A total of 901 (65.1%) operations were performed using general anesthesia and 478 (34.9%) using local anesthesia. Trainees operated on 159 (33.4%) patients by using local anesthesia and 316 (66.6%) patients by using general anesthesia: VS on 319 (35.2%) and 585 patients (64.8%), respectively. There were no significant differences in shunt use (16% T vs. 17.8% VS), whereas tack down sutures were used significantly more often by trainees (46.8% vs. 34.7%; $P < 0.001$). Clamping time was longer for trainees (41.9 vs. 33.5 min; $P < 0.001$), as was total operating time (121.2 vs. 101.8 min; $P < 0.001$).

Table 1 Patient characteristics

	Trainee ($n = 475$)	VS ($n = 904$)	*P* value
Age (yr)	66.91	67.48	0.245
	(SD: 8.632)	(SD: 8.532)	
Male sex	340	669	0.334
	71.6%	74%	
Diabetes	128	249	0.917
	27%	27.6%	
Occlusive arterial diseases	132	234	0.454
	27.8%	26%	
Hypertension	369	770	<0.001
	77.8%	85.4%	
Smoking history	205	311	0.001
	43.2%	34.5%	
Coronary heart disease	206	419	0.289
	43.5%	46.5%	
Renal dysfunction	79	168	0.664
	16.6%	18.6%	
Contralateral occlusion	64	121	0.964
	13.5%	13.4%	
Redo operations	1	23	0.01
	0.2%	2.5%	
Asymptomatic	182	390	0.074
	39.2%	43.2%	
Minor stroke	183	303	
	39.9%	33.6%	
Major stroke	99	209	
	20.9%	23.2%	

VS vascular surgeon, *SD* standard deviation

Table 2 Operation details

	Trainee ($n = 475$)	VS ($n = 904$)	*P*-value
General anesthesia	159	319	0.952
	(33.4%)	(35.2%)	
Local anesthesia	316	585	
	(66.6%)	(64.8%)	
Shunt	76	160	0.452
	16%	17.8%	
Tack down suture	222	313	<0.001
	46.8%	34.7%	
Operating time	121.25	101.89	<0.001
	(SD: 30.053)	(SD: 26.868)	
Clamping time	41.94	33.56	<0.001
	(SD: 18.572)	(SD: 15.746)	

VS vascular surgeon, *SD* standard deviation

There were no significant differences in the incidence of stroke and death (3.2% vs. 3.1% and 0.4% vs. 0.9%, respectively). Peripheral nerve complications were significantly more common in the trainee group (12.2% vs. 6.5%; $P < 0.0001$). Of these, 8% vs. 4.2% hypoglossal nerve lesions, 2.7% vs. 1.6% lesions of the mandibular branch of the facial nerve, and 1.5% vs. 0.7% of the laryngeal nerve. At the 3-month follow-up, only 0.4% of these nerve injuries were persistent.

Discussion

The daily working hours of trainee surgeons are going through dramatic changes everywhere in the western world [9]. As a result of the simultaneous emergence of endovascular techniques, the change is particularly evident in the field of open vascular surgery. Becoming proficient with carotid surgery may be limited because of the decreasing case volume and the increase of endovascular procedures. Recent studies from Denmark, the United Kingdom, and the United States suggest that the changes in training may not be reflected in the outcome [10–13]. Newly developed observer-based systems, such as that used in Sheffield [14], or the use of synthetic carotid endarterectomy models, such as that used in St Mary's Hospital, London [15], are attempted solutions. Irrespective of the training model, the goal is a stepwise progression of level of competence [16].

The need for changes in vascular training has been debated recently. Vascular surgery is recognized as a subspecialty within the European Union [17]. In this context, the role of surgical skill and the quality of training have to be constantly emphasized, especially in operations, such as carotid endarterectomy, which is still the "gold standard" for the management of carotid stenosis [8].

In our study, a "trainee" was defined as a general surgeon, licensed in Germany, who had assisted at least 25 carotid endarterectomies before her/his first attempt as the main operating surgeon working in a vascular surgical unit accredited by the Ministry of Health for training.

In our series, the outcome was not significantly different with regard to stroke and death. Similar results have been reported in other studies [18–21]. However, those studies are limited due to small numbers of operations; the study of Bradbury et al. [18] reported the results of 466 (from 1975–1996) operations, and the others the results of 200 or less. Based on 1,379 operations, our series is clearly one of the largest of its kind so far.

In our study, the total operating and clamping times were significantly longer in the trainee group, which also was seen in the study by Beard et al [14]. It may reflect particularly careful dissection due to less experience and a teaching situation with discussions between the trainer and the trainee. However, the longer operating times of the trainees are not reflected on outcome.

Gelabert and Moore [22] reported the overall incidence of peripheral nerve complications in CEA as 8–17%. In our series, there were significantly more peripheral nerve injuries in the trainee group (12.2% vs. 6.5%; $P < 0.0001$). Using routine laryngoscopy, Hertzer et al. [23] detected laryngeal nerve injuries in 6.7%, those of hypoglossal nerve in 5.8%, and lesions of the mandibular branch of the facial nerve in 1.8%. The investigators noted that only two-thirds of these injuries were apparent on cursory clinical examination. Most of these lesions were transient and resolved within 2–3 months.

The disability from cranial nerve injuries varies from minimal to severe. Of our patients, 99.6% fully recovered within 3 months. Six (0.4%) patients had residual problems for a longer period of time. In general, cross-innervation from contralateral nerves often will enable patients to resume most functions. Comparing our results to those of others [3, 18–22, 24], we conclude that the results of the trainees are acceptable. At least the transient hypoglossal nerve injuries seen in our study—as well as those of others—may have been caused by an overly zealous consultant pulling the retractor too hard while trying to keep a close eye on the operating field as well as the trainee!

Conclusions

Open carotid surgery can be safely performed by an appropriately prepared trainee vascular surgeon. Supervision by a specialist vascular surgeon is important. Well-structured training programs are needed to provide adequate experience.

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