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A Short Incision for Carotid Endarterectomy Results in Decreased Morbidity

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Objectives. *To investigate the effect of a short incision (<5 cm) on the complication rate of the carotid endarterectomy (CEA).*

Design. *A retrospective cohort study.*

Patients and methods. *From January 1994 to December 2005, 874 patients underwent 1048 primary carotid endarterectomy (CEA) procedures. Seven hundred and sixty nine operations were performed through a long neck incision (group A), while 279 were performed through a smaller incision (<5 cm) according to a standard protocol (group B). Preoperative and postoperative cranial nerve assessment was completed on all patients. The main outcome measures were stroke, death, cranial and cervical nerve injuries rates.*

Results. *The 30-day mortality rate was 0.26% in group A and 0.35% in group B ($p = .792$). The stroke rate was 0.13% and 0% in group A and B respectively ($p = .839$). The mean length of stay was 2.59 days in group A and 1.67 days in group B ($p < .0001$). In group A the overall incidence of motor and sensory nerve deficits was 13.5% (104 CEA, 92 patients) but in group B 2.9% (8 CEA, 7 patients, $p < .0001$, odds ratio [OR] 0.189, 95% confidence interval [CI] 0.091–0.393).*

Conclusions. *Carotid endarterectomy through a small incision is a feasible and safe approach that provides cosmetic results and fewer nerve complications without compromising the safety of the procedure.*

Keywords: Carotid endarterectomy; Skin incision; Nerve injury; Morbidity.

Introduction

Carotid endarterectomy (CEA) is the most effective intervention for stroke prevention in patients with symptomatic stenosis of the carotid bifurcation.[1–4] Improvements in techniques and meticulous pre- and postoperative care have considerably decreased the perioperative complication rate. In fact, many referral centers report stroke and death rates after CEA that are much lower than those reported in the literature.[5–7] Like any surgical procedure, CEA, has recognized morbidity. Cranial or cervical nerve injury, wound hematomas and poor cosmesis continue to impact on patient care,[8–12] thus, making less invasive techniques more attractive.[13–15] We attempted to see if by decreasing the length of the cervical incision used for CEA we would decrease the incidence of perioperative morbidity.

Patients and Methods

This study is a retrospective study that analyzed outcomes from 874 patients undergoing 1048 CEAs at the First Department of Surgery of the University of Athens. The procedures were performed from January 1994 to December 2005. From 1994 to 2002, 646 patients underwent 769 CEA (group A) through a traditional skin incision (>10 cm in length) extending from the sternal notch to the mastoid process. From 2003 to 2005, 228 patients underwent 279 CEAs (group B) through a short incision. We adopted this change in policy because the exposure provided by the traditional longer incision was usually longer than the exposure required to suture the carotid patch and because an initial short incision could be tailored to the patient's anatomy if the need arose without compromising the safety of the procedure. All patients in group A had the degree of carotid stenosis estimated angiographically using NASCET (North American Symptomatic Carotid Endarterectomy Trial) criteria. In group B, 53% of patients had angiography and

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47% had ultrasound to determine degree of carotid stenosis. Patients underwent CEA if they were symptomatic and had >70% angiographic stenosis or were asymptomatic and had >80% stenosis on ultrasound. CEA was performed under general anesthesia. Systemic heparin administration (100 U/kg) and shunt placement (Argyle, Sherwood Med. St. Louis, MO) was routinely carried out. All patients received a vein patch Fig. 1.

Patients of group B had a small incision starting at the level of the thyroid cartilage. The initial incision was no more than 3.0 cm in length and extended toward the direction of the mastoid. From past experience with ultrasound, it was observed that this is a safe starting point because the carotid bifurcation is localized 2 cm cephalad from this point with a 1 cm standard deviation in the majority of patients. After identifying the carotid bifurcation and assessing of the extent of carotid disease, the CEA was performed either through this limited incision or lengthened to allow safe completion of the case. The length of incision was measured early in the procedure, because use of retractors and laxity of skin might impact on the measurement performed at the end of the CEA. A neurologist examined each patient for alteration in neurological status and presence of cranial and cervical nerve injuries. The assessment was performed pre and post operatively on the day of the procedure and on the day of discharge. Patients with symptoms of vagus nerve injury had vocal cord evaluation with direct fiberoptic laryngoscopy. Other endpoints evaluated were 30 day mortality and postoperative stroke rate.

Statistical evaluation of results was performed using the student's t-test and chi-square analysis (SPSS for Windows, version 10.0.1). Statistical significance was inferred at $P < .05$.

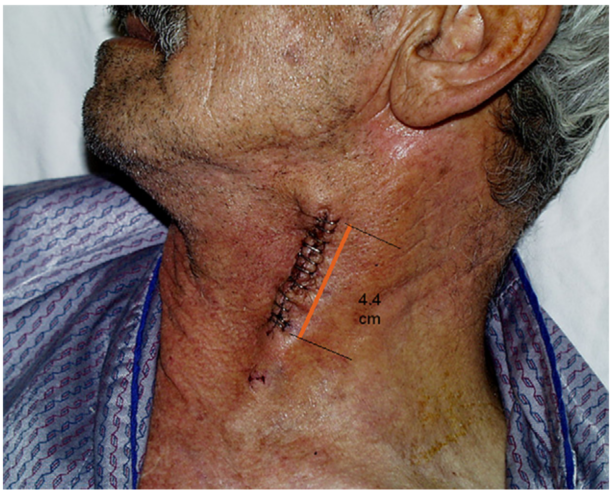


Fig. 1. Postoperative incision for carotid endarterectomy 4.4 cm of length at the time of procedure.

Results

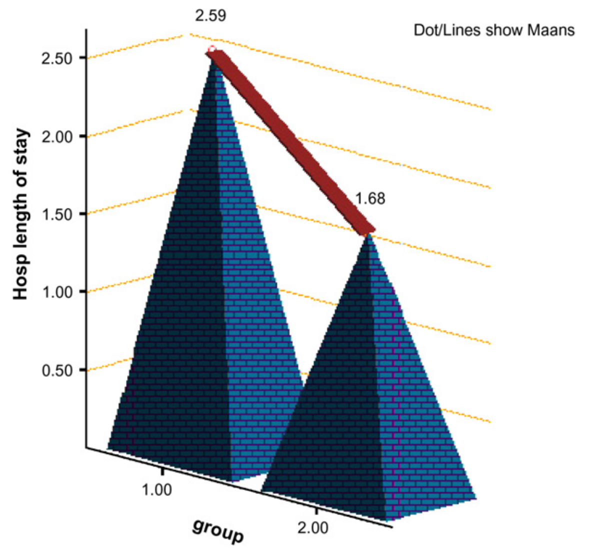
In group A, out of the 646 patients, 492 were males (76.2%) and 154 females (23.8%) with a mean age of 71.2 years (range 56 to 90). In group B, out of 228 patients, 178 were males (78.1%) and 50 were females (21.9%), with a mean age of 70.3 years (range 51−91). The preoperative demographic data and risk factors were similar in the two groups (Table 1). The 30-day mortality rate was 0.26% in group A and 0.35% in group B ($p = .792$). The stroke rate was 0.13% in group A and 0% in group B ($p = .839$). The overall stroke and mortality rate was 0.10% in group A and 0.29% in group B. The solitary stroke in group A occurred in a patient who developed an intracerebral haematoma on the first postoperative day. A second patient in group A, died 2 days after the operation due to a myocardial infarction. In group B one patient died due to severe pulmonary infection and pulmonary insufficiency, 10 days after the procedure. The mean length of stay was 2.59 days in group A and 1.67 days in group B ($p < .0001$; 95% confidence interval [CI] = 0.8194−1.0091) (Table 2). The average length of incision in group B, was 5.05 cm (range 3.2−8.8 cm, Standard Deviation [SD]. 9583). In 256 (91.8%) of procedures performed in group B, the length of vein patch was longer than the length of skin incision. The mean length of vein patch was 5.3 cm (range 4.1−6.4 cm). It is important to note that the mean length of incision in the first 50 cases in group B was 5.77 cm (SD 1.1367), whereas in the last 50 cases it was 4.55 cm (SD 0.7086, $p < .0001$) (Table 3).

In group A the overall incidence of motor and sensory nerve deficits was 13.5% (104 CEA, 92 patients). In group B, the incidence of motor and sensory nerve deficits was 2.9% (8 CEA, 7 patients). This difference in neurologic deficit was statistically significant. ($p < .0001$, odds ratio [OR] 0.189, 95% CI 0.091−0.393). The types of nerve injury in group A included, 25 injuries of the marginal mandibular branch of the facial

Table 1. Demographic data of patients

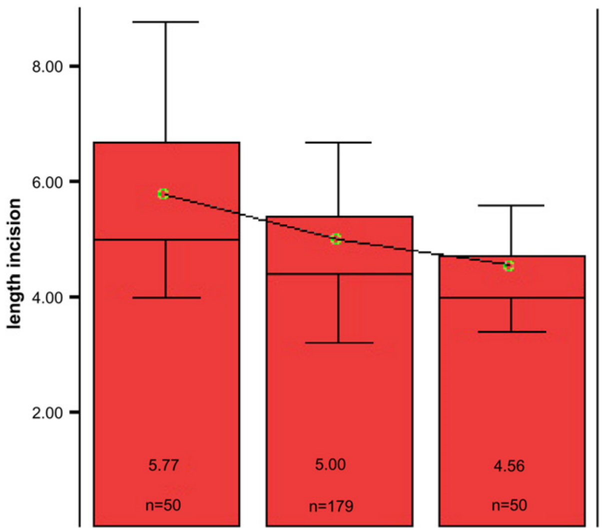
Data	Group A	Group B	Total
	No (%)	No (%)	No (%)
No. of operations	769	279	1048
No. of patients	646	228	874
Male	492	178	670 (76.6)
Female	154	50	204 (23.4)
Asymptomatic	339 (44.1)	112 (40.1)	451 (43.0)
Symptomatic	430 (55.9)	167 (59.9)	597 (57.0)

Table 2. Hospital length of stay between Groups. Group A: mean value 2.59 days (SD .6553), Group B: 1.68 days (SD .7842), $p < .0001$



nerve, 36 injuries of greater auricular nerve, 15 injuries of the superior laryngeal nerve, 6 injuries of the hypoglossal nerve, 3 injuries of recurrent laryngeal nerve and 48 injuries of the transverse cervical nerve. By comparison, in group B there were 2 injuries of the superior laryngeal nerve ($p = .162$), 1 injury of the marginal mandibular branch of the facial nerve ($p = .008$, OR 0.107), 2 injuries of the greater auricular nerve ($p = .02$, OR 0.147), 1 injury of the hypoglossal nerve ($p = .459$), 1 injury of the recurrent laryngeal nerve ($p = .941$) and 1 injury of the transverse cervical nerve ($p < .0001$, OR 0.054) (Table 4).

Table 3. Demonstration of mean value of length of incisions in group B according the number of cases



All nerve injuries noted in both groups were transient and resolved within one year of the CEA. The exceptions were 2 injuries of the superior laryngeal nerve that failed to resolve after 1 year follow up.

Discussion

After CEA, the incidence of cranial nerve injuries has been reported to vary from 3% to 48%.[16–18] The risk of injury is correlated with the duration of the operation.[19] There are some features of CEA that increase the length of the procedure. These include use of shunting and vein patching. We have used these adjuncts with low mortality and incidence of perioperative stroke. This established efficacy makes us hesitant to modify these aspects of CEA. The incidence of nerve injury, however, was one feature that we felt we could improve upon. To our knowledge, despite the fact that there have been reports of CEA and endovascular interventions done with small incisions, there is no study in the literature correlating the incidence of nerve injury with the length of incision.[20,21]

In this study we observed a statistical difference ($p < .0001$, OR .189, 95% CI .091−.393) in the incidence of nerve injuries when patients had CEA performed with a smaller incision. Most injuries were to the marginal mandibular nerve, the transverse cervical nerve and the great auricular nerve. Although most of these injuries were transient with recovery within one year, they can result in patient discomfort and significant morbidity.[22]

One of the limitations of this study, is its retrospective design, however, the patients had their surgery performed by one surgeon in one surgical unit thus minimizing confounding variables and selection bias. This study presents a large data set in a contemporary cohort with emphasis on the kind and frequency of cranial nerve injuries that accompany CEA. The low incidence of perioperative mortality and stroke attest to the care with which this procedure is performed. The modification in technique had a learning curve as evidenced by decrease in the length of incision

Table 4. Results and distribution of nerve injuries between groups

	Group A		Group B		Total		Statistics
	%	*N*	%	*N*	%	*N*	*P*
Facial nerve (MMB)	3.3	25	0.4	1	2.5	26	0.008
Transverse cervical nerve	6.2	48	0.4	1	4.7	49	<0.0001
Great auricular nerve	4.7	36	0.7	2	3.6	38	0.002
Sup. Laryngeal nerve	2.0	15	0.7	2	1.6	17	N/S
Rec. Laryngeal nerve	3	0.4	0.4	1	0.4	4	N/S
Hypoglossal nerve	0.8	6	0.4	1	0.7	7	N/S

used by the operating surgeon from 5.77 cm in the first 50 cases of group B to 4.55 cm in the last 50 cases of group B. The length of incision in group A patients was not measured exactly, but extended from the sternal notch to one fingerbreadth below the angle of the mandible. This length is greater than 10 cm and is closer to 13 cm. The protocol in the author's surgical unit is to have all patients with CEA examined by a neurologist perioperatively. This focused examination has resulted in identification of a relatively high incidence of cranial and sensory nerve dysfunction. We believe that the decrease in incidence of motor and sensory nerve injuries from 13.5% in patients with longer incisions to 2.9% in patients with shorter incisions results from decrease in length of surgical incision used, rather than surgeon or neurologist inexperience or neurologist vigilance.

Probable mechanisms of nerve injury during CEA include thermal or electrical damage, ischemia and perineural haematoma due to rupture of small supporting vessels. Damage to local nerves, during carotid endarterectomy occurs because of pressure applied from retractors, either directly or indirectly to the nerves. Although exposure using smaller incisions can result in greater retraction to optimize exposure, it seems that preserving the tissue surrounding nerves, protects their blood supply and, decreases pressure-induced damage.

Sensory deficits after carotid endarterectomy include paresthesias over the earlobe and the angle of the mandible and also numbness to the anterior cervical triangle. Injuries of the greater auricular and transverse cervical nerves account for these types of deficits. Both these nerves are situated at the superior aspect of the sternocleidomastoid muscle and the traditional long incision may disrupt the integrity of the above nerves. The morbidity of these injuries is documented in Dehn's study where 20% of patients with similar injuries continued to complain of symptoms 6 months after the procedure.[22]

Injury of the marginal mandibular branch of the facial nerve leads to ipsilateral lip drop and involuntary drooling. Long incisions with forceful retraction at the angle of the mandible damage this nerve.[16] Other nerves at risk during CEA are the spinal accessory nerve and the glossopharyngeal nerves. Potential risk of aspiration is one of the most severe consequences after injury to the glossopharyngeal nerve due to deviation of the uvula. Again the risk of injury increases with use of longer and more superiorly placed incisions.

There is no doubt that a short incision provides better cosmesis and less potential for scar formation. Another way to achieve cosmetic results is by the use of a transverse incision for carotid exposure; however, this type of approach has a similar incidence of nerve complications as the conventional incision paralleling the border of the sternocleidomastoid.[11,12]

In conclusion, we believe that CEA can be performed using a short incision. Use of a short incision does not necessitate radiologic localization and is thus cost-effective. The procedure can be performed safely with no change in mortality or incidence of perioperative stroke. There are fewer nerve complications incurred and superior cosmesis. Like any surgical modification, there is a learning curve and of course, the incision must always be adequate to allow performance of the operation with proper visualization of the pertinent anatomy. Use of a shorter incision has value in CEAs performed under local anesthesia, where the avoidance of manipulation around the angle of the mandible is less disturbing for awake patients. Since there is a trend towards, minimally invasive techniques, the impetus exists for modifications in open surgery that minimize discomfort and recovery time.

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