Patient and observer scar assessment scores favour the late appearance of a transverse cervical incision over a vertical incision in patients undergoing carotid endarterectomy for stroke risk reduction

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Background: Carotid endarterectomy (CEA) is a very common operation, but there is no agreement on the appropriate orientation of the surgical incision.

Methods: We retrospectively reviewed the charts of patients who had undergone CEA between Jul. 1, 2010, and Dec. 31, 2013. We contacted patients identified in the review to solicit participation in a clinical follow-up examination, during which the esthetic outcome of the scar was evaluated using the Patient and Observer Scar Assessment Scale (POSAS).

Results: During the study period 237 CEAs were performed. Nine patients refused the use of their personal health information in this study. There were no significant differences in the neurologic outcomes of patients based on the incision orientation (perioperative stroke and death 1.4% with transverse incision v. 0% with a vertical incision, p = 0.44). Fifty-two patients presented for follow-up examination. Thirty-three had a transverse incision and 19 had a vertical incision. Results of the POSAS significantly favoured the transverse incision (p = 0.03). Vertical incisions were more often associated with persistent, mild marginal mandibular nerve dysfunction (p = 0.04).

Conclusion: Carotid endarterectomy performed through a transverse skin incision compared with a vertically oriented skin incision is associated with improved esthetic outcome, as measured by the POSAS, without an observed statistically significant difference in the risk of perioperative stroke or death between the 2 techniques.

Contexte : L'endartériectomie de la carotide est une intervention chirurgicale très courante. Toutefois, il n'existe aucun consensus sur l'orientation de l'incision.

Méthodes : Nous avons analysé rétrospectivement les dossiers de patients ayant subi une endartériectomie de la carotide entre le 1er juillet 2010 et le 31 décembre 2013. Nous avions communiqué au préalable avec les patients concernés pour solliciter leur participation à un examen de suivi clinique au cours duquel le résultat esthétique de leur cicatrice serait évalué au moyen de l'échelle d'évaluation des cicatrices par les patients et les observateurs (POSAS).

Résultats : Au cours de la période visée, 237 endartériectomies de la carotide ont été pratiquées. Neuf patients ont refusé qu'on utilise leurs renseignements médicaux personnels dans le cadre de l'étude. Aucune différence significative n'a été observée quant aux capacités neurologiques des patients selon l'orientation de leur incision chirurgicale (décès et accident vasculaire cérébral périopératoires : 1,4 % avec incision transversale contre 0 % avec incision verticale, p = 0,44). Au total, 52 patients se sont présentés pour un examen de suivi : 33 avaient eu une incision transversale et 19, une incision verticale. Les résultats à la POSAS étaient nettement meilleurs pour les incisions transversales (p = 0,03). Les incisions verticales étaient plus souvent associées à un dysfonctionnement léger, mais persistant de la branche marginale de la mandibule du nerf facial (p = 0,04).

Conclusion : Notre étude indique que d'après la POSAS, l'endartériectomie de la carotide est associée à un meilleur résultat esthétique lorsqu'elle est pratiquée au moyen d'une incision cutanée transversale qu'au moyen d'une incision verticale. Par ailleurs, aucune différence statistiquement significative n'a été observée quant aux risques de décès et d'accident vasculaire cérébral périopératoires associés à l'une ou l'autre de ces 2 techniques.

The utility of carotid endarterectomy (CEA) in preventing transient ischemic attack (TIA) and stroke has been demonstrated in patients with symptomatic[1–3] and asymptomatic[4–8] carotid artery stenosis caused by atherosclerosis. Although CEA is very common and has been performed for more than 50 years,[9] the specific surgical technique is variable from surgeon to surgeon with respect to the use of general or local anesthesia, eversion or conventional endarterectomy, use of intraoperative shunt and carotid artery patching.[10–13]

In addition, there is no agreement on the appropriate orientation of the surgical incision. The standard operative approach uses an incision oriented parallel with the anterior border of the sternocleidomastoid muscle. Some surgeons, however, prefer to expose the operative site through an incision that follows the transverse skin creases of the neck. Surgical principles suggest that a transverse incision may provide the patient with a better cosmetic outcome because the scar is oriented along Langer's lines.

The Patient and Observer Scar Assessment Scale (POSAS) was developed and validated in patients with burn scars[14] and has demonstrated validity in the assessment of linear surgical scars.[15] The POSAS observer score rates the scar on a scale of 1 (normal skin) to 10 (worst scar imaginable) in 5 categories: vascularization, pigmentation, thickness, relief and pliability. Similarly, for the patient component score, the patient self-rates the scar in 6 categories: pain, itching (on a scale of 1 [no complaints] to 10 [worst imaginable]), colour, stiffness, thickness and irregularity (on a scale of 1 [normal skin] to 10 [very different]). The POSAS has previously been used to report on scar outcomes following neck surgery (parathyroidectomy and thyroidectomy),[16] but to our knowledge it has not been applied previously to study differences in the outcomes of vertical and transverse incisions for CEA.

Methods

Within the geographic region of this study, all CEAs were performed within a single, 3-surgeon vascular surgery practice that provides care to a population of approximately half a million individuals. Carotid endarterectomies performed between Jul. 1, 2010, and Dec. 31, 2013, form the basis of our study.

Cases were identified through a computerized query of the discharge abstract database maintained by the region's health records department, and hospital charts fitting the inclusion criteria were retrospectively reviewed. We collected data on patient sex, age, date of hospital admission, date of surgery, operating surgeon, operative side, operative indication, degree of internal carotid artery stenosis as documented by ultrasound and/or computed tomography angiography (CTA), presence of diabetes, history of coronary artery disease, presence of atrial fibrillation, history of valvular heart disease, presence of hypertension, hypercholesterolemia or dyslipidemia, renal failure, smoking history, anesthetic type, use of intraoperative neurologic monitoring, use of intraoperative shunt, combination of CEA with another operative intervention under the same anesthetic, neurologic outcome to 30 days postoperatively, postoperative cardiac complications, wound complications (hematoma or infection), date of discharge, and death. Vertical incisions were defined as those oriented parallel to the anterior border of the sternocleidomastoid muscle. Transverse incisions were defined as those parallel to the skin creases of the neck.

All eligible participants identified in our chart review were contacted by telephone to obtain informed consent to participate in the study. Patients who agreed to the retrospective use of hospital chart data were also invited to attend a follow-up visit. During the study follow-up visit, all participants were interviewed and examined by a single observer (M.D.). Participants were asked to complete the patient questionnaire portion of the POSAS and the observer completed the observer portion of the POSAS. The observer also confirmed the orientation of the participants' surgical scars, confirmed the retrospectively abstracted chart data, and performed a physical examination of the marginal mandibular nerve ipsilateral to the surgical site. Marginal mandibular nerve weakness was classified as absent, mild or severe.

This study was approved by the Research Ethics Boards of Regina Qu'Appelle Health Region and the University of Saskatchewan through a harmonized ethics review process.

Statistical analysis

All data were stored in an anonymized electronic database for analysis, and we analyzed the data using Microsoft Excel. Study subgroups were compared statistically using the Fisher exact test for categorical variables and the Student *t* test for continuous variables. We used analysis of variance (ANOVA) to compare multiple means and regression analysis to examine possible correlations between continuous variables. Results were considered to to be significant at $p < 0.05$.

Results

During the study period 237 CEAs were performed. Nine patients refused the use of their personal health information in this study and were excluded from analysis. Of the remaining 228 CEAs performed, 193 were undertaken for symptomatic carotid stenosis, and 35 (15%) were performed in asymptomatic patients. The majority of patients (147 [64%]) had 80%–99% internal carotid stenosis on the operative side, as measured by duplex ultrasonography and/or CTA. The remaining 81 patients had 50%–79% stenosis of the internal carotid artery. All patients who underwent surgery for 50%–79% internal carotid artery

stenosis had recent ipsilateral, focal neurologic symptoms. The operative indication for symptomatic patients included stroke in 51 (26%) patients, TIA in 95 (49%) and amaurosis fugax in 47 (24%).

Carotid endarterectomies were performed according to the preference of the attending surgeon with regards to the orientation of the incision. One of the 3 surgeons consistently used a vertical incision for all carotid surgeries. The remaining 2 surgeons used both vertical and transverse skin incisions (32% transverse incision and 78% transverse incision, respectively). For 1 patient, a vertical incision was chosen to specifically accommodate a long common carotid artery plaque that extended into the lower neck. In 2 other patients, the incision followed a scar from previous surgery. In the remaining patients, there was no documented reason why the surgeon chose a vertical or transverse incision.

New postoperative strokes within the 30 days after surgery occurred in 4 (1.8%) patients. Three patients died within 30 days of surgery (1.3%). One patient with stroke also died, yielding a combined stroke/death rate of 2.6%.

Eight patients underwent carotid endarterectomies combined with another operative intervention (7 coronary artery bypass grafting, 1 thoracotomy/lobectomy for lung cancer), and 220 patients received CEA alone. Within the group undergoing CEA alone, we observed a stroke rate of 1.4% and a combined stroke/death rate of 2.3%.

We identified 70 patients with a transverse incision on the basis of follow-up observation or clear documentation in the operative report. Similarly, we identified 89 patients with vertical incisions on the basis of follow-up examination or clear documentation in the operative report. A definite incision orientation could not be determined in 69 patients, as these individuals did not present for follow-up, and the incision orientation could not be determined unequivocally from the operative record.

All postoperative strokes occurred in patients in whom the incision orientation could not be determined. Of the patients with a transversely oriented incision, there were no strokes and 1 death (1.4%). In the group of patients with a vertical incision, there were no strokes and no deaths. The difference in the mortality between the groups was not significant ($p = 0.44$).

Most operations were performed with the patients under local anesthesia (72%) and the remainder (28%) were done with the patients under general anesthesia, based on patient preference. Of the operations performed under general anesthesia, approximately half had a planned carotid shunt placed for cerebral protection, while the other half had selective shunting on the basis of intraoperative electroencephalography (EEG) monitoring. The choice of planned shunting or intraoperative monitoring for patients under general anesthesia was based on surgeon preference. Seventy percent of all cases were performed without carotid shunting, 15% had a planned shunt, and 15% of cases had a shunt on the basis of EEG criteria or declining neurologic status in a patient under local anesthesia. A planned carotid shunt did not appear to be associated with the choice of incision orientation. Among patients undergoing planned carotid shunting, a vertical incision was documented in 34% of patients and a transverse incision was documented in 23%; the incision orientation could not be determined in 43%. These findings did not differ significantly from those in which a shunt was not planned (vertical incision 40%, transverse incision 32%, unknown incision 28%, $p = 0.23$).

Of the 228 patients who consented to the use of their health information for this study, 52 patients volunteered for follow-up examination and scar assessment at a mean follow-up of 25.9 ± 3.1 (range 7–48) months after surgery. In this subgroup, 33 patients had transverse incisions and 19 had vertical incisions. None of the 52 patients presenting for follow-up evaluation had CEA combined with another surgery, and none had prior ipsilateral neck surgery, radiation exposure or steroid use. All wound closures had been done with a subcuticular, absorbable, monofilament closure (Monocryl, Ethicon). The outcomes in relation to the incision orientation are shown in Table 1. Observer assessment of the patient's surgical scar showed a nonsignificant trend favouring the appearance of a transverse scar, whereas patient assessment scores showed a significant preference for the appearance of a transverse scar. The total POSAS score showed a significant result favouring the late appearance of the transverse incision. Severe dysfunction of the ipsilateral marginal mandibular nerve was not observed in any patients presenting for follow-up. We identified mild marginal mandibular nerve dysfunction in 3 of 19 patients with a vertical incision (15.7%) and none of the patients with a transverse incision ($p = 0.044$).

Within this subgroup of 52 patients, there were no observed correlations between the POSAS score and patient age ($R^2 = 0.04$), sex ($p = 0.70$), diabetes ($p = 0.71$), history of coronary artery disease ($p = 0.34$), hypertension ($p = 0.90$), history of hypercholesterolemia ($p = 0.12$), renal insufficiency ($p = 0.85$), smoking ($p = 0.62$), anesthetic type (general v. local; $p = 0.69$), or duration of follow-up ($R^2 = 0.09$). The only variables that showed significant correlation with

Table 1. Patient outcomes related to the orientation of the carotid endarterectomy incision

Outcome	Incision, mean ± SD*		*p* value
	Transverse, *n* = 33	Vertical, *n* = 19	
Observer score (out of 50)	9.0 ± 2.7	10.9 ± 4.1	0.09
Patient score (out of 60)	7.5 ± 2.1	10.2 ± 5.0	0.036
Total POSAS score (out of 110)	16.5 ± 3.9	21.1 ± 8.3	0.034
Marginal mandibular nerve dysfunction, no	0	3	0.044

POSAS = Patient and Observer Scar Assessment Scale; SD = standard deviation.
*Unless otherwise indicated.

POSAS score were incision orientation ($p = 0.034$) and surgeon ($p = 0.011$). There was a significant covariance between these last 2 factors ($p < 0.001$).

Of the 52 patients for whom a POSAS score was obtained, 34 had surgery under the care of a single surgeon who showed preference for the use of a transverse incision (27 transverse incisions, 5 vertical incisions); 8 patients were under the care of a surgeon who used both types of incisions (4 transverse incisions and 4 vertical incisions), and the remaining 10 patients were under the care of a surgeon who only used the vertical incision. There were no significant differences in POSAS score among the 3 surgeons when considering only patients with vertical incisions ($p = 0.48$), nor was there a significant difference in POSAS score between the 2 surgeons who used transverse incisions when considering only those patients ($p = 0.24$). Owing to the small numbers of patients in the subgroups, a multivariate analysis to identify the individual impact of surgeon and incision orientation was not possible.

Discussion

In order for an individual patient to benefit from CEA, the long-term stroke reduction afforded by the procedure must outweigh the risk of procedural complications in that individual. This demands technical excellence in the conduct of each CEA to keep the risk of procedural complications low. To satisfy the technical demands of the surgery, intraoperative visualization of the region of the carotid bifurcation must not be compromised. Many carotid surgeons, therefore, prefer the traditional vertical incision that is oriented along the anterior border of the sternocleidomastoid muscle and provides excellent exposure of the surgical site. The vertical incision, however, compromises the surgical principle of orienting an incision along Langer's lines when possible, to improve wound healing. Our data are consistent with the principle of better healing of incisions parallel to Langer's lines, with significantly better POSAS scores associated with transversely oriented skin incisions.

There were no significant differences in stroke and mortality rates between the cohorts of patients undergoing surgery with transverse or vertical incisions. We were able to determine stroke and mortality rates from retrospective chart review of 228 patients. Within this sample, we could compare only 70 patients with transverse incisions and 89 patients with vertical incisions. The lack of a measurable difference in stroke and death is reassuring that a transverse incision can afford a good technical outcome from the operation. The strength of this observation, however, is compromised by the inability to determine the incision orientation in 69 patients (30% of the total); all 4 strokes and 2 deaths were observed in this group.

We hypothesized that exposure of the distal internal carotid artery through a transverse neck incision would require greater retraction force on the upper wound edge than a vertically oriented incision and that this would be associated with crushing of the marginal mandibular nerve against the margin of the jaw. However, our observations demonstrated no late marginal mandibular nerve dysfunction in patients with transverse incisions. Marginal mandibular nerve defects were mild and uncommon, and they were observed only in patients with vertical incisions. The reason for the association between vertical incisions and persistent marginal mandibular nerve dysfunction is not clear.

Limitations

There are a number of important limitations to our study that require caution when interpreting the results. This study is limited by its retrospective nature. The choice of vertical or transverse incision was not randomly assigned. With the exception of 1 case in which a vertical incision was selected because of a known common carotid plaque that required extended proximal exposure and 2 cases in which the incision followed a previous surgical scar, there was no documentation to justify the selection of incision orientation. One might consider that planned shunting might be a factor that would favour a vertical incision, but our data did not demonstrate a correlation. It is possible that the choice of incision orientation could be based on factors that are associated with scar cosmesis, but these factors are not apparent in our data, and the elimination of these factors would require a prospective, randomized study.

Nine of 237 (3.8%) patients who underwent CEA during the study period refused the use of their personal health information for this research. Similarly, only 52 of 228 (23%) patients volunteered for follow-up examination using the POSAS. These are potential sources of selection bias that could influence our results.

We did not account for the potential confounding factor of incision length in this study. In the past, other investigators have addressed esthetic outcomes from CEA by using short incisions.[17–19] Some have demonstrated an increase in transient cranial nerve injury following limited exposure.[20] None of the 3 surgeons performing CEA in our study used incisions of limited length to expose the operative site, and both vertical and transverse incisions were extended as needed to provide adequate exposure of the carotid bifurcation. It is, however, possible that vertical incisions are associated with a greater scar length than transverse incisions, and this could be a confounding factor in scar outcome. Further study will be required, as our data do not address this question.

Finally, within our data set there was covariance between the incision orientation and the operating surgeon. One surgeon used only vertical incisions, whereas another surgeon used mainly transverse incisions. Because of small numbers in the subgroups, we were unable to

ascertain whether total POSAS is determined primarily by the orientation of the incision or by the operating surgeon.

In terms of clinical relevance, our POSAS scores ranged from 11 to 39. The majority of scores were clustered near the reported means. However, the relatively high POSAS scores above 30 were observed only in a subset of patients with vertical incisions. This suggests that vertical and transverse incisions can afford comparable cosmetic outcomes in many patients; however, vertical incisions have a higher risk of an unfavourable cosmetic outcome associated with a high POSAS score.

Other authors have promoted the use of transverse incisions for surgical exposure in CEA.[20–22] To our knowledge, this is the first study of CEA scar outcomes using the validated POSAS.

Conclusion

Carotid endarterectomy performed through a transverse skin incision compared with a vertically oriented skin incision is associated with improved esthetic outcome, as measured by the POSAS, without a significant observed difference in the risk of perioperative stroke or death between the 2 techniques. Vertically oriented incisions may be associated with an increased risk of mild, persistent marginal mandibular nerve dysfunction.

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References

1. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 1991;325:445-53.
2. Barnett HJM, Taylor DW, Eliasziw M, et al. Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. *N Engl J Med* 1998;339:1415-25.
3. European Carotid Surgery Trialists' Collaborative Group. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). *Lancet* 1998;351:1379-87.
4. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. Endarterectomy for asymptomatic carotid artery stenosis. *JAMA* 1995;273:1421-8.
5. Halliday A, Mansfield A, Marro J, et al. Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: randomised controlled trial. *Lancet* 2004;363:1491-502.
6. The CASANOVA Study Group. Carotid surgery versus medical therapy in asymptomatic carotid stenosis. *Stroke* 1991;22:1229-35.
7. Mayo Asymptomatic Carotid Endarterectomy Study Group. Results of a randomized controlled trial of carotid endarterectomy for asymptomatic carotid stenosis. *Mayo Clin Proc* 1992;67:513-8.
8. Hobson RW, Weiss DG, Fields WS et al. Efficacy of carotid endarterectomy for asymptomatic carotid stenosis. *N Engl J Med* 1993;328:221-7.
9. Crawford ES, DeBakey ME. Surgical treatment of stroke by arterial reconstructive operation. *Clin Neurosurg* 1963;9:150-62.
10. DeBorst GJ, Moll FL. Evidence overview for shunting, patching, type of endarterectomy and anesthesia during carotid surgery. *J Cardiovasc Surg* (Torino) 2014;55(Suppl. 1):1-9.
11. Meerwaldt R, Hermus L, Reijnen MM, et al. Carotid endarterectomy: current consensus and controversies. *Surg Technol Int* 2010;20:283-91.
12. Curtis JA, Johansen K. Techniques in carotid surgery. *Neurosurg Focus* 2008;24:E18.
13. Byrne J, Feustel P, Darling RC III. Primary closure, routine patching, and eversion endarterectomy: What is the current state of the literature supporting use of these techniques? *Semin Vasc Surg* 2007;20:226-35.
14. Draaijers LJ, Tempelman FRH, Botman YAM, et al. The Patient and Observer Scar Assessment Scale: a reliable and feasible tool for scar evaluation. *Plast Reconstr Surg* 2004;113:1960-5.
15. Stavrou D, Halk J, Weissman O, et al. Patient and observer scar assessment scale: How good is it? *J Wound Care* 2009;18:171-6.
16. O'Connell DA, Diamond C, Seikaly H, et al. Objective and subjective scar aesthetics in minimal access vs conventional access parathyroidectomy and thyroidectomy surgical procedures: a paired cohort study. *Arch Otolaryngol Head Neck Surg* 2008;134:85-93.
17. Marcucci G, Antonelli R, Gabrielli R, et al. Short longitudinal versus transverse skin incision for carotid endarterectomy: impact on cranial and cervical nerve injuries and esthetic outcome. *J Cardiovasc Surg* (Torino) 2011;52:145-52.
18. Bastounis E, Bakoyiannis C, Cagiannos C, et al. A short incision for carotid endarterectomy results in decreased morbidity. *Eur J Vasc Endovasc Surg* 2007;33:652-6.
19. Ascher E, Hingorani A, Marks N, et al. Mini skin incision for carotid endarterectomy (CEA): a new and safe alternative to the standard approach. *J Vasc Surg* 2005;42:1089-93.
20. Falkensammer J, Duschek N, Skrinjar E, et al. Local anesthesia and exposure for carotid endarterectomy: background and technical realization. *J Cardiovasc Surg (Torino)* 2012;53(Suppl. 1 to No. 1): 15-21.
21. Assadian A, Senekowitsch C, Pfaffelmeyer N, et al. Incidence of cranial nerve injuries after carotid eversion endarterectomy with a transverse skin incision under regional anesthesia. *Eur J Vasc Endovasc Surg* 2004;28:421-4.
22. Skillman JJ, Kent KC, Anninos E. Do neck incisions influence nerve deficits after carotid endarterectomy? *Arch Surg* 1994;129:748-52.