

Review of Carotid Endarterectomy at Singapore General Hospital

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ABSTRACT

Aim: To review the outcome of a consecutive series of patients undergoing carotid endarterectomy in a low volume setting.

Design: Retrospective case review.

Patients: During an 11-year period we performed 50 elective carotid endarterectomies on patients with symptomatic severe carotid stenosis: Ages of patients raised from 40 to 87 years (mean 68 years), 88% were Chinese, 6% Malay and 4% Indian. Twenty-eight percent had coronary artery disease, 64% hypertension, 27% diabetes mellitus, 50% hyperlipidaemia, and 52% were smokers. None of the patients had prior neck surgery or radiotherapy.

Results: There were no deaths in this series of 50 cases. Ninety-eight percent of our patients came through surgery without major neurologic deficit. One patient (2%) suffered a major perioperative stroke. Minor neurologic sequelae included one patient (2%) with a mild non-disabling stroke, two patients (4%) with peri-operative TIA without significant sequelae; two patients (4%) with transient cranial nerve weakness (one vagus, one facial nerve).

Conclusion: The surgical outcomes in this series are comparable to that from larger series. Carotid endarterectomy can be safely done in a low volume setting.

Keywords: carotid endarterectomy, low volume

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INTRODUCTION

The purpose of this study was to review the results of carotid endarterectomy performed in the Department of Neurosurgery at the Singapore General Hospital. Numerous authors have replied or suggested that in order for the results of carotid endarterectomy to be acceptable, a surgeon must perform the procedure frequently⁽¹⁻⁴⁾. With the publication of the North America Symptomatic Carotid Endarterectomy

(NASCET)⁽⁵⁾ trial, European Carotid Surgery Trial (ECST)⁽⁶⁾ Veteran Affairs Cooperative Study Group⁽⁷⁾, and the Asymptomatic Internal Carotid Artery Stenosis Trial⁽⁸⁾, we present an audit of our results with a comparison to the current standards in the literature. This is the first such published review of carotid endarterectomy in the local Singapore population.

CLINICAL MATERIAL AND METHODS

Between March 1990 and July 2001 we performed carotid endarterectomies on 50 patients under the direction of two surgeons (including the senior author). The hospital records were reviewed for each case to analyse the patient profiles, medical risk factors, presenting symptoms, anaesthesia used, perioperative complications (which for the purpose of the study was limited to 30 days post surgery), and lengths of postoperative hospitalisation.

PATIENT PROFILE

The mean age of the patients was 68 years, and a median age of 70 years. There were 36 men (72%) and 14 women (28%). The age range for the men was 40-87 years and that for the women was 57-79 years. The ethnic breakdown was Chinese 44 (88%), Malay 3 (6%), Indian 2 (4%) and other 1 (2%). More than 90% of the patients had at least one risk factor for atherosclerotic carotid artery stenosis, including atherosclerotic coronary vascular disease 14 (28%), hypertension 33 (66%), diabetes mellitus 12 (24%), hyperlipidaemia 25 (50%) and smoking 26 (52%). The majority of patients had multiple risk factors (Table I).

All the patients were symptomatic. Three (6%) presented with transient or fixed retinal ischemic deficits, while the remaining 47 (94%) had transient or fixed hemispheric deficits. Procedures were performed on the left in 21 (42%) cases and on the right in 29 (58%) cases.

PERIOPERATIVE MANAGEMENT

All patients were evaluated with computed tomographic brain scanning. Duplex ultrasound scans were obtained

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Table I. Demographics and risk factors.

Total elective cases 1990 - 2001 July: n=50		
Age range		
males	40-87 years	
females	57-79 years	
Sex		
male	36 (72%)	
female	14 (28%)	
Ethnicity		
Chinese	44 (88%)	
Malay	3 (6%)	
Indian	2 (4%)	
Others	1 (2%)	
Risk factors		
	SGH	Nascet
Hypertension	33 (66%)	18%
Diabetes mellitus	12 (24%)	6%
Hyperlipidaemia	68 (50%)	7%
IHD	14 (28%)	13%
Angiographic risk		
- Ipsilateral intracranial disease	11 (26%)	
- Contralateral severe stenosis/occlusion	13 (26%)	15%
CT proven infarct in territory at risk	20 (40%)	33%

Table II. Results of Carotid Endarterectomy in SGH compared with NASCET.

	SGH n=50	NASCET n=328
Neurological		
- major deficit	1 (2%)	7 (2.1%)
- mild deficits	1 (2%)	
- transient deficit	2 (4%)	
Total	4 (8%)	19 (5.8%)
Other complications		
Peri-op AMI	1 (2%)	3 (0.9%)
Wound Haematoma	3 (6%)	18 (5.5%)
Cranial Nerve Injury	2 (4%)	24 (7.6%)
Death	0	2 (0.6%)
Infection	0	11 (3.4%)

in all patients prior to operation and cerebral arteriography was used to confirm results. From this, 20 (40%) had CT proven infarct in territory at risk. As for angiographic risk, 11 (22%) had ipsilateral intracranial disease and 13 (26%) had contralateral severe stenosis/occlusion.

The degree of internal carotid artery stenosis was ascertained by the method employed in the North American Symptomatic Carotid Endarterectomy Trial⁽⁵⁾ (NASCET). Our angiographic criteria for surgery included 70% or greater internal carotid artery stenosis.

Carotid endarterectomies were performed under general anaesthesia with continuous intra-arterial pressure monitoring with normocapnia; No intraoperative EEG was used. Patients on aspirin

continued taking it till the day of surgery. Five minutes prior to clamping the carotid vessels, 5,000 units of heparin was given, Blood pressure was elevated 10-15% above the preoperative resting blood pressure. Intraoperative cerebral protection was provided by administering intravenous thiopentone. The average clamping time was 18.5 minutes with a range of 11 to 43 minutes. Intraoperative arterial shunting was selectively employed in 3 (6%) patients. This was related to surgeon preference based on increased risk due to angiographic factors or prolonged clamp time. No patch grafts were used. Heparinisation was not reversed. Endarterectomy was performed without the aid of magnification.

Postoperatively, all patients were transferred to the high dependency unit. The vital signs and a neurological assessment were obtained at intervals of one hour for the first 24 hours postoperatively. The only invasive monitoring used was intra-arterial pressure monitoring. Hypotension was treated with intravenous fluids, and an evaluation for myocardial infarction was undertaken if there were associated cardiopulmonary symptoms or electrocardiographic changes.

Hypertension was treated with sublingual nifedipine and with intravenous labetalol for those patients who did not respond to nifedipine. Aspirin was re-administered on the next postoperative day and continued indefinitely in the postoperative period. Patients were encouraged to eat and walk the day following the surgery if they were clinically and neurologically stable. Intravenous fluids at maintenance volumes were administered for 24 hours postoperatively to ensure adequate hydration.

All patients were kept in the hospital until removal of their stitches. The mean time to discharge after surgery in this series was 6.5 days. Patients were reviewed in the outpatient clinic on day 30 after surgery.

RESULTS (TABLE II)

There were no deaths related to the fifty operations. Two patients (4%) had postoperative stroke. One patient (2%) had mild non-disabling deficit. He had a residual weakness of the left hand of a very minimal degree. The one patient with major deficit (2%) however had significant weakness of both his upper and lower extremities:

Two patients (4%) had TIAs of a very brief duration: one had a sensory TIA, and one had dysphasia.

- One patient (2%) suffered peri-operative acute myocardial infarct, in the first 24 hours of surgery. He went on to make an uneventful recovery.
- Three patients (6%) developed postoperative wound haematomas. This complication occurred within 24 hours of surgery in all these cases. Two of

the three required evacuation of the haematomas within 24 hours of surgery, while the other was treated expectantly. It had resolved by day 30 of review.

- Two patients (4%) were noted to have transient cranial nerve injury. One had hoarseness (vagus nerve) and the other had weakness of the lower lip (facial nerve). Both symptoms had markedly resolved by day 30.
- There were no infections, intracerebral haemorrhage or seizures in any of the patients.
- Statistical analysis was done comparing neurological and other complications between the patients in this series and the NASCET group using chi-square test. There was a neurological deficit of 8% in the SGH group and 5.8% in the NASCET group which was not statistically significant ($p=0.512$). Neither was there a statistically significant difference in any of the other complications between the two series (Table II).

DISCUSSION

Carotid stenosis can be stratified into three groups, according to the degree of stenosis, as mild (0-29%), moderate (30-69%) and severe (70-99%). The NASCET and the ECST trials showed that when acceptably low surgical morbidity and mortality are achieved, carotid endarterectomy improves outcome in symptomatic patients with severe carotid stenosis.

In the NASCET group, the 30-day stroke morbidity and mortality rate for the surgical group was 5.8%. The cumulative risk of any ipsilateral stroke at two years was 9% for surgery and 26% for patients treated without surgery. Therefore carotid endarterectomy is three times as effective as medical therapy alone in reducing the incidence of stroke in patients with symptomatic stenosis. Table III shows a summary of the risk for medically treated patients.

In the ECST group, patients with severe stenosis who were treated medically had a significantly increased risk of outcome events. During the three-year follow-up, risk of ipsilateral stroke and peri-operative death was 10.3% for patients with surgery and 16.8% for those without. Risk of death due to carotid endarterectomy or stroke from any cause was 12.3% for surgical patients and 21.9% for non-surgical patients; this shows a clear benefit in surgery.

This series was compiled over a period of about 11 years by the authors under the direction of two senior surgeons including the senior author. This is a low frequency of cases averaging about five a year, which is below the frequency level of individual surgeons reported in most series. Contrary to suggestions of other authors, our morbidity rate of

Table III. Summary of the NASCET trial analysis of risk of stroke at two years in the medical group.

Symptomatic severe stenosis (SSS)	26%
SSS + TIA	18.6%
SSS + retinal TIA	16.6%
SSS + hemispheric TIA	43.5%
SSS + recurrent TIA	41.2%
SSS + ulcerated plaque	26.3-73.2%
SSS + contralateral carotid occlusion	69%

4% (stroke rate) compares favourably with those from large institutions⁽⁹⁻¹²⁾, which range from a total percentage of 2.6% in Ferguson's⁽¹³⁾ series to 6.6% reported by Robertson and Auer⁽³⁾. It also compares with Kushner et al⁽¹⁴⁾ who reported on a series of 40 patients over a 10-year period with overall mortality and morbidity rate of 5%.

The centres that were involved in the NASCET trial had a stroke morbidity and mortality rate of less than 6% within 30 days of surgery for at least 50 consecutive operations within the previous 24 months. These centres clearly had a high level of expertise and quality control for the benefits of carotid endarterectomy plus medical therapy compared to medical therapy alone, to be apparent. However if the stroke morbidity and mortality rates were to reach 10%, then the benefits of surgery disappear entirely.

Therefore it is imperative that centres performing carotid endarterectomy adopt a strict criteria of accreditation and audit of surgical results to ensure that benefits of surgery are maintained and complications are kept within recognised limits. This is particularly important in low volume centres.

From this series we see that despite the low volume of cases in our practice we are able to achieve morbidity rates that are comparable to published series from large centres with high volume. This could be attributable to:

- a) a dedicated team of surgeons with an interest in carotid endarterectomy.
- b) meticulous surgical technique of plaque removal and arteriotomy closure.
- c) improving techniques and strong support staff.
- d) improved anaesthetic technique including minimising swings in blood pressure and heart rate intraoperatively, pharmacological elevation of blood pressure during carotid cross clamping and strict control of blood pressure postoperatively.
- e) Intraoperative heparin administration without reversal and continuing postoperative aspirin therapy.

Attention to surgical detail and anaesthetic technique may explain in part the absence of deaths due to cardiac failure in our series.

Wound haematoma is a relatively common complication in this series (6%). This could be attributable to the continuation of anti-platelet therapy up to the day of surgery, neck dissection with exposure of raw areas, labile blood pressure in the postoperative period and non-reversal of heparin. Meticulous haemostasis during wound closure is the most important factor in reducing this complication.

CONCLUSION

Carotid endarterectomy can be performed in a safe and efficient manner without compromising patient care in a low volume practice. This is made possible by improved surgical and anaesthetic technique and postoperative management.

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