ORIGINAL ARTICLE

Carotid endarteretomy: A single vascular centre experience in Malaysia

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ABSTRACT

Introduction: Carotid artery stenosis remains one of the leading causes of major stroke. Carotid endarterectomy (CEA) has proven effective in preventing debilitating major stroke. However, the data on CEA in Malaysia is still lacking. University of Malaya Medical Centre, Kuala Lumpur, Malaysia first embarked on CEA since 2017. We are reporting the outcomes of CEA performed in our centre.

Materials and Methods: This was a retrospective case series of 20 patients who underwent CEA from the year 2017 until 2024. Patients having asymptomatic (≥60-99%) and symptomatic carotid artery stenosis (≥50-99%) were selected for the procedure. All patients received best medical treatment, which include antithrombotic medications, lipid lowering therapy, blood pressure management, diabetes mellitus management and lifestyle modifications especially smoking cessation. All the patients underwent CEA under general anaesthesia. Shunting was done routinely. Preoperative, intraoperative, and postoperative data were collected and evaluated. Mortality, myocardial infarction, stroke, postoperative bleeding, surgical site infection and cranial nerve injury at 30 days were the outcomes investigated. We also evaluated restenosis after CEA.

Results: Most patients in our series were males 70% (n = 14) compared to 30% (n = 6) females. There were more symptomatic patients (n = 14) than asymptomatic patients (n = 6). There was one 30-day mortality among the symptomatic patients, while there was no 30-day mortality in the asymptomatic patients. The 30-day myocardial infarction was 5% (n = 1), which was the same symptomatic patient who died. In this cohort, only one patient had 30-day stroke (5%), which was a symptomatic patient. The patient recovered from the stroke after two weeks. Cranial nerve injuries happened in four patients (20%), where the commonest nerve injured was recurrent laryngeal nerve (n = 3). Only one patient had postoperative bleeding which did not need any reintervention. No surgical site infection was noted on all patients. Three patients developed restenosis, which was noted at two to six months post CEA. Two of the patients had symptomatic restenosis (more than 50% stenosis) which resulted in them being reoperated.

Conclusion: The uptake of CEA in Malaysia is still slow. By sharing the outcomes data, hopefully it will create awareness among medical practitioners on the importance of early referral for carotid artery stenosis. Long term outcomes are very much needed.

KEYWORDS:
Carotid artery stenosis, stroke, carotid endarterectomy, Malaysia

INTRODUCTION

Stroke is the third leading cause of death, and probably the most important cause of long-term disability, burdening the patients, their families and societies.[1] 85% of strokes are ischaemic in nature.[2] Carotid artery disease is a recognized cause of ischaemic stroke. Atherosclerotic plaques can rupture and lead to thrombosis and emboli, resulting in stroke if they occur in a carotid artery.[3]

In Malaysia, stroke is the third most common cause of death.[4] Stroke patients in Malaysia were generally younger, with the mean age of stroke onset between 54.5 and 62.6 years.[5-10] This trend is alarming as this will lead to loss of productive age, which will jeopardize the national income. Up to two-third of reported stroke cases in Malaysia were of ischaemic in origin.[6-11] However, the data on carotid artery stenosis causing ischaemic stroke in Malaysia is still lacking.

Carotid endarterectomy (CEA) is one of the interventions offered to prevent stroke. There have been abundant improvements ever since the first CEA described by Eascott et al, in 1994.[12] CEA has now been shown to be superior to carotid artery stenting (CAS) in several randomized studies.[13-14] To our knowledge, there is no review of outcomes of CEA done in Malaysia as of now. We are reviewing the outcomes of the CEA procedures done in University Malaya Medical Centre, Kuala Lumpur, Malaysia from 2017 until 2024. University Malaya Medical Centre is a 1600-bedded tertiary hospital, receiving vascular referrals from Peninsular Malaysia.

MATERIALS AND METHODS

We report a retrospective case series of 20 patients who underwent CEA in University Malaya Medical Centre from October 2017 until July 2024. Institutional Review Board approval was taken for the study. Preoperative duplex ultrasound was used initially to measure the severity of stenosis. We adopted the North American Symptomatic Carotid Endarterectomy Trial (NASCET) method, in which the residual lumen diameter is used as the numerator and the

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diameter of disease free internal carotid artery (ICA) above the stenosis, where vessel walls were parallel is used as the denominator.[15] In all patients, computed tomography (CT) angiography of the carotids or magnetic resonance angiography (MRA) were done to corroborate the duplex ultrasound findings.

The decision to operate on each patient was brought to multidisciplinary team (MDT) discussions involving the vascular surgeons, neurologists, interventional radiologists, anesthetists and occasionally the ear, nose, and throat (ENT) surgeons. The indication of surgery was classified into symptomatic and asymptomatic. For symptomatic carotid artery stenosis, the threshold of carotid artery revascularization should be more than 50% until 99% of stenosis. The symptomatic patients were being divided into either transient ischaemic attack (TIA), stroke or chronic ocular ischaemia syndrome. The symptoms should be within the past six months. If a patient presented with stroke, the severity of symptoms should be scored using the modified Rankin Score (mRS). For patients who experienced disabling stroke and have a mRS of >3, we did not offer any carotid revascularization as to minimize the risk of postoperative parenchymal hemorrhage. Meanwhile, for asymptomatic carotid artery stenosis, the threshold should be more than 60% until 99% of stenosis. Carotid artery total occlusion was not intervened. All patients received best medical treatment (BMT), which include antithrombotic medications, lipid lowering therapy, blood pressure management, diabetes mellitus (DM) management and lifestyle modifications especially smoking cessation.

All the patients underwent CEA under general anaesthesia (GA). All the patients received prophylactic antibiotics prior to operation. The incisions were a longitudinal anterior sternomastoid incision, while the carotid artery was exposed via antegrade approach. We adopted the routine shunting approach. Our technique for CEA was conventional patched endarterectomy where the patch used was made of bovine pericardium. Heparin was given pre carotid clamping (80units/kilogram body weight). No protamine reversal was given. All patients had active drain placed and it would be removed only if the output was less than 30ml/day. Every patient was managed in intensive care unit (ICU) postoperatively.

Data regarding patient demographics, degree of stenosis, indications for surgery, intraoperative data, and post-operative outcomes were collected and analyzed. The outcomes that we investigated were 30-day mortality, 30-day myocardial infarction (MI), 30-day stroke, 30-day cranial nerve injury (CNI), 30-day postoperative bleeding, 30-day surgical site infection (SSI) and restenosis.

RESULTS

The data summary of the population studied is summarized in Table I. A total of 20 CEA was performed. Majority was male (70%). The commonest age group we operated on was from age of 60-69 years old (60%) followed by age group 70-79 years old (20%). Mean age was 65 years old. There were more symptomatic patients who underwent CEA (n = 14) than asymptomatic patients (n = 6). Five of the symptomatic patients had stroke within the past six months. Their mRS was either one or two. Seven of the symptomatic patients suffered from TIA, while two had chronic ocular ischaemia syndrome.

The percentage of stenosis was 60-90% for symptomatic patients, while 70-90% for asymptomatic patients. Three of the patients had contralateral carotid total occlusion (two symptomatic and one asymptomatic). One patient had bilateral carotid artery stenosis operated as a staged procedure where the symptomatic side was operated first followed by the asymptomatic side six months later. One patient had post radiation carotid artery stenosis. The patient had nasopharyngeal cancer post radiotherapy and was asymptomatic with stenosis of 70%. The contralateral carotid had total occlusion. However, three years later, restenosis occurred and at that time, the patient suffered from multiple TIA. As a result, we performed re do CEA for the patient. Unfortunately, this patient was still symptomatic despite the redo operation, hence we resorted to CAS for the next reintervention.

85% of the patients had hypertension while 55% had DM. Two patients had coronary artery disease (CAD) and one had non-dialysis-dependent chronic kidney disease (CKD). 45% of the patients identified themselves as smokers. There was no standardized protocol for antithrombotic medications prior to CEA. 70% of the patients were started on aspirin 100mg daily and clopidogrel 75mg daily. Three of them were commenced on only aspirin 100mg daily prior to CEA. One patient was on aspirin 100mg daily and ticagrelor 90mg twice daily before the CEA. This patient was asymptomatic and had contralateral CAS 18 months prior in another centre for symptomatic stenosis. Another patient was already on apixaban before the CEA as there was sigmoid sinus and internal jugular vein thrombosis before.

The timing of surgery for symptomatic patients was recorded. This is defined as time from onset of symptoms until the date of surgery. Only one patient was operated within seven days of symptoms onset. Three patients were operated from eight days to 14 days of symptoms onset while 10 patients were operated after more than 15 days. All the symptomatic patients were operated within six months. The mean operative time for CEA was 173 minutes. The average pre shunt clamp time was five minutes, while post shunt clamp time was six minutes. Median ICU stay was one day, and median length of hospital stays were three days. Just like the preoperative antithrombotic medications, the postoperative antithrombotic medications were also not standardized. 45% of them continued to take aspirin and clopidogrel after the CEA. The rest of the patients were reduced to just single antiplatelet, either aspirin (30%) or clopidogrel (20%).

The outcomes of each population studied including the subgroup analysis are summarized in Table II and III. 30-day mortality happened in only one patient (5%). This patient was symptomatic (TIA). The patient already had background of CAD. The clamping time were three minutes each for pre and post shunt. This patient died five days after CEA from MI. The same patient also had haematoma at operation site

Table I: Summary of the patients' population

Variables	N, % in parentheses
Age	
40-49 years old	2 (10)
50-59 years old	2 (10)
60-69 years old	12 (60)
70-79 years old	4 (20)
Gender	
Male	14 (70)
Female	6 (30)
Indications of surgery	
Symptomatic	14 (70)
Asymptomatic	6 (30)
Symptomatic patients' presentations (n = 14)	
Transient ischaemic attack	7 (50)
Stroke	5 (35.7)
Chronic ocular ischaemia syndrome	2 (14.3)
Percentage of stenosis of operated side	
60-69%	5 (25)
70-79%	7 (35)
80-89%	3 (15)
90-99%	5 (25)
Contralateral carotid lesion	
No lesion	10 (50)
20-70% stenosis	7 (35)
Total occlusion	3 (15)
Aetiology of carotid artery stenosis	
Atherosclerotic	18 (90)
Post radiation	2 (10)
Comorbidities	
Diabetes mellitus	11 (55)
Hypertension	17 (85)
Coronary artery disease	2 (10)
Chronic kidney disease	1 (5)
Smoker	9 (45)
Preoperative antithrombotic medications	
Aspirin and Clopidogrel	14 (70)
Aspirin and Ticagrelor	1 (5)
Aspirin only	3 (15)
Apixaban	1 (5)
Postoperative antithrombotic medications	
Aspirin only	6 (30)
Clopidogrel only	4 (20)
Aspirin and Clopidogrel	9 (45)

Table II: Patients' outcomes in this study

Study parameters	N, % in parentheses
30-day mortality	1 (5)
30-day myocardial infarction	1 (5)
30-day stroke	1 (5)
30-day cranial nerve injury	Recurrent laryngeal nerve palsy = 3 (15) Hypoglossal nerve palsy = 1 (5)
30-day postoperative bleeding	1 (5)
30-day surgical site infection	0 (0)
Restenosis	3 (15)

which did not require any operative intervention. The only patient who had stroke post CEA was symptomatic preoperatively. The patient developed new left precentral gyrus infarct presented with hemiparesis. Nevertheless, this stroke was not disabling. After intensive physiotherapy, the patient was able to move independently two weeks postoperatively.

CNI occurred in four patients. Three of them suffered from recurrent laryngeal nerve injury. They presented with hoarseness of voice after CEA. All of them were referred to the ENT team and managed conservatively. All of them recovered from the symptoms within six months. One patient had hypoglossal nerve injury presented with deviation of tongue. Management was also conservative, and the patient recovered within six months. In terms of restenosis, three

patients developed restenosis, which was noted at two to six months post CEA. Two of the patients were symptomatic restenosis (more than 50% stenosis) which resulted in them being reoperated. One patient was asymptomatic with less than 70% stenosis hence no operative intervention was offered.

DISCUSSION

Meta-analysis of 6092 patients was performed by The Carotid Endarterectomy Trialists Collaboration (CETC) which revealed that CEA conferred benefit in symptomatic patients with moderate (50-69%) and severe (70-99%) stenoses compared to BMT alone.16-18 Regarding CEA versus CAS in symptomatic patients, a meta-analysis of 4754 patients from four large trials (>500 patients) showed that CAS was associated with higher 30-day stroke and death as compared to CEA.[19-22] Meanwhile, in asymptomatic patients, Asymptomatic Carotid Surgery Trial (ACST-1) and Asymptomatic Carotid Atherosclerosis Study (ACAS) found that CEA conferred notable reductions in any stroke at five years compared to BMT alone.[23-24] CAS was found to have higher rate of 30-day stroke and death compared to CEA in asymptomatic patients.[25] However, CAS had lower 30-day MI.[25] Following this evidence, we opted for CEA as first option of carotid revascularization in our centre. The MDT discussion remains pivotal in deciding this. There are instances where despite the patient having previous neck scar or radiation, we still proceeded with CEA as CAS was deemed technically challenging.

It is interesting to note on the six asymptomatic patients who underwent CEA. Two of them were symptomatic on the contralateral carotid and had revascularization before by CEA and CAS. Hence, they were already screened for both carotids. The patient with nasopharyngeal cancer was detected to have carotid artery stenosis by surveillance CT scan. Another patient was referred by colorectal team as the patient had to go for rectal cancer surgery but had TIA three years prior. Thus, carotid duplex was done as screening prior to non-cardiac surgery. Society of Vascular Surgery (SVS) in its guideline advised on carotid screening for patients with risk factors such as peripheral arterial disease, age > 65 years with CAD, smoking, or hypercholesterolaemia.[26] Patients undergoing major non-cardiac surgery with three to four cardiovascular risk factors such as age, CAD, CKD, hypertension, DM, smoking, body mass index (BMI) > 35 kg/m^2, chronic obstructive pulmonary disease (COPD), prior stroke/TIA had a 0.7% risk of peri-operative stroke.[27-28] The SVS guidelines stated that patients with carotid disease undergoing non-cardiac surgery should have the same indications for intervention as the general population.[26] In our centre, we do not practice routine screening for carotid stenosis in the asymptomatic patients with risk factors as mentioned above. However, if a patient was already intervened before being it CEA or CAS, the patient would be screened for contralateral carotid stenosis. Some patients were referred after six months of symptoms which considered them asymptomatic. We did performed CEA if the threshold were more than 60% until 99% of stenosis.

European Society of Vascular Surgery (ESVS) guideline on antithrombotic therapy stated that protocols for antiplatelet therapy for symptomatic patients prior to CEA should be made by local teams.[29] A retrospective study by Donners et al.found that the effectiveness and safety of double antiplatelet therapy (DAPT) did not differ from single antiplatelet therapy (SAPT) in patients undergoing CEA.[30] Despite excluding patients going for CEA, two randomized controlled trials (RCT), POINT and CHANCE, showed that DAPT reduced the risk of stroke, MI, and cardiovascular death by 30%, compared with aspirin alone for patients with TIA or minor stroke.[31-32] This formed the basis of us mainly using DAPT (aspirin and clopidogrel) before CEA. Despite DAPT, there was only one patient of us that experienced postoperative hematoma. There is no RCTs that evaluated clopidogrel monotherapy or combination antiplatelet therapy in asymptomatic patients undergoing CEA. We extrapolated the results of POINT and CHANCE trials to our asymptomatic patients by initiating clopidogrel and aspirin before CEA.

CEA in symptomatic patients confers maximum benefit if performed within 14 days of symptoms onset.[16-18] Even ESVS recommended that in symptomatic patients with a 50-99% stenosis, carotid intervention should be performed within 14 days of symptom onset.[15] In contrast to that, majority of our symptomatic patients were operated after 15 days. The main reason for operative timing after 15 days was due to late referrals by the referring team. Moreover, the patients who were referred need preoperative cardiac/anesthetic assessment with the optimization of preoperative status, which delayed the procedure even further. Certainly, the timing of surgery needs further improvement. The awareness among the referring teams, such as the neurology, ENT, ophthalmology, and family medicine must be reinforced. In this modern and digital age, social media holds a very important yet exciting role in disseminating awareness and information to health personnel and general population. We also believe that a key performance indicator (KPI) for timing of carotid revascularization in Malaysia will need to be established. Reflecting on UK National Vascular Registry, CEA was performed in only 10% of patients within 2 weeks of the index event in 2008, rising to 37% in 2009 and 58% in 2014.[33] By setting a national standard for timing of carotid revascularization, it will be obligatory for each Malaysian vascular centre to work towards achieving this goal.

It is advised that the 30-day risk of stroke/ death when performing CEA in patients reporting ipsilateral carotid territory symptoms of less than six months should be 6% or less.[34] For asymptomatic patients, it should be 3% 30-day risk of stroke/death.[34] This number is not only important in setting a worldwide standard in centres intending to embark in CEA, but it also acts as a reminder for the performing surgeons whenever they are counseling their patients. The performing surgeons should quote to patients their own procedural risks especially pertaining to death and stroke. The major cause of stroke in CEA is embolism. Few steps were described in literature to prevent embolism from happening. The administration of intravenous heparin prior to clamping has become a standard of care and our centre is not an exception. Hannan et al reported that all surgical specialties

that performed CEA used heparin extensively with 97.5% of all patients received heparin.[35] Another strategy described was by Pratesi and Bourke whereby early distal control of internal carotid artery was achieved.[36-37] They demonstrated that the strategy was independently associated with a lower risk of developing intraoperative neurological deficit.[36-37] 'Flow-control' CEA technique was described by Yoshida et al where they clamped the proximal common carotid artery (CCA), external carotid artery and superior thyroid artery, then dissected the bifurcation of the CCA and ICA before clamping the distal ICA.[38] New embolic lesions as detected by diffusion-weighted MRI were significantly decreased compared with the conventional method of CEA.[38] In our cohort of patients, all of dissection started from antegrade, whereby CCA was dissected first. Another limitation in our cohort is that we did not specify the sequence of clamp applied which may influence the risk of stroke.

Based on a meta-analysis, cranial nerves most injured during CEA are recurrent laryngeal (4.2%), hypoglossal (3.8%), mandibular branch of facial nerve (1.6%), glossopharyngeal (0.2%), and the spinal accessory (0.2%).[39] In our cohort of patients, CNI happened in 20% of the patients (three recurrent laryngeal and one hypoglossal nerve). All the nerve injuries resolved within six months after CEA. Most of these injuries were caused by excessive retraction. During carotid artery dissection, trauma may occur if the dissection is not kept close to the wall of the artery.[35] A careful retraction and early identification of the cranial nerves remain paramount in preventing CNI. Pertaining to recurrent laryngeal nerve, indirect laryngoscopy is not a routine in our centre. It was only reserved for those who has previous scars over the neck and those who had radiation to the head and neck. If the patient had previous contralateral CEA, total/partial thyroidectomy, or radical neck surgery, indirect laryngoscopy is a must to exclude contralateral recurrent laryngeal nerve palsy as bilateral nerve injuries can be fatal.[15] CAS should be considered if there is already presence of unilateral recurrent laryngeal nerve palsy.[15]

There is currently no concrete evidence to support routine surveillance post CEA.[15] Nonetheless, we decided to do duplex ultrasound surveillance at three months, six months then annually for all our CEA patients. For symptomatic restenosis where there was 50-99% stenosis, we attempted redoing CEA or CAS. Meanwhile, the threshold for reintervention for asymptomatic restenosis was above 70% stenosis. We had three patients who had restenosis after CEA. Two of them needed reintervention due to persistence of symptoms despite CEA. These were the patients who had radiation therapy-induced carotid stenosis (RCIS). Questions remain whether CEA or CAS will be better for RCIS in terms of restenosis. In a meta-analysis, CAS had a higher rate of restenosis compared to CEA in RCIS patients, however CEA had more temporary CNI40. In RCIS, since it is different from atherosclerotic stenosis, a more careful patient selection is important in determining which patient need intervention and which intervention is the best.

This study has its limitations. The number of patients analyzed was only 20. This is low compared to other countries' data. A multicentre review of outcomes in CEA performed in Malaysia is very much required for us to better counsel our patients for the operation. The data collected is mainly limited to 30-day post-surgery. A prospective study looking at long term complications and outcomes are needed especially on the ones looking at restenosis rate and recurrence of symptoms. It is also interesting to see a randomized controlled trial comparing outcomes of CEA and CAS being conducted in Malaysian setting. With that, participation of various disciplines will be needed especially among the vascular surgeons, neurologists and interventional radiologists.

CONCLUSION

CEA remains the first choice of intervention for symptomatic and asymptomatic carotid artery stenosis. However, its uptake in Malaysia is still poor despite all the evidence shown in literature. To our knowledge, we are the first centre in Malaysia to report on CEA outcomes. A prospective study looking at long term complications and outcomes are needed, especially in Malaysian setting.

CONFLICT OF INTEREST

The authors have no conflicts of interest.

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