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ORIGINAL ARTICLE

IMPACT OF EVERSION TECHNIQUE IN CAROTID ENDARTERECTOMY: MANSOURA EXPERIENCE

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Aim: *To review our experience in eversion technique in carotid endarterectomy in patients with carotid artery stenosis with particular attention to restenosis, occlusion, recurrent stroke or TIA.*
Methods: *This prospective study included 12 patients with symptoms of unilateral carotid artery stenosis who were investigated, operated and followed up in Vascular Surgery Unit of Mansoura University Hospital during the period from July 2004 to January 2008. Eversion carotid endarterectomy (ECEA) was carried out for all patients.*
Results: *Carotid restenosis rate (>50%) during follow up was (0%) after eversion CEA at the end of the study. The cumulative stroke free survival rate was 85.7% at the end of the study.*
Conclusion: *ECEA is a feasible and safe alternative technique for management of extracranial carotid stenosis, an excellent technique for handling of the kink, spiral or redundant internal carotid artery. It can be performed while patients under local or general anesthesia according to the general condition and cooperation of the patient.*

Keywords: *Recurrent stroke, recurrent stenosis, conventional CEA.*

INTRODUCTION

Carotid endarterectomy (CEA) Large-scale randomized clinical trials have established the superiority of CEA over medical management in preventing neurological events in patients with high-grade carotid stenosis. A pooled analysis of the randomized data showed that surgery was highly beneficial for individuals with symptomatic stenosis > 70% and of some benefit for those with 50% to 69% stenosis. In asymptomatic patients, surgery has been associated with a small but definite reduction in the risk of stroke in the presence of a stenosis >60 %.(1)

Since the 1960s, two different techniques have evolved, namely conventional and eversion carotid endarterectomy, which is a modified version of the original method. Conventional endarterectomy involves longitudinal arteriotomy extending to the internal carotid distal to the lesion and closure either primary or using patch. Eversion endarterectomy of the carotid artery, as first described by DeBakey et al in 1959, involved transection of the distal common carotid artery (CCA) and simultaneous eversion of both the internal carotid artery (ICA) and the external carotid artery.(2)

Kasprazak and Raithel, in 1989, presented a modified eversion endarterectomy that involved transection of the ICA at its origin at the carotid bulb. This modified method avoids the longitudinal arteriotomy of the standard procedure, the need for patch angioplasty, and the shortcomings posed by transection of the CCA with full visualization of the distal end point.(3)

The aim of our study is to review our experience in

eversion technique with particular attention to restenosis and recurrent stroke.

PATIENTS AND METHODS

Thirty-five patients with symptoms and signs suggestive of carotid artery disease and duplex evidence of carotid stonosis were admitted in Vascular Surgery Unit of Mansoura University Hospital during the period from July 2004 to January 2008. only 12 patients did eversion carotid endarterectomy.

All patients were subjected to thourough history taking and medical examination, CT scan, Duplex ultrasound examination to detect the size and extent of atheromatous plaque, degree of stenosis, as well as other associated anomalies. MR angiography (MRA) was done to delineate more anatomical and pathological details and to show any lesion in the cerebral vessels that could not be visualized by duplex (Fig. 1). Laboratory investigations in the form of blood picture, prothrombin time, APTT, serum creatinine, blood sugar and complete lipid profile were evaluated.

The degree of stenosis in our study was measured according to the North American Symptomatic Carotid Endarterectomy Trial (NASCET) method = (narrowest part of lumen / internal carotid diameter beyond stenosis) x 100.

Inclusion criteria for carotid endarterectomy were: Lesion with 50% stenosis or more by duplex + MRA associated with transient ischemic attacks (TIAs), Amaurosis fugax or Hemispheric cerebrovascular accidents with complete or near complete recovery.

Selection criteria for eversion technique:

- Localized stenosis at the origin of internal carotid artery and no extensive distal or proximal extension.
- Atherosclerotic spiral or coiled internal carotid artery.
- Patients done were those who can tolerate test closure of ICA for 3 minutes and so will not need shunt placement.

Operative technique of eversion carotid endarterectomy (ECEA): With the patients under local or general anesthesia and in the flat position with the head extended and rotated away from the operation side with a sandbag beneath the shoulders, one incision has been employed for exposure of the carotid bifurcation. This is a vertical incision parallel to the anterior border of the sternocleidomastoid muscle. The common facial vein is a constant landmark for the carotid bifurcation and represents the venous analogue of the external carotid artery. The vein is mobilized, ligated and divided. Once the vein is divided, the carotid artery can be appropriately visualized. The common carotid artery is mobilized circumferentially and encircled with a vessel loop. The peri-arterial dissection continues superiorly to expose the carotid bifurcation.

As soon as the bifurcation is identified (Fig. 2), 1 to 2 ml of 1% lidocaine is injected into the tissues between the external and the internal carotid arteries to block the nerves to the carotid body and carotid sinus.

Particular care must be taken during this part of the dissection to avoid undue manipulation or palpation of the carotid bifurcation and bulb of the internal carotid artery. This is the location of the atheromatous lesion and because the lesion may be quite friable or contain thrombotic or atheromatous debris, manipulation may cause dislodgement with subsequent cerebral embolization and stroke.

The internal carotid artery is mobilized to a point well above the palpable atheromatous lesion where it is unquestionably soft not diseased. The same is done for the external carotid artery, taking care not to injure the superior thyroid branch. In patients with a high carotid bifurcation or a lesion that goes relatively far up the internal carotid artery, additional exposure can be obtained by carefully dividing the tissues in the crutch formed by the internal and the external carotid arteries. This maneuver should be performed between clamps because, on occasion, the ascending pharyngeal artery can be located in this position and in some cases division of the posterior belly of digastric muscle.

Determination of cerebral tolerance to carotid cross-clamping:

Under local anesthesia: after the carotid bifurcation is exposed, trial occlusion of the common, external and internal carotid arteries is done for 3 minutes. During this time, the patient is asked to talk and move the arm and leg on the side affected by the carotid lesions. If there is no evidence of weakness or disturbance of consciousness, the intracranial circulation is judged to be adequate and operation can be continued without additional circulatory support.

Under general anesthesia: we use intra-operative transcranial Doppler (TCD) that enables warning of embolization from unstable plaques during carotid dissection and allows the surgeon to modify operative technique, ensures optimal shunt function by immediately identifying kinking, impaction of the distal shunt lumen against a distal ICA coil, and ensuring mean middle cerebral artery (MCA) velocity is above 15cm/s and enables rapid identification of the very rare patient who is at risk of developing on-table thrombosis.

Performance of Eversion carotid endarterectomy:

We transected ICA at its origin (Fig. 3) then the ICA was 'everted' and the tube of atheroma was then expelled. Once the distal limit was exposed, the lesion was excised by DeBakey forceps that was used to grasp the plaque and the vessel wall, the latter being gently peeled back and thus everted (Fig. 4). Care must be taken not to tug at the plaque itself, which can lead to premature plaque fracture. Near the distal end point, the plaque was pinched and removed from the vessel. The end point was then inspected for semi-adherent fibers that were picked out with a ring forceps. Such fibers were easily recognized by irrigation with heparinized saline. The plaque on the ECA was removed by traction and partial eversion. The plaque on the CCA was then extracted by eversion and transection of the plaque flush with the everted edge. As with the ICA, the inner lumen was irrigated and inspected for loose debris. The ICA was then reanastomosed to the bifurcation after endarterectomy of the CCA (Figs. 5,6). Closure of the incision was done in layers with the use of negative suction drainage system.

Postoperatively: all patients were transferred the intensive care unit for 24 hours, then shifted to the surgical ward for further management and follow up for about one week. All patients received low molecular weight heparin (prophylactic dose) and antiplatelet (Aspirin) 150 mg daily as well as broad-spectrum antibiotics.

Post operative follow up (Surveillance program)

All patients were followed up in the outpatient clinic of vascular surgery unit every one week for one month, and then monthly for a period ranged from 3 – 36 months (mean 20.17 ± 9.86 months) with evaluation of the expected complications including TIA, reversible ischemic neurological deficits (RINDs), or stroke morbidity and asymptomatic occlusive events. Duplex examination was done before discharge, one week postoperatively, to assess patency of the vessel and any possible complications, and then was performed 6, 12 months and every one year to detect recurrent stenosis. Postoperative MRA showing patency of carotid vessel without stenosis.

Statistical analysis: Patency rates were calculated after construction of life table analysis.

RESULTS

This study included 12 patients with symptoms and signs suggestive of occlusive carotid artery disease. They underwent eversion carotid endarterectomy. They were 10 males and 2 females with a mean age 60.58 ± 8.57 years (range 45 – 74 years). Six patients (50%) presented with recurrent stroke, four patients (33.3%) with recurrent TIA, and two patients (16.7%) with stroke + amaurosis. All patients were investigated, treated and followed up in Vascular Surgery Unit, Mansoura University Hospital.

The risk factors associated with carotid disease in our patients were in the form of smoking in 50%, ischemic heart disease in 75%, diabetes in 66.67%, hypertension in 75% and 50% had high lipid profile. Twenty-five percent of the studied group showed significant lesions by color duplex examination in the left ICA, 58.4% in the right ICA and 16.6% in the right CCA. The mean degree of stenosis among the studied groups was 72.9% by duplex (range 57-90) and 86.7% by MRA (range 60-99)

Eight patients were operated upon under local anesthesia and four patients were operated upon under general anesthesia because there was either high lesions in ICA or the patient was not cooperative.

Neck hematoma had occurred in 2 patients (16.67%) which was managed conservatively. One patient showed hypoglossal nerve affection that was temporary and improved within 6 months. Other complications in the form of recurrent stroke and TIA had occurred in one patient (8.3%). Carotid restenosis was not met during the follow up in the eversion CEA (0%) Table 1.

The cumulative stroke free rate among eversion CEA was 85.7% at the end of the study (table 2). Whereas, the cumulative stenosis free rate was 100% for eCEA Table 2.

Table 1. Life table analysis for recurrent stenosis free rate (less than 50%) among eversion CEA.

Interval (months)	Number entering	Number with drawn	No exposed to risk	No. of terminal	Interval recurrent stenosis free	Cumulative recurrent stenosis free	ST standard error
0	12	0	12	0	100%	100%	0
6	12	1	11.5	0	100%	100%	0
12	11	0	11	0	100%	100%	0
18	11	0	11	0	100%	100%	0
24	11	4	9	0	100%	100%	0
30	7	0	7	0	100%	100%	0
36	7	4	5	0	100%	100%	0

P= 0.45

Table 2. Life table analysis for stroke free survival rate among eversion CEA.

Interval (months)	Number entering	Number withdrawn	No exposed to risk	No of stroke	Interval stroke free rate	Cumulative stroke free rate	SE standard error
0	12	0	12	0	100%	100%	0
6	12	1	11.5	0	100%	100%	0
12	11	0	11	0	100%	100%	0
18	11	0	11	0	100%	100%	0
24	11	4	9	1	85.7%	85.7%	13.2%
30	7	0	7	0	100%	85.7%	13.2%
36	7	4	5	0	100%	85.7%	13.2%

P= 0.51

Fig 1. Preoperative MRA showing tight stenosis of left ICA.

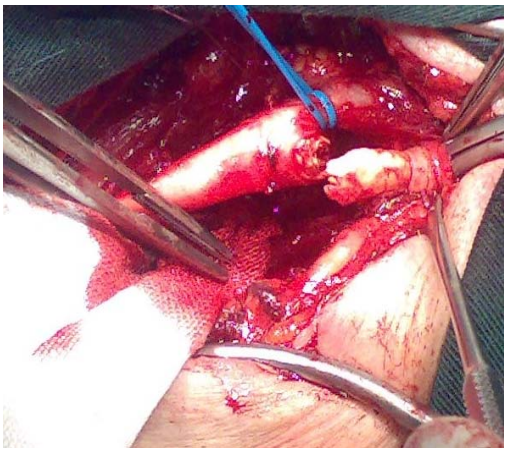

Fig 4. Removal of the plaque from the internal carotid and 'peeled back' vessel shown.

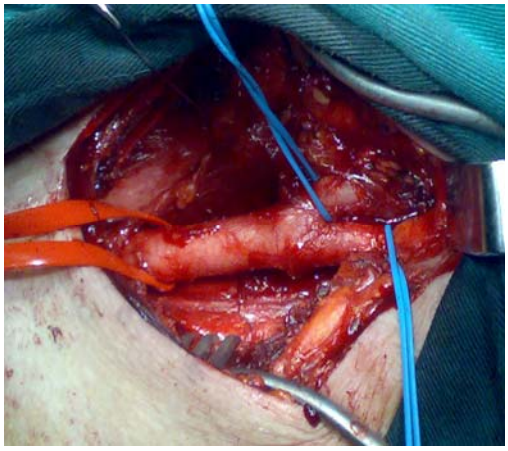

Fig 2. Exposure of C.C.A bifurcation.

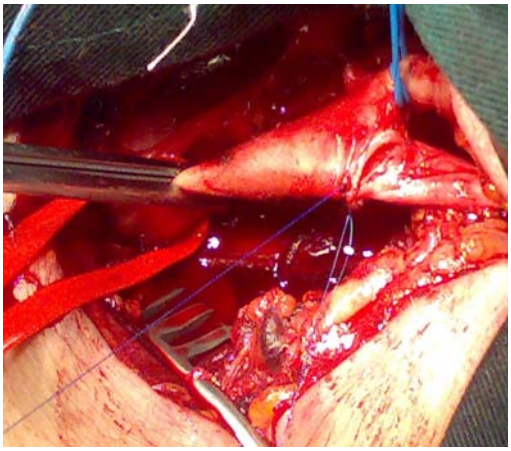

Fig 5. Backwall anastomosis completed.

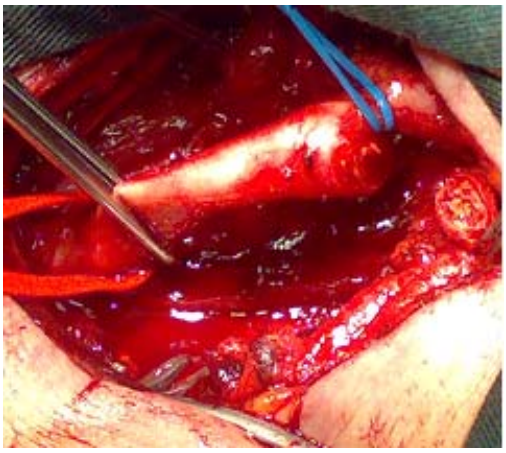

Fig 3. Division of internal and common carotid arteries showing the atheroma inside the vessels.

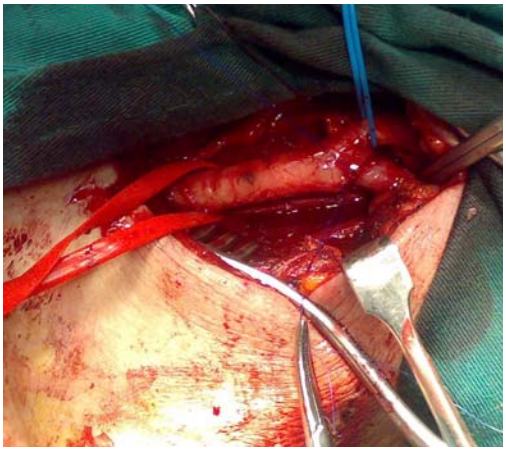

Fig 6. Anastomosis completed after internal carotid vessel being fashioned to match common carotid artery.

DISCUSSION

The role of endarterectomy for treatment of atherosclerotic stenosis of carotid bifurcation for prevention of stroke has been well established.

To be beneficial in selected patients with and without symptoms, a low incidence of perioperative stroke is necessary because technical errors still account for a large percentage of perioperative neurologic complications, and durability of CEA is affected by recurrent stenosis due to technical or local factors than to systemic factors, and the already low perioperative stroke rate and incidence of recurrent stenosis can clearly be further reduced by improving technical aspects of the surgical procedure.[4]

However, if the operative risk were to exceed 4%, the surgeon should not recommend CEA in any patient with asymptomatic disease. To date, no randomized trial has identified these reliably, but, intuitively, they are likely to include men with bilateral severe (> 75%) stenosis or contralateral occlusion and irregular or ulcerated lesions.[5] In our study we don't recommend CEA in patients with asymptomatic disease because the operative risk still exceeds 4% and according to Asymptomatic Carotid Atherosclerosis Study (ACAS), 24 asymptomatic patients with a 60-99% stenosis would have to undergo CEA to prevent one stroke at 5 years which is very much cost to pay.[6] Only one prophylactic case was done in this study: this patient has total occlusion of internal carotid on right side presented with left sided hemiplegia and 70% stenosis of ICA of left side by MRA.

Using the NASCET criteria, there is no evidence that symptomatic patient with a stenosis <50% benefit from CEA. Patients with NASCET 50-69% (70-79% ECST) gain a small but significant, benefit from CEA.[7] In our study, all patients were symptomatic with NASCET >50% stenosis and one asymptomatic case was done in this study.

The evidence regarding loco-regional anesthesia versus general anesthesia is conflicting. Few randomized trials have been performed and none has shown that loco-regional anesthesia reduces the overall stroke or cardiovascular risk. However, a meta-analysis of non-randomized studies suggested that loco-regional anesthesia may be associated with a reduction in the rate of perioperative stroke, myocardial infarction, and pulmonary complications.[8]

In our study we used both general and local anesthesia, the general anesthesia used when the patient is not cooperative to withstand local anesthesia, but in high risk patients for general anesthesia or when we need the patient to be awake for monitoring we shifted to local anesthesia.

Eversion endarterectomy in its modern sense directly addresses two technical issues in CEA surgery; management of the end point is simplified because it is circumferentially everted into the field, the suture line involves closure of two spatulated large arteries (ICA and distal CCA), which in turn serve to patch each other. So, produce a wide anastomosis. Closure of such a large anastomosis is invariably a simple task and effectively simplifies the closure of the artery. This is probably the principal advantage of eversion endarterectomy. Finally, any redundancy of the arteries can simply be amputated before reanastomosis.[9]

In our study with the introduction of eversion endarterectomy, the technique was easy in most patients who don't need shunting because the plaque was peeled from the everted artery easily with full visualization of the distal end point, also closure of the arteries is simple because the arteriotomies are large and the anastomosis is away from the distal end point and there is no possibility to cause stenosis at this point.

The attitude toward shunting of many authors dealing with the eversion CEA is controversial, however, some recommend shunting to simplify the eversion especially in cases of long running plaque.[10] Others find shunt placement extremely awkward preferring alternative means of cerebral protection and discouraging eversion CEA in patients in whom a shunt is required. The role of TCD (Transcranial Doppler) in monitoring is to warn of on table thrombosis and particulate embolization from unstable plaques during dissection, thereby enabling modification of the surgical technique, to ensure that MCAV (middle cerebral artery blood flow velocity) is always more than 15 ml/s.[11]

In our study we started using eversion CEA at 2004; shunt placement appeared more difficult than with conventional CEA. So, any case showed deterioration of neurological function under local anesthesia or ischemia using TCD after clamping, we shifted to conventional CEA with the use of shunt. But with time, we will gain more experience in shunt placement with eversion technique.

Although much is known about residual and recurrent stenosis after CEA with primary or patch closure , surprisingly little data are available on the location and character of these lesions after eversion endarterectomy.

The EVEREST (Eversion carotid Endarterectomy Versus Standard Trial) randomized 1353 patients between E-CEA and CEA with division of the CEA into primary and patch closure. Patients were followed up for a mean of 33 months. The incidence of restenosis was similar between the patched CEA and the E-CEA, and both were lower than CEA closed primarily (1.5% vs. 3.3% vs. 7.9%).[12]

Recurrent carotid stenosis after CEA remains challenging because of differences in the duration of follow-up, criteria used to determine and define recurrent stenosis and methods of closure of the arteriotomy.[13]

In our study, there is no recurrent stenosis (0%) during the follow up period associated with E-CEA. This shows that eversion CEA is more durable procedure, which, is due to reanastomosis of the ICA in the CCA which simplifies the arteriotomy closure and prevents potential distal ICA narrowing caused by a longitudinal primary or patch closure through or just beyond the critical end point. But still we need proper selection of patients who can be operated without shunt.

In conclusion: Eversion CEA is a feasible and safe alternative technique for management of carotid artery stenosis with lower incidence of restenosis,, an excellent technique for handling of the kink, spiral or redundant internal carotid artery, avoids the need for patch in women with small arteries , and also, avoids a longitudinal arteriotomy of ICA. We think that familiarity with both techniques is important, while, neither one is superior in every instance.

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