Carotid endarterectomy in Iraq: a single-center experience

Abdulsalam Y. Taha[a], Akeel S. Yousr[c], Saoud Y. Al-Neaimy[b], Muhammad Y. Al-Shaikh[d]

[a]Department of Cardiothoracic and Vascular Surgery, School of Medicine, Faculty of Medical Sciences, University of Sulaimaniyah and Sulaimaniyah Teaching Hospital, [b]Departments of Thoracic and Vascular Surgery, Sulaimaniyah Teaching Hospital, Sulaimaniyah, [c]Department of Cardiothoracic & Vascular Surgery, Ibn-Alnafees Teaching Hospital, Baghdad, [d]Department of Thoracic and Vascular Surgery, Al-Jumhouri Teaching Hospital, Mosul, Iraq

Correspondence to Abdulsalam Y. Taha, MBChB, FICMS (CTVS), Mamostayan Street 112, Road 22, House 10, Sulaimaniyah 46001, PO Box 414, Iraq
Tel: 00964(0)533280787;
E-mail: salamyt_1963@hotmail.com

Received 11 January 2015
Accepted 22 February 2015

The Egyptian Journal of Surgery
2015, 34:110–117

Background

Carotid endarterectomy (CEA) refers to surgical removal of carotid atheroma. It was first reported in 1956 and eventually became widely accepted as an effective operation for stroke prevention. Herein, we present the experience of a single Iraqi center in CEA.

Patients and methods

We conducted a retrospective study of 21 patients with significant symptomatic carotid stenosis that was surgically managed in Ibn-Alnafees Hospital, Baghdad, over the period 2009–2014. Workup consisted of duplex ultrasonography and computed tomography angiography of the carotid arteries. General anesthesia, a standard technique, and routine carotid shunts were used, followed by patch closure, mostly a venous patch. Aspirin and antiplatelets were given postoperatively to patients who underwent a venous patch; otherwise, warfarin was prescribed.

Results

There were 20 male patients. Ages ranged between 37 and 82 years, with a mean of 60.3 ± 12.2 years. One-third of the patients ($n = 7$) were in the seventh decade. Six of 12 patients had jobs consistent with a low economic status. Smoking, hypertension, and diabetes mellitus were the main risk factors. Most patients had hemiparesis ($n = 17$, 81%). All patients had significant carotid stenosis (moderate to severe). Twenty-two operations were performed (one patient underwent two operations). Left-sided operations were more frequent (14/8) ($P < 0.05$), as well as venous patches (20/2 Gore-Tex) ($P < 0.05$). There was no incidence of stroke, but cervical hematomas ($n = 22$), tongue deviation ($n = 2$), and hyperperfusion syndrome ($n = 2$) were seen, all of which resolved spontaneously; one case of mortality was reported (4.8%), in a 73-year-old-man.

Conclusion

Although this study is the first on CEA in Iraq with a small number of patients, the results compare favorably with the published literature.

Keywords:
atherosclerosis, carotid endarterectomy, carotid stenosis, stroke, transient ischemic attacks

Egyptian J Surgery 34:110–117

1110-1121

Introduction

Michael E. De Bakey is credited with performing the first successful carotid endarterectomy (CEA) in 1953 at the Methodist Hospital in Houston, Texas [1], but unfortunately he did not report the procedure until 1959 [2].

The first published report of CEA for atheromatous disease is by Yousif D. Al-Naaman, a pioneer cardiovascular Iraqi surgeon, and his colleagues Denton A. Cooley and Charles A. Carton from the USA, which was published in 1956 [2,3]. Their patient was a 71-year-old white man with nonhemispheric symptoms in whom angiography revealed a preocclusive lesion of the distal common carotid artery just proximal to the bifurcation. An in-dwelling arterial shunt was used, and the procedure was uncomplicated [2,3].

Eastcott and colleagues are given credit for popularizing carotid intervention for symptomatic atheromatous disease. On 7 May 1954, Anna Tuckwell, a 66-year-old woman, underwent operation in St. Mary's Hospital for atheromatous obstruction of the left internal carotid artery (ICA). Eastcott elected to excise the diseased segment and reconstruct the vessel with end-to-end anastomosis between the distal common and ICAs. Mrs Tuckwell survived an additional 20 years without further neurological events [2]. Hence, Eastcott's procedure was not strictly an endarterectomy as we now understand it [4] but a carotid arterectomy [2–4].

CEA eventually became a widely accepted operation after clinical trials conducted in Europe and America (1991–1995) and conclusively showed its benefit in preventing stroke [4–7]. CEA is now the most commonly performed peripheral arterial surgery in the USA [8]with nearly 140 000 operations performed in 2003 [4].

Symptomatic carotid stenosis has a high risk for stroke within the next 2 days. Therefore, National Institute for Health and Clinical Excellence (NICE) guidelines recommend that symptomatic patients with moderate to severe (50–99%) stenosis should undergo 'urgent' endarterectomy as soon as possible and preferably within 2 weeks to get maximum benefit from the operation [4,8].

In asymptomatic patients, the incidence of stroke, including fatal stroke, is 1–2% per year [4]. Surgeons are divided over whether asymptomatic patients should be treated with medication alone or should undergo surgery. Current surgical best practice restricts surgery for asymptomatic carotid stenosis to patients with at least 70% stenosis, provided that surgery is performed with 3% or less risk for perioperative complications [4].

CEA cannot be performed when there is a complete ICA occlusion, a previous ipsilateral stroke with heavy sequelae, or when the patient is considered unfit for surgery because of comorbidities [4,5].

As more and more vascular and neurosurgeons began to perform endarterectomy, it soon became clear that it was the most effective strategy for partially occlusive lesions rather than for total occlusions, in which restoration of flow was possible in only 40% of cases and in many of which operation was contraindicated because of the clinical presence of acute profound strokes, with operative mortality being reported to range from 20 to 60% [5]. It was gradually realized that the principal role of CEA was one of stroke prevention in patients with transient ischemic attacks (TIAs), mild deficits, and asymptomatic stenoses, rather than treatment for completed or profound strokes, as in the early days of endarterectomy [1,5].

Lyons C. (1959) [cited in 1] stated that a patient who slips into a coma with a vascular accident should not be explored. Similarly, De Bakey (1959) had reported the case of three patients with severe cerebral arterial insufficiency who had presented with coma and paralysis preoperatively and had died from irreversible ischemic brain damage despite restoration of circulation [1]. On the other hand, Crawford (1959) [cited in 1] had operated successfully upon patients in a coma and had them regain consciousness on the operating table when the restoration had been completed.

Although the first case report of a successful CEA for atherosclerotic carotid artery stenosis was partly authored by a vascular surgeon from Iraq (Al-Naaman YD, 1956) [2,3,5], it is unclear to us why this operation was not widely practiced in Iraq. A search on the net revealed no single publication on CEA from Iraq apart from that aforementioned. Literature review showed that this operation had witnessed a rise and fall in its popularity in the USA, Canada, and Europe in the 1980s, based on published outcomes from clinical studies [5,8]. The high stroke and/or mortality rates from the operation reported by some published studies induced fear and reluctance in neurologists to refer their patients with symptoms and signs of carotid artery stenosis, resulting in reduced popularity of the technique; however, the good surgical outcome from the technique compared with medical therapy in other studies led to a surge in its demand [5,8]. The operation's acceptance by the neurological community was slow and awaited controlled clinical trials [5,6]. In most Arab countries, results of CEA for carotid stenosis were not assessed before 2009 [7]. Neurologists in Iraq might have been reluctant to take the (risky) surgical route and preferred to treat their patients conservatively. Similarly, vascular surgeons could have had the same attitude. However, the multiple clinical trials of the early 1990s that showed superior results of CEA over medical treatment [5,6] definitely changed the attitude of both neurologists and surgeons in Iraq towards surgery.

Recently and particularly in the last few years some young Iraqi surgeons have begun to perform this procedure in some centers in Baghdad, Sulaimaniyah and Mosul (personal communication); unfortunately, no one has published his experience yet. Therefore, the present series may be the first study of CEA from Iraq.

Patients and methods

This is a retrospective study of 21 patients with symptoms and signs of carotid stenosis referred to the Department of Thoracic and Vascular Surgery, Ibn-Alnafees Teaching Hospital, Baghdad, Iraq, over a 5-year period (2009–2014) who underwent CEA. Informed consent was obtained from the patients before enrollment in the study. An informed written consent in accordance with the hospital Ethical Committee was also obtained.

The patients in this study were seen by a team of neurologists and a vascular surgeon. Detailed history was obtained from every patient with respect to chief complaints, such as unilateral body weakness, limb paresthesia, slurred speech, decreased visual acuity etc. Risk factors such as smoking, hypertension, diabetes mellitus (DM), hyperlipidemia, and alcohol use, as well as details of drugs used by the patient, were also noted. A thorough physical examination was carried for evidence of neurological deficits, carotid bruit, and features of atherosclerosis elsewhere in the body, such as ischemic heart disease, abdominal aortic aneurysm, and peripheral arterial disease.

Duplex ultrasonography, color Doppler, and computed tomography (CT) angiography of the carotid arteries were used to evaluate the severity of carotid stenosis. Other investigations included chest radiography, ECG, and echocardiography to assess cardiopulmonary status, and blood biochemistry and serum virology tests. Symptomatic patients with moderate (50–69%) to severe (>70%) carotid stenosis were chosen for surgery.

Preoperative measures included a thorough medical checkup, fitness for general anesthesia (GA), and blood preparation; a written high-risk consent form was signed by each patient. Smoking patients were asked to quit smoking for at least 2 weeks before surgery. Aspirin and antiplatelets were stopped 3 days preoperatively. Antihypertensive and statin medications were continued, and diabetic patients receiving oral hypoglycemic drugs were switched to soluble insulin until the fifth postoperative day.

All operations were performed under GA and by the same surgeon. Because of nonavailability of intraoperative electroencephalography (EEG) or transcranial Doppler ultrasonography of cerebral blood flow, intraluminal carotid shunts were used routinely to provide cerebral protection during ICA clamping. The standard surgical procedure of CEA was employed [4,5]. Unfractionated heparin (5000 IU) intravenously was given just before arterial clamping and the patients were switched to LMWH 6000 IU twice daily subcutaneously for 5 postoperative days. The arteriotomy was closed mostly by a venous and occasionally by a prosthetic patch. A tube drain was used after securing the hemostasis.

The patients were carefully evaluated for any evidence of cranial nerve injuries and stroke, as well as for cervical hematoma. The tube drain was removed when the volume of drainage fell below 50 ml/day. The same preoperative medications were resumed, besides warfarin therapy for prosthetic patch receivers only. The patients were discharged home once they were stable, usually within 5 days after surgery. The late outcome of all patients in this series was assessed by frequent clinical and Doppler US exam during their visits to the consultation clinic.

Statistical analysis was performed using the *Z*-test for two population proportions and the *t*-test for two dependent means.

Results

There were 21 patients in this study (male, n = 20 and female, n = 1). The male to female ratio was 20: 1. This difference was statistically significant ($P < 0.05$). The youngest patient was a 37-year-old man and the oldest was an 82-year-old man. The mean age was 60.3 ± 12.2 years.

Table 1 shows the age and sex distribution. Most patients were in the seventh decade of life (n = 7, 33.3%).

The jobs of nine patients were not documented in the medical files; the jobs held by the remaining 12 are shown in Table 2. Of these 12, six had jobs consistent with a low economic status (worker, n = 3; farmer, n = 2; and housewife, n = 1).

The risk factors are shown in Table 3. Smoking topped the list, whereas alcohol consumption was the least prevalent. Hypertension and DM were also frequently observed. However, hyperlipidemia was not documented.

Table 1 Age and sex distribution

Age (years)	Male (*n*)	Female (*n*)	Total [*n* (%)]
30–40	1	0	1
41–50	4	0	4
51–60	4	1	5
61–70	7	0	7
71–80	3	0	3
81–90	1	0	1
Total	20 (95.2)	1 (4.8)	21 (100)

Table 2 Jobs versus sex and age of the patients

Jobs	Male		Female		Total
	<40 years	>40 years	<40 years	>40 years	
Housewife	0	0	0	1	1
University professor	0	1	0	0	1
Teacher	0	1	0	0	1
Officer	0	1	0	0	1
Engineer	1	0	0	0	1
Lawyer	0	1	0	0	1
Merchant	0	1	0	0	1
Worker	0	3	0	0	3
Farmer	0	2	0	0	2
Unmentioned	0	9	0	0	9
Total	1	19	0	1	21

Table 3 Risk factors versus age of the patients

Risk factors	Age <40 years	Age >40 years	Total
Smoking	1	19	20
Hypertension	0	12	12
DM	0	11	11
Alcohol consumption	0	2	2
Undocumented	0	2	2
Total	1	46	47[a]

DM, diabetes mellitus; [a]Some patients had more than one risk factor.

Table 4 shows the clinical characteristics of the patients. The vast majority had unilateral body weakness (n = 17, 81%). Other neurological deficits occurred less frequently.

The workup of the patients in this study was based on carotid Doppler and CT carotid angiography, which revealed significant carotid stenosis (moderate to severe).

Table 5 shows the performed operative procedures. The total number of operations was 22. Left-sided operations were significantly more frequent than right-sided ones ($P < 0.05$). Venous patches were used more frequently than prosthetic patches to close the arteriotomy ($P < 0.05$).

Complications on the basis of the side of operation are shown in Table 6. Both cervical hematoma and death were significantly higher on the left side ($P < 0.05$), whereas tongue deviation and cerebral hyperperfusion were significantly higher on the right ($P < 0.05$).

The patients are being regularly followed up by the operating surgeon and are doing well.

Table 4 Clinical characteristics

Symptoms and signs	n	Symptoms and signs	n
Unilateral body weakness	17	Associated operations for atherosclerotic disease elsewhere in the body before or after CEA	5 [aorto-bifemoral bypass graft (n = 2) CABG (n = 2) Femoropopliteal bypass (n = 1)]
Right-sided	9	Decreased visual acuity	1
Left-sided	8	Amaurosis fugax	1
Slurred speech	3	Carotid bruit	1 (the remaining 20 patients had no mention of carotid bruit)
Limb paresthesia	3	Ptosis	1

CABG, coronary artery bypass graft; CEA, carotid endarterectomy.

Table 5 Operative procedures

Side of CEA	Type of patch[a]		
	Venous	Gore-Tex	Total
Right	8	0	8
Left	12	2	14
Total	20	2	22[b]

CEA, carotid endarterectomy; [a]The result was significant at $P < 0.05$; [b]One patient had bilateral CEA; The result was significant at $P < 0.05$.

Table 6 Complications versus side of surgery

Type of complication	Side of surgery	
	Right [n (%)]	Left [n (%)]
Transient tongue deviation	1 (12.5)	1 (7.1) (the result was significant at $P < 0.05$)
Stroke	0 (0)	0 (0)
Mild to moderate hematoma resolving spontaneously	8 (100)	14 (100) (the result is significant at $P < 0.05$)
Cerebral hyperperfusion	1 (12.5)	1 (7.1) (the result is significant at $P < 0.05$)
Re-exploration	0	0
Wound infection	0	0
Death (4.8%). The patient was a 73-year-old man who died 2 days after surgery. He developed deterioration of consciousness level and acute renal failure	0 (0)	1 (7.1) (the result is significant at $P < 0.05$)

Discussion

There is a definite relationship between carotid atherosclerosis and age. This is evident in previous as well as recent studies. With regard to age, Smyth GE (1956) [cited in 3] found the majority of carotid stenosis in the sixth and seventh decades, similar to our findings [seven cases (33.3%) in the seventh decade]. De Weerd *et al.* [9] likely noted an increasing prevalence with age. In the study by Willeit and Kiechl [10], the variable 'age' was without doubt the strongest and most consistent indicator of carotid atherosclerosis. In their opinion, the strong relation of age to carotid atherosclerosis is probably an indirect expression of the continuous exposure to various risk factors rather than the result of an intrinsic process of aging [10].

Only a few studies address the question 'to what extent does the prevalence of carotid atherosclerosis differ between the sexes' [10]. Smyth GE (1956) [cited in 3] observed that the condition was about twice as common in men as in women. De Weerd *et al.* [9] similarly observed that moderate carotid stenosis was more prevalent among men than among women. Willeit and Kiechl found a 2: 1 preponderance of men in the 40–59 age group. With advancing age, however, the differences, although still detectable, were found to decrease, which possibly reflects the loss of the protective premenopausal status [10]. In the present study, male patients were significantly more than female patients (male: female = 20: 1; $P < 0.05$). As that CEA also appeared to be more beneficial in men than in women, screening for asymptomatic carotid stenosis might be more worthwhile among men with reasonable life expectancy than among women [9].

Half of our patients (6/12) had jobs consistent with a low economic status. Socioeconomic status (SES) is significantly associated with cardiovascular morbidity and mortality [11]. There is a strong association between SES and atherosclerosis. This association is mediated by known atherosclerotic risk factors and is evident in the early stages of atherosclerosis [12]. Compared with the lowest SES group, men with the highest SES had 14–29% less atherosclerotic progression [11], whereas men with poor education and low income had significantly greater progression of carotid atherosclerosis than did men with higher education and income [11]. The findings strengthen the contention that SES plays a significant role early in the atherosclerotic disease process and that reducing the burden of atherosclerotic vascular disease associated with lower SES will require approaches that focus on all stages of life [11].

Survivors of a TIA or stroke represent a population at increased risk for subsequent stroke. Approximately one-quarter of the 795 000 strokes that occur each year are recurrent events [13]. Control of the modifiable risk factors is, therefore, an important measure of preventing a second stroke. The most significant risk factor for stroke is hypertension [10]. A person with untreated hypertension is four times more likely to have a stroke than someone whose blood pressure falls within the healthy range [14]. High blood pressure occurs in 80% of patients with acute ischemic stroke [14]. Twelve of our patients (57.1%) were hypertensive. Diabetes is a clear risk factor for first stroke, but the data supporting diabetes as a risk factor for recurrent stroke are more sparse [13]. Prevalence of DM is 15–33% in patients with ischemic stroke [13]. In our study, 11 patients (52.4%) were diabetic. With regard to lipid profile, studies have shown an association of ischemic stroke risk with elevated levels of total cholesterol, low-density lipoprotein, triglycerides, and low levels of high-density lipoprotein [13]. Unfortunately, only one of our patients had a record of lipid profile. There is strong evidence that cigarette smoking is a major risk factor for ischemic stroke [13,15]. Almost all patients in this series were smokers. Likewise, there is strong evidence that chronic alcoholism and heavy drinking are risk factors for all stroke subtypes [14]. Two of our patients (9.5%) were alcoholics [13].

Patients with symptomatic carotid artery stenosis typically have either TIA or minor stroke, defined as a focal neurologic deficit affecting one side of the body, speech, or vision [4,5]. Asymptomatic patients have narrowing of their carotid arteries, but have not experienced a TIA or stroke [4,5]. The true prevalence of TIA is difficult to gauge because a large proportion of patients who experience a TIA fail to report it to a healthcare provider [9,13]. By conventional clinical definitions, the presence of focal neurological symptoms or signs lasting less than 24 h has been defined as a TIA [13]. A new tissue-based definition of TIA is as follows: a transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia, without acute infarction [13]. All of the patients in this series were symptomatic; two patients presented with amaurosis fugax (transient loss of vision in one eye), one had ptosis, three had slurred speech, three had limb paresthesia, and the majority (17/21) had unilateral hemiparesis. Although carotid artery bruit is an important physical finding in patients with carotid stenosis, it was recorded only once in this study. Irrespective of the detection of a carotid artery bruit in patients with possible vascular events, most authorities would still recommend imaging studies [16].

At a bare minimum, all stroke patients should undergo brain imaging with CT or MRI to distinguish between ischemic and hemorrhagic events, and both TIA and ischemic stroke patients should have an evaluation sufficient to exclude high-risk modifiable conditions such as carotid stenosis or atrial fibrillation as the cause of ischemic symptoms [13]. Accurate diagnosis of the degree of ICA stenosis is needed for decisions regarding optimal stroke prevention. Although controversy now exists over the most appropriate method of measuring carotid stenosis [5], many authors consider duplex ultrasound imaging as the method of choice for the evaluation of carotid atherosclerosis in clinical practice [14]. Not until 1937, however, when Moniz introduced an efficient method for carotid arteriography, was accurate diagnosis of carotid stenosis made possible, and since that time the disease is being recognized with increasing frequency [3]. Noninvasive magnetic resonance angiography is being proposed and used as a replacement for the gold standard, intra-arterial angiography [17]. CT angiography of the head and neck is readily available and can be part of the routine imaging of stroke patients [18]. The workup of all patients in this study was based on carotid Doppler and CT carotid angiography.

Methods to determine the adequacy of the cerebral circulation include the xenon method, temporary carotid occlusion under local anesthesia, determination of the stump pressure in the occluded distal ICA, EEG monitoring, transcranial Doppler monitoring, and sensory-evoked potential monitoring [5,15]. Unfortunately, none of these techniques was available in our study. Some surgeons believe that awake testing under locoregional anesthesia is the only reliable method of monitoring cerebral circulation [19].

The procedure may be performed under GA or local anesthesia [4,8]. The latter allows for direct monitoring of neurological status by intraoperative verbal contact and testing of grip strength. With GA, indirect methods of assessing cerebral perfusion must be used, such as EEG, transcranial Doppler analysis, and carotid artery stump pressure monitoring. At present there is no reliable evidence to show any major difference in outcome between local anesthesia and GA [4]. Proponents of regional anesthesia claim many advantages over GA, such as ease of monitoring of cerebral perfusion, lower cardiovascular morbidity due to lower requirements for shunting, shorter hospital stay, and reduced overall costs [15].

The first author of this paper (Professor Taha AY) describes his observation of CEA that was performed in Guy's Hospital, London, UK (March 2009). The operation was performed on an awake patient under local anesthesia according to the patient's will. The patient was an 80-year-old lady with TIAs 2 weeks earlier. She had more than 70% carotid stenosis as shown by duplex ultrasonography. To detect any alteration in neurological function, verbal communication with the patient was maintained throughout the operation and she was repeatedly requested to squeeze a balloon that produced a sound to test her muscle power especially after clamping the ICA. Moreover, the blood flow and velocity in the cerebral artery were monitored by transcranial Doppler ultrasonography. A reduction in cerebral blood flow indicated the need for carotid shunting. The standard surgical technique for CEA was followed and a big atheroma was quickly removed. However, once the ICA artery was clamped, the cerebral blood flow reduced and a shunt was necessary. The patient recovered with no neurological deficit.

In the past, hypothermia, hypercarbia, and hypocarbia were used for cerebral protection [5]. Eastcott *et al.* [3] used cerebral hypothermia as a method of cerebral protection during the period of cross-clamping in their landmark case of carotid arterectomy and anastomosis of common carotid artery to ICA (1954) [3,6]. Soon thereafter, shunting replaced hypothermia [3,6]. The case described by Cooley and colleagues [3,5] is of interest in that an external shunt was used for cerebral protection, the first reported use of a shunt for CEA. Arterial flow was restored after 9 min of carotid clamping [3]. The shunt consisted of a polyvinyl tube with a 14-G needle at its lower end and a 16-G needle at its upper or internal carotid end. Additional cerebral protection was attempted by immersing the patient's head in crushed ice for 30 min. Despite this the patient suffered an operation-related stroke from which he recovered rapidly over the course of several weeks [5]. The use of a shunt is still under discussion. Some surgeons use it routinely [5], others use it selectively on the basis of an assessment of the collateral circulation, whereas some rarely or never use it [5]. Today the temporary shunt remains the most effective means of providing cerebral protection when judged necessary [4,5]. In our series, routine intraluminal shunting was elected as all of the operations were performed under GA and we lacked any facility for monitoring the cerebral function intraoperatively.

Controversy revolves around patching versus simple closure of the arteriotomy after CEA [5,20]. Thompson JE [5] believes that patching is useful for small arteries and reoperation but is probably not necessary as a routine maneuver [5]. Saad *et al.* [20] from Egypt used patching after endarterectomy in 45 patients with good results and therefore recommend it over simple closure. We share the same opinion and have applied this technique in all of our cases as it gives less incidence of postoperative thrombosis, stenosis, and recurrent stroke [20]. It has been suggested that the flow characteristics of patched carotid arteries may be superior to those of primary closed arteries in terms of preventing early thrombosis. Dirrenberger and Sundt [cited in 20] state that the endarterectomized artery is thrombogenic for the first several hours after CEA, during which time the carotid artery is most vulnerable to acute thrombosis. Others have attributed this improvement to widening of the artery with a corresponding reduction in the effect of intimal hyperplasia [20]. Opponents of carotid patching highlight the increased operative time of 15–20 min required for patch closure, risk of patch rupture, and false aneurysm formation [20].

The choice of patch material has also been a subject of debate [20]. Seabrook [cited in 20] states that the autogenous vein is superior to prosthetic materials because the luminal surface is less thrombogenic and more resistant to infection. Synthetic patch (PTFE) has the advantages of availability, resistance to aneurysmal formation, or patch rupture [20]. Opponents to synthetic patches fear bleeding through the patch material, intraluminal thrombosis, and infection [20]. In our study, venous patches were significantly more frequently used than prosthetic ones (20: 2) as we believe they are less thrombogenic and more resistant to infection.

The chief complication of CEA, apart from death, is the production or aggravation of stroke [5]. None of our patients had stroke after surgery. Hemorrhage of the wound bed is potentially life threatening, as swelling of the neck due to hematoma could compress the trachea. Although cervical hematoma developed in all of the patients in this series, it was mild and resolved spontaneously. Occasionally, the hypoglossal nerve can be damaged during surgery. Two patients in this study developed tongue deviation toward the side of the operation but both eventually resolved. Another rare but potentially serious complication is hyperperfusion syndrome because of the sudden increase in perfusion of the vasculature distal to stenosis [4]. Two of our patients had this syndrome (one recovered while the second died on the second postoperative day). Thompson JE believes that results of the operation have progressively improved with proper selection of patients, arteriography performed by skilled radiologists, avoidance of surgery for those with acute profound and progressing strokes, meticulous operative techniques used by well-trained surgeons, and appropriate use of cerebral protection [5].

The surgical mortality of endarterectomy ranges from 1 to 2% to as much as 10% [4]. In a survey of 15 960 CEAs, Hertzer [cited in 5] found the overall average operative mortality rate to be 1.4%. Perioperative CEA risks for combined 30-day mortality and stroke risk should be less than 3% for asymptomatic patients and less than or equal to 6% for symptomatic patients [4,7]. Patients with multiple medical problems have a higher postoperative mortality rate [4,7]. In our series, we had a single incidence of mortality (4.8%), which was within the reported standard rate.

Fourteen of 22 (63.6%) operations in this series were left-sided. Similarly, Johnson and Walker (1951) [cited in 3] found that carotid stenosis was 6.5 times more common in the left carotid than in the right. The exact explanation for this finding is unknown and of great interest is the influence of the side of CEA on its outcome. Recent randomized controlled trials and observational studies have suggested that outcomes may be poorer in left-sided procedures [21]. Girard *et al.* [21] in a mixed method study that involved 7048 patients have demonstrated that left-sided surgery is an independent risk factor for increased rates of postoperative stroke or death after CEA. Surgeon-handedness and microemboli are two speculations that could explain this finding. Some surgeons anecdotally report that, for anatomic reasons, left-sided CEA is technically more difficult for a right-handed surgeon. If handedness is indeed found to be a contributing factor, there would be a need to develop modified surgical approaches that improve ergonomics for right-handed surgeons operating on left carotid arteries. Stork *et al.* [21] reported that left-sided CEA was associated with an increased risk for microembolic events detected intraoperatively. If microemboli from surgery account for the phenomenon, then consideration could be given to the use and evaluation of embolic capture devices similar to those being considered in the context of coronary artery procedures and during carotid artery stenting. Further research is definitely needed to clarify the underlying mechanism(s) and to determine whether these mechanisms can be modified [21].

In our study, all operations were performed by one surgeon who was right-handed. The single death occurred following a left-sided CEA. Both cervical hematoma and death were significantly higher on the left side ($P < 0.05$), whereas tongue deviation and cerebral hyperperfusion were significantly higher on the right side ($P < 0.05$).

This study has some limitations. Being a retrospective study, the documentation was not optimum. The number of patients enrolled in this study was small. Long-term follow-up was not available for all patients.

Conclusion

Although this study is the first on CEA in Iraq in which a small number of patients were enrolled, the results compare favorably with the published international literature (a 4.8% death rate that is lower than 6% for CEA in symptomatic carotid artery stenosis and a 0% incidence of stroke and persistent cranial nerve injuries).

Acknowledgements

Conflicts of interest

None declared.

References

1 De Bakey ME, Crawford ES, Cooley DA, Morris GC Jr. Surgical considerations of occlusive disease of innominate, carotid, subclavian, and vertebral arteries. Ann Surg 1959; 149:690–710.

2 Whittemore AD. Endarterectomy for carotid artery stenosis. Curr Probl Surg 1999; 36:601–650.

3 Cooley DA, Al-Naaman YD, Carton CA. Surgical treatment of arteriosclerotic occlusion of common carotid artery. J Neurosurg 1956; 13:500–506.

4 Roseborough GS, Perler BA. Carotid artery disease: endarterectomy. In: Cronenwett JL, Johnston KW, editors. *Rutherford's vascular surgery*. 7th ed. Philadelphia: Saunders Elsevier; 2010. 1443–1473.

5 Perler BA. Carotid endarterectomy: indications, techniques, and results. In: Ascher E, editor. *Haimovici*'*s vascular surgery*. 6th ed. West Sussex: Blackwell Publishing Ltd; 2012. 405–436.

6 Connolly JE. The epic 1954 operation that led to one of surgery's major advances: carotid endarterectomy. Grand Rounds 2004; 4:L15–L17.

7 Elsharawy MA. Carotid endarterectomy in high-risk Arab patients. Interact Cardiovasc Thorac Surg 2009; 8:100–103.

8 Kassem HH, Abd-Allah F, Wasay M. Update on carotid revascularization: evidence from large clinical trials. In: Rita Rezzani, editor. *Carotid artery disease — from bench to bedside and beyond*. Rijeka, Croatia InTech; 2014. 105–124. Available at: *http://www.intechopen.com/books/carotid-artery-disease-from-bench-to-bedside-and-beyond/update-on-carotid-revascularization-evidence-from-large-clinical-trials*

9 de Weerd M, Greving JP, de Jong AW, Buskens E, Bots ML. Prevalence of asymptomatic carotid artery stenosis according to age and sex: systematic review and metaregression analysis. Stroke 2009; 40:1105–1113.

10 Willeit J, Kiechl S. Prevalence and risk factors of asymptomatic extracranial carotid artery atherosclerosis. A population-based study. Arterioscler Thromb 1993; 13:661–668.

11 Lynch J, Kaplan GA, Salonen R, Salonen JT. Socioeconomic status and progression of carotid atherosclerosis. Prospective evidence from the Kuopio Ischemic Heart Disease Risk Factor Study. Arterioscler Thromb Vasc Biol 1997; 17:513–519.

12 Lynch J, Kaplan GA, Salonen R, Cohen RD, Salonen JT. Socioeconomic status and carotid atherosclerosis. Circulation 1995; 92:1786–1792.

13 Furie KL, Kasner SE, Adams RJ, Albers GW, Bush RL, Fagan SC, *et al.* American Heart Association Stroke Council, Council on Cardiovascular Nursing, Council on Clinical Cardiology, and Interdisciplinary Council on Quality of Care and Outcomes Research Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2011; 42:227–276.

14 Salehnejad G, Aliramaei N, Zobeiry K, Naderi A. Study of relationship between high blood pressure and clinical markers and individual cerebrovascular accident in clients that referred to Towhid Hospital in Sanandaj (Kurdistan of Iran) in 2010. Life Sci J 2013; 10:441–450. Available at: *http://www.lifesciencesite.com*

15 Beleta MI, Abdalla AA, Ali AR. Anaesthesia for carotid endarterectomy MSc thesis]. Giza, Egypt: Cairo University; 2004

16 Ocava LC. Carotid artery disease unpublished lecture notes]. Albert Einstein College of Medicine of Yeshiva University/Jacobi Medical Center/ Vascular Neurology Department. Date of Lecture is unknown

17 Debrey SM, Yu H, Lynch JK, Lövblad KO, Wright VL, Janket SJ, Baird AE. Diagnostic accuracy of magnetic resonance angiography for internal carotid artery disease: a systematic review and meta-analysis. Stroke 2008; 39:2237–2248.

18 Josephson SA, Bryant SO, Mak HK, Johnston SC, Dillon WP, Smith WS. Evaluation of carotid stenosis using CT angiography in the initial evaluation of stroke and TIA. Neurology 2004; 63:457–460.

19 McCleary AJ, Maritati G, Gough MJ. Carotid endarterectomy; local or general anaesthesia? Eur J Vasc Endovasc Surg 2001; 22:1–12.

20 Saad EM, Sharaf H, Abd El-Latif A, Mowafy K, Al-Mongy A. Carotid endarterectomy: primary closure versus patch angioplasty. EJS 2003; 22:59–68.

21 Girard LP, Feasby TE, Eliasziw M, Quan H, Kennedy J, Barnett HJ, Ghali WA. Complication rates after left- versus right-sided carotid endarterectomy. Circ Cardiovasc Qual Outcomes 2009; 2:642–647.