Neurobehavioral effects of carotid endarterectomy

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ABSTRACT

Objective: Nineteen patients with symptomatic carotid stenosis (>70%) were subjected to carotid endarterectomy in a prospective study to evaluate neurobehavioral changes before and 6 months following the operation.

Method: All patients were subjected to neurobehavioral rating scale one week before and 6 months after the operation.

Results: There were no significant changes in the 27 items of this scale before and 6 months following the operation. Some patients showed no difference at all in some items of this scale before and after operation such as suspiciousness excitement, speech and articulation using Mann-Whitney rank test, P values were (> 0.05) as regards to all items of neurobehavioral rating scale.

Conclusion: Uncomplicated carotid endarterectomy does not seem to be associated with significant long time neurobehavioral impairment following the operation.

Keywords: Carotid endarterectomy, neurobehavior.

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Stroke is the leading cause of disability and the third leading cause of death in United States. It has devastating physical, psychological and socio-economic consequences.[1] Extracranial carotid atherosclerotic disease is thought to be a principal cause of strokes and is the major risk factor in 15% to 20% of patients. One method of prophylactic therapy to prevent strokes from occurring is surgery. More than one million operations for carotid artery stenosis have been performed in United States since the early 1950's.[2] The conclusion of these studies are that carotid endarterectomy carotid endarterectomy is the most effective means of preventing stroke when the stenosis is greater than 70% in symptomatic patients at centers where surgical morbidity and mortality are less than 3%. Because of these studies, we have seen a dramatic increase in the number of patients undergoing this type of surgery.[3] There were some studies that mentioned that some major neurological changes occurred as a complication of carotid endarterectomy.[4,5] Other authors found some subtle changes in cerebral functions as determined by a battery of neuropsychological tests.[5,6] We think that, with the progress in medical technology and the more experience of Vascular Surgeons these complications of this life saving surgery will be less and less. The aim of this study is to assess some neurobehavioral changes after carcinoembryonic antigen.

Methods. Thirty three patients undergoing elective carotid endarterectomy were recruited to participate in this study. All patients had more than 70% stenosis of the operative carotid artery. Written informed consent was obtained to participate in this study. All patients had a history of transient ischemic attack or cerebrovascular stroke or both. The patients were chosen from King Khalid University Hospital through the time from September 1999 to May 2000. All patients had been operated

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Table 1 - Demographic changes in patients with CEA (No:19 patients).

Variables	Results
Age, Years	61 y
Operative side (right/left)	8 (42%) / 11 (58%)
Sex (male/female)	13 (68%) / 7 (32%)
Diabetes mellitus	13 (68%)
Hypertension	10 (53%)
Previous MI	6 (31.5%)
Previous stroke or TIA	All (100%)
Previous CEA	None (0%)
Duration of surgery, min without patch with patch	 98 min. 125 min.
Cross-clamptime, min without patch with patch	 38 min. 45 min.
Fentanyl µg/kg	2 (0.7)
Midazolam mg/kg	0.04 (0.1)

MI - myocardial infarction; TIA - transient ischemic attack.
Values are mean (SD) or percentage
Min - Minute, CEA - carotid endarterectomy

upon by the same surgeon. Patients were assessed two at a time with the Neurobehavioral Rating Scale: At first: one week before surgery to establish a performance base line. The second time was 6 months following operation. Six patients who had baseline evaluations withdrew from the study. Eight patients missed the follow up examination.

Anesthesia. General anesthesia was induced primarily with tentanyl, midazolam (mean total dose [SD] were 2 [0.7] mg/kg and 0.04 [0.10] mg/kg, respectively and vecuronium 5.9 [4] mg and maintained with isoflurane [0.1 - 0.4] exp.) as tolerated. Standard monitors were applied including an arterial catheter for measuring blood pressure continuously. All hemodynamic data plus temperature were monitored continuously and recorded every minute. After the internal carotid artery was cross-clamped, EEG changes were monitored by an 8 channels electroencephalogram.

Surgery. All operations were carried out mainly by the senior author of this study. The surgery for carotid endarterectomy consisted of positioning the patient supine with the head in an extended midline position. An incision was made along a skin crease from just below the angle of the mandible to near the midline through skin, subcutaneous tissue, and platysma. The common internal and external carotid arteries were exposed and controlled. A shunt was prepared and used only if changes consistent with cerebral ischemia were noted on EEG. After heparin (5000 IU) was administered intravenously, the common, internal and external carotid arteries were occluded. A longitudinal incision was made in the common carotid artery proximal to the bifurcation and extended into the internal carotid artery distal to

Table 2 - Postoperative neurobehavioral changes in the study group.

	Scale items	Pre-op	Post-op	t	Z	P
1.	In attention	1.18(.5)	1.16(.5)		.00	1
2.	Sometime Concern	1.37(.83)	1.47		-.24	.81
3.	Disorientation	1.1(.46)	1.1(.46)		.00	1
4.	Anxiety	1.37(.9)	1.37(.8)		-.28	.78
5.	Expressive deficit	1.16(.8)	1.10(.46)		-.56	.57
6.	Emotional withdrawal	1.16(.50)	1.21(.53)		-.45	.65
7.	Conceptual disorganization	1.05(.23)	1.05(.23)		00	1
8.	Disinhibition	1.1(.32)	1.0(.00)		-1.43	.15
9.	Guilt feelings	1	1		.00	.1
10.	Memory deficit	2.11(1.6)	1.63(.96)		-.66	.51
11.	Agitation	1.16(.69)	1.05(.23)		-0.4	.97
12.	Inaccurate insight	1.11(.32)	1(.00)		-1.43	.15
13.	Depressive mood	1.37(.76)	1.21(.54)		-.52	.60
14.	Hostility	1.21(.71)	1(.00)		-1.43	.15
15.	Decreased motivation	1.21(.92)	1.11(.46)		-0.4	.97
16.	Suspiciousness	1	1		.00	1
17.	Fatiguability	1.53(1.12)	1.42(.77)		-.16	.88
18.	Hallucinatory behavior	1.05(.23)	1(.00)		-1.00	.32
19.	Motor retardation	1.11(.46)	1.16(.50)		-.56	.57
20.	Unusual though content	1.05(.23)	1(.00)		-1.00	.32
21.	Blunted affect	1.11(.46)	1.05(.23)		-0.4	.97
22	Excitement	1	1		.00	1
23.	Poor planning	1.05(.23)	1(.00)		-1.00	.32
24	Liability of mood	1.47(1.02)	1.11(.32)		-1.01	.31
25	Tension	1.53(1.17)	1.32(.95)		-.48	.63
26	Comprehensive deficit	1.21(.54)	1.21(.54)		-.00	1
27	Speech articulation defect	1	1		.00	1
	Global assessment	32.7 (6.6)	30.7 (4.6)	1.09		.29

P=Level of significance when P is < 0.05
t=t-test, z=level of significance of Mann-Whitney rank test

the plaque. The atheroma was removed with the use of dissector. Family attached intact intimate was left above and below the area of atheroma resection. When a vein patch was inserted, it was taken from the proximal saphenous vein. Before, the final sutures were placed, back-bleeding from the common, internal and external carotid arteries was performed, and the lumen was washed with heparinized saline. Debris and air were expelled by releasing the clip on the superior thyroid artery, which provided inflow as the final sutures were secured. Clamps were sequentially removed from the external, common, and internal carotid arteries.

Neurobehavioral evaluation. The Neurobehavioral Rating Scale was applied on all patients one week before operation and 6 months following operation (on 19 patients only who came for follow up). This scale is consisted of 27 items. Each item has a score from 1 to 7 (not present to extremely severe). This scale was originally designed for patients with head trauma but it can be used in cases of dementia. To our knowledge, this is the first time to be applied on old patients who are subjected to carotid endarterectomy. This test was applied by a Clinical Psychologist under the supervision of the 2nd author. According to Diagnostic and Statistical Manual - IV[7,] two patients showed the criteria of alzheimer's dementia, who had been operated upon.

Statistical analysis. The decline in the score of the previous mentioned scale means improvement, we compared the changes in the mean score of this scale items before and after operation using Mann-Shitney rank test and t-test was used to compared the global mean scores of the scale before and after carotid endarterectomy. All statistical analysis were performed by using the SPSS-PC + package. The data were expressed as mean values + standard deviation and P-value of < 0.05 was considered to be statistically significant.

Results. The demographic and anesthetic variables are shown in Table 1 for all patients. Patients with a venous patch sewn into the carotid artery had statistically longer duration of cross clamp times (Table 1). Most patients had a history of hypertension 53%, diabetes mellitus 68%, previous stroke or transient ischemic attack in all cases and a previous myocardial infarction (31.5%). None of these patients had previous carotid endarterectomy. Patients who refused the study and who missed the follow up were excluded. Neurobehavioral assessment was carried out by comparing each mean score for each item (27 items) before and after operation. Mann-Whitney rank test was used because the data was not equally distributed. Some items of the scale showed no difference before and after operation eg., guilt feeling, suspeciousness and excitement 80, Z = O. No significant difference was found before and 6 months after operation. Reduction in the mean value of global score of the Neurobehavioral Rating Scale was noticed (mean values were 32.7 [6.6] and 30.7 [4.6] before and after carotid endarterectomy respectively). This meant that, there was a non-significant improvement in neurobehavioral aspects of patients following carotid endarterectomy (Table 2).

Discussion. Some authors mentioned that, cartotid endarterectomy patients showed significant improvement as regards to cognition, psychologic and neurologic functions after operation.[8-14] Other authors, on the, contrary, mentioned neuropsychological impairment after carotid endarterectomy.[15-17] A third group of authors found that no significant changes in neuropsychological aspects following carcinoembryonic antigen.[18,19] In the present study we found no significant changes in the neurobehavioral symptoms following carotid endarterectomy, the same like the third group of authors. The 2nd group of authors mentioned neurologic and psychologic changes following carotid endarterectomy in the form of increased lethargy, headache, paraneoid ideation and depression especially in patients with carotid occlusions (>70%). The authors explain these symptoms by the phenomenon of reperfusion.[20] Cerebral reperfusion injury of ischemic cerebral tissue causes further injury by; (1) increasing the size of infarcted tissue; (2) increase cerebral edema;[21] and (3) converting an anemic infarct to lethal hemorrhagic infarct.[22] Two unique microarculatory phenomena have been described in the early phase of cerebral reperfusion injury. First, ischemic regions may remain ischemic as a result of the "no reflow phenomenon". Continued ischemia during reperfusion ("no reflow") is a result of impeded blood flow at the microarculatory level. Bleep formation,[23] hemoconcentration,[24] and perivascular glad cell swelling[25] have all been implicated as a contributing factors. Second, the failure of microcirculatory autoregulation and concomitant vasodilatation during reperfusion can lead to a "reactive hyperemia". This phenomenon is thought to be the result of lactic acidosis and capillary endothelial lining damage. The hyperemia that accompanies an increased pressure head when the occlusive lesion is removed may contribute to expansion and rupture of capillaries in regions of microcirculatory changes.[26] As regards to the authors who mentioned significant improvements following carotid endarterectomy, this can be explained on the following basis: (1) the improvement is highly dendent on social relations, suggest that postoperative changes in lifestyle; (2) better control of risk factors postoperatively, as a result of careful ambulatory care might have contributed to neurobehavioral symptoms;[27] (3) there are no clear guidelines for judging what is a significant improvement in performance because

such improvement may in part reflect "practice effect". Even in on elderly surgical population, patients significantly improved their performance with repeated psychometric assessment.[28] Bornstein et al[29] compared the performance of patients having carcinoembryonic antigen to two control groups: One a surgical population in which surgery did not involve the brain or cerebral vasculature, and the other a non-operative population with cerebrovascular symptoms. Performance on their neuropsychometric battery was significantly improved in patients having carcinoembryonic antigen on the right carotid artery who had a stroke compared with all other groups.[30] In addition to these effects, patients had increased cerebral blood flow (CBF) in the ipsilateral middle cerebral artery post-operatively, and increased cerebral area perfused. These increases may lead to improved neurobehavioral performance. In general, improvement occurred in those patients who had low flow endangered brains. This may explain why patients having carcinoembryonic antigen with low pre-operative CBF had greater improvement in a battery of neuropsychometric tests than a control group also having carcinoembryonic antigen for carotid artery stenosis but with hemodynamically in significant lesions.[31] Owens et al, demonstrated that if patients with greater than 50% stenosis and normal CT scans and computerized radionucleotide angiograms before and after carcinoembryonic antigen, they showed cognitive improvement, measure by a battery of neuropsychometric tests in the immediate post-operative period (3-10 days) but deteriorated in their cognitive performance if these tests demonstrated evidence of small infarcts or if there was clinical evidence of a stroke. Only those with small infarcts improved at later follow-up testing (3-6 months).[18,32] In 1997, Iddon et al, studied 30 inpatients with symptomatic carotid artery disease admitted for carcinoembryonic antigen were assessed with a comprehensive battery of neuropsychological tests administered immediately before and after (48-72h) surgery. No significant difference was found in the cognitive scores post-operatively as compared with the patients' pre-operative scores.[33] The present study is relatively similar to the previously mentioned study with regards to the presence of no significant difference in neurobehavioral symptoms before and after carcinoembryonic antigen. In view of the modernization and change of life and dietary pattern in the Middle East area during the last 2-3 decades, there is no reason why such serious carotid diseases should not be equally common.[34,35] The awareness of the potential beneficial role and hazards of carcinoembryonic antigen is not proportionate to the magnitude of this problem in our Middle East countries, not only among patients but also among medical disciplines. Actually this is one of the aims of this study which is increasing the awareness of medical professionals especially Psychiatrists, Neurologists, Cardiologists and Physicians in general about the safety of carcinoembryonic antigen as a life saving operation in severe (>70%) carotid stenosis especially if it is associated with stroke or transient ischemic attack.

In conclusion, uncomplicated carcinoembryonic antigen is not associated with neurobehavioral impairment.

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