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Neuropsychological Functions After Carotid Endarterectomy

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Summary. Psychological testing was performed on 23 patients (mean age 60.7 years) with unilateral or bilateral stenoses of the carotid arteries prior to and 10 months after carotid endarterectomy. Intellectual functions were slightly improved, mnemic functions impaired, psychomotor functions and dimension of personality remained unchanged. Carotid endarterectomy, although improving neuropsychological functions in a few cases, on average does not cause a significant improvement. This underscores the preventive character of the surgical intervention.

Key words: Carotid endarterectomy - Neuropsychological changes

Zusammenfassung. Wir führten bei 23 Patienten mit uni- oder bilateralen hämodynamisch relevanten Carotisstenosen vor und zehn Monate nach einer Endarterektomie testpsychologische Untersuchungen durch. Präoperativ hatten die meisten Patienten TIA (15), fünf hatten einen leichten Schlaganfall erlitten, drei waren asymptomatisch. Die Nachuntersuchung zeigte leicht verbesserte intellektuelle Funktionen, während die mnestischen Funktionen eher schlechter waren als vor der Operation. Die psychomotorischen Funktionen zeigten – ebenso wie die persönlichkeitsbezogenen Tests – keine wesentlichen Unterschiede. Die prophylaktische Wirkung der Endarterektomie zur Vorbeugung von Schlaganfällen ist unumstritten; eine wesentliche Verbesserung der neuropsychologischen Veränderung ist aber in der Regel nicht zu erwarten.

Schlüsselwörter: Endarterektomie - Carotisstenose - Neuropsychologische Veränderungen

Introduction

Carotid endarterectomy is now well established in the prevention of stroke after transient ischemic attacks (TIA). The effect of this procedure on global brain function as assessed by neuropsychological tests is still controversial. While some investigators found no difference prior to and after carotid endarterectomy (Williams and McGee 1964; Goldstein et al. 1970; Horne and Royle 1974; Grobe et al. 1979), others described significant improvements of intellectual and mnemic brain functions (Perry et al. 1975; Haynes et al. 1976; Kelly et al. 1980; Bornstein et al. 1981; Hemmingsen et al. 1982; Jacobs et al. 1983). The purpose of the present study was to evaluate intellectual functions in patients who had undergone a carotid endarterectomy. Our hypothesis was that patients suffering from a bilateral stenosis of the carotid artery or a combination of an occlusion on one side and a stenosis of hemodynamic significance on the other should improve after surgery. Patients were selected for this study provided there was evidence of impaired neuropsychological functions prior to endarterectomy (Hamster and Diener 1984).

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Methods and Material

The original group included 33 patients (Hamster and Diener 1984). Neuropsychological retests after 10 months were possible on only 23 of these patients; 2 patients died in the time interval between surgery and retesting—1 suffered from a severe stroke (contralateral to the operated carotid artery), 4 patients refused surgery, and 3 patients refused to be tested again. The remaining group of patients (21 men, 2 women) included 15 patients suffering from TIA, 5 suffering from minor strokes, and 3 asymptomatic patients. The mean age was 60.7 $\pm$6.7 years. Of the 23 patients, 11 had a unilateral stenosis of the internal carotid artery (exceeding 50%), 12 had a bilateral stenosis or an occlusion combined with a stenosis, and only 1 patient suffered from a transient neurological deficit due to intraoperative ischemia. Neurological and neuropsychological examinations were performed 1 week prior to and 9-10 months after carotid endarterectomy. None of the patients showed neurological changes on the second examination. Carotid endarterectomy was performed under general anesthesia without shunting in unilateral stenoses and with an intraluminal shunt in cases of bilateral stenosis.

Psychometric Methods

The details of neuropsychological testings are described in the preceding paper (Hamster and Diener 1984). We investigated the intellectual functions by means of the culture fair intelligence test and the digit symbol test. Mnestic functions were evaluated using the visual retention test. Attention was tested by the attention set test, the revision test and the attention stress test. Additionally we performed psychomotor tests (Vienna reaction timer) and evaluated the dimensions of personality with the FPI (Freiburg Personality Inventory). The subjective symptoms and complaints of the patients were evaluated using two self-rating scales (CIPs scales, BL-BL'). For the statistical analysis we used parametric test for homogeneous and inhomogeneous variance, a one way analysis of variance (ANOVA) and paired t-tests. The level of significance was set to $p=0.05$.

Table 1. Mean values (M) and standard deviation (SD) of psychometric tests in patients with unilateral carotid artery disease ($n=11$). Comparison of pre- and postoperative values (paired t-test)

			Unilateral stenoses		
			Preoperative (M_1)	Postoperative (M_2)	$2p$
Intellectual function[a]					
Culture fair intelligence test	(CFT-2)	IQ	97.1 (9.8)	110.6 (14.7)	0.05
Digital symbol test	(DS)	IQ	102.2 (14.3)	98.2 (19.8)	NS
Mnemic function					
Visual retention test	(VRT)				
Right reproductions		RP	5.7 (2.0)	4.1 (2.0)	0.05
Total errors		RP	6.9 (3.1)	9.0 (4.0)	0.05
Attention stress[b]					
Attention set test	(AET)	SW	97.1 (13.2)	101.0 (17.0)	NS
Revision test	(Rev.T.)	SW	95.1 (10.4)	94.9 (11.8)	NS
Attention stress test	(Test d2)	SW	96.4 (5.9)	98.2 (6.3)	NS
Psychomotor function[b]					
Vienna reaction timer					
Visual reaction time		SW	89.1 (12.4)	87.1 (11.4)	NS
Auditory reaction time		SW	93.4 (12.4)	92.2 (9.6)	NS
Choice reaction time		SW	86.3 (16.9)	82.9 (14.9)	NS
Dimensions of personality[c]					
FPI (Freiburg personal inventory)					
Scale 1-9					NS
Scale E, N, M					NS
BL-BL' (List of complaints)		St	7.8 (1.6)	8.0 (1.1)	NS

Standard values: [a] IQ M=100 SD=15; [b] SW M=100 SD=10; [c] St M=5 SD=1
RP=Raw points

Table 2. Mean values (M) of psychometric tests in patients with bilateral carotid artery disease ($n=12$). Comparison of pre- and postoperative values (paired t-test)

		Bilateral stenoses		
		Preoperative (M_1)	Postoperative (M_2)	$2p$
Intellectual function				
CFT-2	IQ	92.2 (14.1)	105.6 (12.6)	0.05
DS	IQ	100.7 (17.0)	103.6 (14.1)	NS
Mnemic function				
VRT correct reproductions	RP	5.4 (1.7)	4.5 (1.8)	NS
VRT total errors	RP	6.8 (3.4)	8.0 (3.3)	NS
Attention stress				
AET	SW	101.0 (13.3)	100.0 (11.3)	NS
Rev.T.	SW	97.5 (11.3)	96.0 (10.3)	NS
Test d2	SW	89.9 (9.4)	94.8 (6.8)	0.05
Psychomotor function				
Vienna reaction timer				
Visual reaction time	SW	91.3 (11.2)	84.1 (9.7)	NS
Auditory reaction time	SW	93.3 (11.5)	90.6 (10.0)	NS
Choice reaction time	SW	88.5 (10.6)	90.3 (11.5)	NS
Dimensions of personality				
FPI				
Scale 1-9				NS
Scale E, N, M				NS
BL-BL'		7.0 (1.5)	7.0 (1.5)	NS

Table 3. Comparison of mean values and standard deviation (SD) of psychometric tests in patients with unilateral ($n=11$) and bilateral carotid artery diseases ($n=12$)

		Postoperative		
		Unilateral	Bilateral	2 p
Intellectual function				
CFT-2	IQ	111.4 (13.6)	105.8 (11.4)	NS
DS	IQ	97.8 (21.2)	103.6 (13.9)	NS
Mnemic function				
VRT correct reproductions	RQ	4.5 (2.3)	4.9 (1.7)	NS
VRT total errors	RP	9.1 (4.0)	8.0 (3.3)	NS
Attention stress				
AET	SW	98.8 (17.1)	97.3 (12.7)	NS
Rev. T.	SW	94.3 (12.4)	96.1 (10.1)	NS
Test d2	SW	97.9 (6.0)	94.8 (6.8)	NS
Psychomotor function				
Vienna reaction timer				
Visual reaction time	SW	87.7 (11.1)	84.2 (11.6)	NS
Auditory reaction time	SW	92.4 (9.6)	90.6 (11.7)	NS
Choice reaction time	SW	96.1 (11.5)	90.0 (12.1)	NS
Dimensions of personality				
FPI				
Scale 1, 2, 4, 5, 6, 7, 8, 9				NS
Scale E, N, M				NS
Scale 3 ("depressiveness")	St	4.3 (2.3)	6.6 (1.5)	0.05
BL-BL′	St	5.3 (2.5)	6.8 (1.4)	NS

Results

A. *Patients with Unilateral Stenosis or Occlusion*

Intellectual functions as determined by the culture fair intelligence test were significantly improved after carotid endarterectomy (Table 1). The mnemic functions, however, were impaired, considering the number of correct reproductions and total errors in the visual retention test. Psychomotor functions and concentration were unaltered. The dimensions of personality tested and the list of complaints showed no difference prior to and after carotid endarterectomy.

B. *Bilateral Carotid Disease*

Similar results were obtained in the group of patients with bilateral stenoses (Table 2). These patients showed a significant improvement of their testable intelligence and again an impairment of mnemic functions. The test d2 revealed a significant improvement in the power of concentration whereas the psychomotor functions and the tested dimensions of personality were unchanged.

Patients perceived themselves as being more self-conscious and more anxious after operation and reported a greater number of subjective complaints. The comparison of patients with unilateral and bilateral carotid disease after surgery did not with one exception reveal significant differences. The exception was that patients with a bilateral stenosis were significantly more depressed (Table 3).

Discussion

An improvement of intellectual functions has also been noted by others (Perry et al. 1975; Haynes et al. 1976; Kelly et al. 1980), and consideration should be given as to whether this is solely due to practice although parallel tests were used, or whether this reflects partial recovery. Haynes et al. (1976) examined 17 patients with carotid stenoses prior to and 6 weeks after carotid endarterectomy compared to a control group of 9 patients who were admitted to the hospital for a major surgical procedure which was not neurological in nature. Only the patients with endarterectomy showed an increase in verbal comprehension and perceptual organization IQ, so the results argue against practice as the sole cause. Contrary to other studies (Kelly et al. 1980; Hemmingsen et al. 1982), we did not find an improvement in memory and attention, but rather an increased frequency of errors in the visual retention test (mnemic function). This difference could perhaps be attributed to a much higher proportion of patients with minor strokes in the studies mentioned above with spontaneous improvement of neuropsychological functions along the course of recovery. Bornstein et al. (1981) observed that stroke patients undergoing endarterectomy improved in a significantly higher percentage than patients operated on because of TIA. But Hemmingsen et al. (1982) reported a significantly greater improvement for the TIA group ($n=14$) in the visual gestalt, block design, and story recall tests compared to the stroke patients ($n=14$).

Jacobs et al. (1983) observed significantly greater postoperative improvements in memory and mental abilities in patients with multiple occlusive neck vessel lesions compared to those who underwent endarterectomy for hemodynamically insignificant lesions. We, in contrast, found no differences when comparing patients with unilateral or bilateral hemodynamically significant stenoses of the carotid arteries not only prior to, but also 10 months after surgery.

According to our findings endarterectomy for the purpose of improving neuropsychological disturbances cannot be recommended at the present controversial state of knowledge.

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