

Carotid Endarterectomy

Review of 276 Cases in a Community Hospital

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Two hundred seventy-six carotid endarterectomies performed on 232 patients in a community hospital were reviewed. All the surgery was performed in a routine manner utilizing systemic heparinization and an indwelling shunt. There were three deaths in this series, giving a mortality of 1.08%. A transient neurological deficit occurred in seven patients. All of these cleared within a 7-day period; this represents 2.5%. Only one patient had a permanent deficit. Long-term follow-up from 6 months to 9 years showed that the majority of deaths occurred from myocardial disease and malignancies. Only eight patients later died from stroke.

SINCE THE FIRST CAROTID RECONSTRUCTION by Carrea et al. in 1951² and the first carotid endarterectomy by DeBakey et al. in 1953³ and the popularization of the operation by Eastcott and coworkers as it is most commonly performed today,⁵ carotid surgery has become a rather standard procedure.¹¹ Reviews of carotid surgery have been published from medical school vascular services^{6,10,12} and from metropolitan hospitals, but very little has been written of the results from private practice surgery in a community hospital. Many of the latter hospitals have the capability to do excellent arteriography, and with the advent of vascular fellowships, there are well-trained vascular surgeons in communities of less than 100,000 population.

This paper reviews the authors' experiences with 276 carotid endarterectomies in a community hospital, with discussions of the indications of the need for surgery, the results of surgery and the complications, morbidity and mortality of surgery. Although it has not been proven that carotid surgery significantly prolongs survival, certainly it is well accepted that the quality of survival can be markedly improved by prevention of the much dreaded stroke. Research shows that we are

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not only preventing strokes but also improving the patients' well-being by establishing better blood flow to the brain.⁸ This improvement occurs in a significant percentage of patients who have greater than 50% stenosis of the internal carotid artery. A small number of patients are also prevented from having significant alteration in their vision.

Materials and Operative Procedure

During the past nine years, 1969–1978, a total of 276 carotid endarterectomies were performed on 232 patients. Forty-four patients had bilateral carotid surgery. In all of the bilateral cases, the second surgery was delayed at least ten days after the first; in ten of these patients, the second side endarterectomy was done more than four months later.

All the operative cases were classified in four categories: 1) transient ischemic attacks—classic, 2) completed strokes with permanent neurological deficit, 3) chronic cerebral dysfunction which includes dizziness, near syncope, memory loss and personality changes, and 4) asymptomatic, to be done when other major surgery is planned. Table 1 records the distribution of patients within each category.

Arteriograms were performed in all patients prior to operation. These were performed with the patient under local anesthesia using the Seldinger technique, except in the early years 1969–1972, when a direct stick of the left side and axillary stick of the right side were used. All patients during the past four years, 1975–1978, have had complete intracranial studies, and some few have had a brain scan if there was any question about intracranial pathology. Over 3000 arteriogram studies have been performed without a

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TABLE 1. Symptoms

Group I: Transient ischemic attack—classic; paralysis cleared less than 48 hours		
Right side	56	
Left side	53	
Vision	41	
	Total	150
Group II: Completed stroke; permanent paralysis		
Right side	1	
Left side	0	
	Total	1
Group III: Chronic cerebral dysfunction including		
Dizziness		
Near syncope		
Memory loss		
Personality changes		
	Total	111
Group IV: Asymptomatic; other major surgery planned		
	Total	14
	Total endarterectomies	276

death or permanent neurological deficit. Two patients had transient weakness of an extremity which cleared, and ten patients had vagal reflexes during the procedure. Renografin-60® has been the dye of choice.

Operative procedures were performed with the patient under general anesthesia. Good oxygenation and blood pressure were maintained during the procedure. From 3000 to 5000 units of heparin were given intravenously 3 minutes prior to clamping the artery. All patients were temporarily shunted with a simple, sized Argyle® shunt with a suture tied in the middle for easy removal. In doing the arteriotomy, care was taken to ensure that the artery was opened above the stenotic area in order to decrease the probability of knocking off debris into the cerebral circulation. Backflow was allowed during insertion of the shunt; and on removing the shunt, a clamp was put across the internal carotid to flush the debris, if present, into the external carotid artery. All arteriotomies were closed with a 5-0 Dacron® or Prolene® suture. The average total operating time was 55 minutes. The shunt was in place for an average of 8 minutes, 20 seconds; the longest time was 42 minutes, and the shortest time was 5 minutes. The total operating time on the artery, including the insertion and removal of the shunt, averaged 10 minutes and 20 seconds.

There were three deaths within 30 days after endarterectomy.

Patient Analysis

The 232 patients who underwent the 276 carotid operations included 125 males and 107 females. The age distribution is shown in Table 2. It is interesting to note that although there were 17 patients over 80 years old, the three deaths occurred in patients under 70 years of

TABLE 2. Physical Findings of 232 Patients

Age (per case)	
40-49	6
50-59	43
60-69	115
70-79	95
80-93	17
Males	125
Females	107
Blood Pressure (per case)	
Greater than 140/90	131
Less than 140/90	145
Bruit (per case)	
Neither side	62
Single side	84
Both sides	130

age (Table 2). Blood pressure on admission to the hospital was greater than 140/90 in 131 patients and less than 140/90 in 145 patients. Physical examination revealed bruits on both sides in 130 patients and on one side in 84 patients; no bruits were present in 62 of the operative patients.

Arteriogram Findings

The arteriogram findings in the 232 patients revealed that 113 patients had some degree of bilateral obstruction. In 87 of these patients, the arteriograms revealed bilateral internal carotid stenosis or ulceration greater than 50% in each side. In one other patient, the internal carotid stenosis or ulceration was greater than 50% in one side and less than 50% in the other. Each of the remaining 24 patients with bilateral obstruction had one carotid vessel 100% occluded and the other more than 50% occluded. It is worth noting that these 24 patients tolerated the procedure rather well despite such extensive obstruction. One hundred nineteen patients had single vessel involvement. The arteriogram findings are summarized in Table 3.

Results of Surgery

During the early postoperative period 16 patients had hematomas of the wound. Four patients had to be

TABLE 3. Arteriographic Findings of the 232 Patients

Patients with bilateral internal carotid stenosis or ulceration		
both vessels greater than 50%	88	
one greater than 50%; one less than 50%	1	
Patients with one vessel completely occluded; the other		
greater than 50%	24	
less than 50%	0	
Patients with single vessel involvement		
right, greater than 50%	60	
right, less than 50%	3	
left, greater than 50%	55	
left, less than 50%	1	
	Total	232

TABLE 4. *Complications*

Hematoma of wound		16
Required evacuation	8	
Infection		1
Laryngeal edema		3
Required tracheostomy	2	
Hoarseness		3
Transient stroke		7
Permanent stroke		4
Death from stroke	3	
Bleeding		14
Significant skin bleeding	10	
Suture line requiring reoperation	4	

taken back to the operating room because of suture line bleeding. There were ten patients that had significant skin bleeding, but only six of these required suturing; in the remainder bleeding stopped after the heparin was reversed with protamine. It is interesting that one patient who bled three times from his suture line six days to six weeks postoperatively was diagnosed definitively as having leukemia some nine months later; his blood picture was abnormal during his first hospitalization. Only one infection occurred. In three patients there was laryngeal edema; two required a tracheostomy. In neither of these patients was there vocal cord paralysis. Hoarseness occurred in three patients; one of these had a paralyzed vocal cord, evidently from injury to the vagus nerve and probably caused by pressure from the retractor. Seven transient strokes, which cleared prior to the patients' leaving the hospital, and one permanent paralysis occurred. There were three deaths following surgery; all were related to the cerebrovascular system. No patient was lost as a result of myocardial disease, and there were no proven myocardial infarctions either during or after operation. Two deaths occurred due to our misinterpretation of symptoms as transient cerebral ischemia, when in fact the patient had infarction in the brain and an ischemic infarct was converted to a hemorrhagic one. The other death was due to basilar artery thrombosis. The symptoms of basilar arteriosclerosis were identified prior to the operation, but the patient had such significant carotid disease that an attempt was made to increase the total blood flow to the brain. Autopsy confirmed the basilar artery thrombosis. The complications following surgery are summarized in Table 4.

Cognitive and Personality Improvement After Carotid Endarterectomy

The results from a previous study of 18 patients in this group support the conclusions that carotid endarterectomy not only serves as a prophylactic measure against cerebrovascular accidents but also serves to improve the quality of life through better cognitive

functioning. Carotid endarterectomy patients showed remarkable increases in perceptual I.Q.; verbal I.Q. showed fewer but still significant changes. It appears that about 50–60% of patients improve mentally after carotid surgery, and a small percentage show extreme improvement. Very few patients have a deterioration of mental function.

Discussion

There is general agreement that symptomatic patients who have arteriographic findings of greater than 50% involvement or who have an ulcerated plaque should be considered for carotid endarterectomy. These criteria were met in all cases reported in this study. Only 14 among the 232 patients were considered asymptomatic. Twenty-four patients in this series had one carotid artery completely occluded, and it should be noted that not a single patient with occlusion on one side was operated on for a stenosis of less than 50% or an ulcerated plaque on the other side.

Only 44 patients in this series had bilateral carotid endarterectomies. In the other 44 bilaterally affected but non-occluded patients, the symptoms cleared when the indicated or worse side was operated on. These patients have been followed for symptoms referable to the second side. Table 5 records the long-term follow-up on all patients.

As noted above, there were three deaths in this series of 276 carotid endarterectomies performed on 232 patients—two caused by converting ischemic into hemorrhagic infarcts and one caused by basilar artery thrombosis. In addition, there were seven transient neurological deficits, and one patient with permanent hemiparesis. Three deaths in 276 operations give an operative mortality of 1.08%. This operative mortality rate and the stroke morbidity rate of 0.36% are well within reasonable limits when compared to results reported by Thompson,¹¹ Nunn,⁹ DeWeese, et al.,⁴ Fields et al.⁷ and Blaisdell et al.¹

The low operative mortality of this entire series can well be explained by our belief that patients who have a permanent neurological deficit from completed stroke rarely can be helped by carotid surgery. This assumption is reinforced by the high operative mortality (some 40%) reported from centers where patients with permanent deficits have had carotid surgery.

TABLE 5. *Long-term Follow-up (55 Deaths)*

Heart disease	32
Stroke	8
Malignancies	11
Other	4
	—
Total	55

With careful preoperative evaluation, competent and experienced anesthesia personnel and trained vascular surgeons, carotid surgery can be done very safely and with apparent benefit to the patient in the community hospital. The operative mortality and morbidity for carotid surgery need be no greater than for many routine surgical procedures today. Many patients will not receive the benefit of vascular surgery if the community hospital is not interested in providing this care.

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DISCUSSION

DR. WILLIAM HAWKINS EDWARDS (Nashville, Tennessee): I agree with Dr. Haynes in his approach to the patient with extracranial cerebral occlusive disease, and I'm certainly delighted with his results, as I'm sure he is.

I think this paper points up the fact that a well-trained surgeon who has vascular training during his residency training program can perform this type of surgery in any setting, be it a community hospital or a university center. Our residents, after spending several months with us on our vascular service, sometimes like to refer to carotid surgery as the hernia of vascular surgery. I point out to them that as all of us mature as surgeons, we realize that hernias can be very complicated and require exacting technique, and as they see more carotid endarterectomies, I try to impress on them the importance of meticulous technique in this operation, because I think that, of all the vascular procedures that we perform, there is no question but what technique is of prime importance in this operation.

Dr. Haynes alludes to arteriography in his manuscript. I might just make a comment, in that in our institution we continue to perform arteriograms. We have competent radiologists. However, it is my impression that the complications with the Seldinger technique in arch aortography are higher than those of percutaneous retrograde brachial and percutaneous carotid arteriography. We obtain excellent diagnostic films. Consequently, we continue to perform our arteriograms.

(slide) We have recently reviewed our experience in carotid endarterectomy; 350 operations with three deaths, with transient neurological deficit in four patients, a permanent neurological deficit in two patients. There is an occasional case that we have encountered in which there has been complete occlusion of the internal carotid artery on the symptomatic side, in which we have found stenosis of the external carotid and filling of the carotid siphon by collaterals and the ophthalmic. I would ask Dr. Haynes if he has encountered this in his series. We have found that external carotid endarterectomy can relieve symptoms in these cases.

There is the occasional patient that presents a technical problem to us at the time of endarterectomy; this is the patient with tortuosity of the vessel, as well as marked occlusive disease, and evidence of an ulcerated plaque. I have never felt that tortuosity *per se* produced symptoms in patients with extracranial cerebrovascular disease. The combination, however, creates a problem on insertion of an internal shunt and following endarterectomy leaves a vessel with a tendency to kink. In such a situation a resection of the proximal portion of the diseased vessel, with a reanastomosis of the stump of the internal carotid into the carotid, obviates the problem that is created once an endarterectomy is done.

Dr. Haynes in his list of complications listed a rather high incidence of hematoma. I would suggest to him that maybe the use of surgical clips might help this.

Finally, in patients with bilateral disease, we have generally taken the course of recommending operation in those that are symptomatic, recommending operation in those contralateral lesions that are stenotic, but have not generally recommended operation for ulcerative plaques in an asymptomatic patient. We have, however, had patients develop strokes before they were back for follow-up. I notice Dr. Haynes reports eight strokes in his follow-up period. I wonder if any of these had lesions demonstrated on x-ray.

DR. DON G. HUNT (Dallas, Texas): The thing that I would like to address myself to this morning briefly is the rather perplexing problem of the totally occluded internal carotid artery. In our vascular service in Dallas in the last four years we have operated on 15 such patients, and have been successful in opening up 11 out of the 15. Of course, I'm talking about opening up the internal carotid artery itself, not the external carotid.

We have had one surgical mortality, and one permanent neurological deficit. We have operated upon no patients who have had profound strokes. We feel that an aggressive approach should be taken toward this problem, and I would like to ask Dr. Haynes if in any of the 24 patients he operated on with total occlusion, did he actually attack the internal carotid itself?