University of Nebraska Medical Center
BREAKTHROUGHS FOR LIFE

University of Nebraska Medical Center
DigitalCommons@UNMC

MD Theses

Special Collections

1969

Late results of surgical treatment for extracranial carotid artery insufficiency and a report of 31 cases treated surgically at the VA Hospital, Omaha

Judith A. Pester
University of Nebraska Medical Center

This manuscript is historical in nature and may not reflect current medical research and practice. Search PubMed for current research.

Follow this and additional works at: https://digitalcommons.unmc.edu/mdtheses

 Part of the Medical Education Commons

Recommended Citation

Pester, Judith A., "Late results of surgical treatment for extracranial carotid artery insufficiency and a report of 31 cases treated surgically at the VA Hospital, Omaha" (1969). *MD Theses*. 118.
https://digitalcommons.unmc.edu/mdtheses/118

This Thesis is brought to you for free and open access by the Special Collections at DigitalCommons@UNMC. It has been accepted for inclusion in MD Theses by an authorized administrator of DigitalCommons@UNMC. For more information, please contact digitalcommons@unmc.edu.

LATE RESULTS OF SURGICAL TREATMENT FOR EXTRACRANIAL CAROTID ARTERY INSUFFICIENCY
and
A Report of Thirty-one Cases
Treated Surgically at the
Veteran's Administration Hospital
Omaha, Nebraska from 1959 to 1961

A Thesis
Presented to the Faculty of
the College of Medicine of the University of Nebraska
in Partial Fulfilment of Requirements
for the Degree of Doctor of Medicine

by

Judith A. Pester

under the supervision of Dr. Stephen Dutch

February 3, 1969

TABLE OF CONTENTS

INTRODUCTION 1

HISTORICAL INTRODUCTION 3

MATERIALS AND METHODS 5

RESULTS 8

DISCUSSION 19

CONCLUSION 32

BIBLIOGRAPHY 37

L355i

INTRODUCTION

Clinical recognition of cerebrovascular insufficiency resulting from extracranial arterial occlusive disease has been known for many years, but surgical treatment has been applied only within the past decade. The purpose of this paper is to present a retrospective study performed at the Veteran's Administration Hospital Omaha, Nebraska of the surgical treatment of cerebrovascular insufficiency. Included in this paper will be a discussion from a review of the literature of the surgical results of carotid endarterectomy according to the neurologic status of the patient.

This followup study was concerned with an analysis of the non-surgical and surgical treatment of forty-four patients with manifestations of cerebrovascular insufficiency. This deficiency can be due to a stenosis or occlusion of a major extracranial artery or arteries. In this particular presentation the vessel under consideration was the carotid artery system in the cervical region. The most common area involved was a segmental occlusion of the internal carotid artery.

This study was the first undertaken at the Veteran's Hospital and can be considered as a pilot study in the particular treatment of this disease from which further and more complete studies have evolved. Surgical treatment

consisted of carotid endarterectomy. Dates of such treatment ranged from April, 1959 to February, 1961.

HISTORICAL INTRODUCTION

Spontaneous occlusion of the cervical carotid arteries has been known for more than a century. William Savory [33] first reported a case of a young woman with indistinct vision of the left eye and weakness of the right side of the body. Autopsy revealed thickened intima of the carotid arteries and "irregular patches of an opaque yellowish deposit." Following this observation several articles were reported in the world of similiar symptoms. Williamson [41] presented twelve cases of hemiplegia and embolism of the central retinal artery with thrombus in the internal carotid artery. Cadwallader [4] in 1912 described two cases with sudden loss of vision and contralateral hemiplegia.

In 1914 J. Ramsey Hunt [20] recognized the syndrome of internal carotid arterial occlusion, i.e. hemiplegia, aphasia, convulsions and possible eye destruction on the side of the affected artery. He emphasized "the importance of obstructive lesions of the main arteries of the neck ... in the causation of softening of the brain" and urged "the routine examination of these vessels in all cases presenting cerebral symptoms of vascular origin."

Hunt's recognition of carotid obstruction due to atheroma was finally appreciated when in 1937 Moniz [24] reported instances of thrombosis as shown by arteriography.

Progress in angiography was delayed for a number of years and only the last ten years has seen an increase in the diagnosis and treatment of carotid insufficiency.

Various operations have been performed in the treatment of this disease. Early operations include cervical sympathectomy and arterectomy. In 1953 Strully [36] et al performed a thromboendarterectomy with poor surgical results. However, prior to this Japanese surgeons [34] had reported a case involving a thrombectomy with poor results and no clinical improvement of the patient. Following these operations DeBakey [6] soon reported his experience with endarterectomies.

Most cases of cerebrovascular insufficiency resulting from extracranial arterial occlusion are due to atherosclerosis in the race for which a high cholesterol and fat intake are recorded. The remainder of carotid occlusions are caused by a non-specific arteritis.

The majority of thromboses of the internal carotid artery occur in the sixth and seventh decades. This condition is approximately as common in men as in women. Pathologic evidence as shown by Hultqvist showed occlusion in no less than ninety-one of three thousand five hundred autopsies [35]. Fisher [12] notes in two hundred routine autopsies severe occlusive disease at the origin of the internal carotid artery with norman distal cervical internal carotid arteries and cerebral arteries.

MATERIALS AND METHODS

The study consisted of thirty-two carotid artery operations performed on thirty-one patients during a two year period beginning April, 1959. All patients had unilateral occluding lesions of the cervical portion of the carotid artery system except for one patient in the surgical series who had bilateral lesions of the carotid arteries. In the surgical group of thirty-one patients there were reported two cases of spontaneous dissecting aneurysms which were observed at the time of surgery. All patients were men. The ages ranged from fifty-two to seventy-eight years of age.

Segmental occlusion of the internal carotid artery in the neck has been identified as a common cause of "little strokes." Patients affected demonstrate transient aphasia if the dominant hemisphere is involved, hemiplegia or unilateral weakness on the side opposite the occluded artery, and loss or a decrease in vision on the same side as the affected artery. In this study forty-four patients who had suffered a "little stroke" were compared as to their similarities, differences and results. The group of patients was divided into three categories: (1) those who were treated surgically and circulation was established; (2) those who were treated surgically and circulation was not established; (3) those who were untreated.

Some of the patients had pre- and postoperative electroencephalograms. However, not all patients received both pre- and postoperative electroencephalograms and conclusions can not be made. Arteriographic studies were performed on most of the patients.

All patients had carotid endarterectomy performed. The operation was performed on thirty-two carotid arteries. Retrograde internal carotid blood flow was noted in twenty-one cases. Under local anesthesia of 1% Novocaine and one-half cc. of Adrenalin, the patient was placed in a supine position and the affected side of the neck surgically prepared. The common carotid artery was exposed through an incision approximately eight centimeters in length and extending from the posterior border of the sternocleidomastoid muscle to the thyroid cartilage. An arterial clamp was placed across the common carotid artery. If the patient's clinical condition did not change after application of the clamp and active pulsations were palpable in the internal carotid distal to the arterial clamp, the external carotid, internal carotid and superior thyroid arteries were then clamped. The plaque in the artery was removed through a one and one-half centimeter vertical incision in the bifurcation of the common carotid. In some cases the intima was tacked to the arterial wall. To prevent clotting the lumen of the artery was filled and flushed with a solution of heparin. The arteriotomy incision was closed with a running

suture of silk. Check for retrograde blood flow from the internal carotid artery was done and if present in an adequate amount, the isolated segment was again filled with a solution of heparin and the clamps removed. In most cases a #10 or #12 French catheter was left in the wound as a drain.

RESULTS

There were forty-four patients in this study: twenty patients in Group 1, eleven in Group 2 and thirteen in Group 3. All patients studied were men. Fifty-seven percent of these patients had a stroke on the right side and forty-three percent had their stroke on the left side. In all three series at least eighty percent of the patients were in the sixty or seventy age range. The dates of the onset of the strokes ranged from April, 1956 to January, 1961. Dates of operation for these patients were from April, 1959 to February, 1961. In the group who was not treated the onset of strokes varied from April, 1958 to September, 1963.

The average followup time was a period of two to three years. Followup studies from 1961 to determine the current status in the following years were accomplished in seventeen of the thirty-one surgical patients and in five of the thirteen untreated patients. There were twenty-six patients (59%) living in 1966 with an average age of sixty-nine years and an age range of forty-one to seventy-nine years of age. Of those living twelve patients (46%) were in Group 1, six patients (23%) were in Group 2 and eight patients (31%) were included in Group 3.

There were thirty-two carotid artery operations.

Thirty operations were performed for unilateral occlusion while the other two operations were performed for bilateral carotid artery occlusion.

Group 1 - Treated series with circulation established.

Twenty patients in this group with signs and symptoms of complete or progressive stroke were submitted to surgery. All had complete occlusive lesions of the carotid arteries. There were twenty-one operations. Blood flow was reestablished in every case. The patient with bilateral carotid occlusion received his operations twenty-four and twenty-six months following the onset of his stroke. He expired six months after his last operation. At the time of death, the patient had not improved. The cause of death was an associated cerebrovascular insufficiency.

Operative death was defined as any death occurring within thirty days following surgery. There were two operative deaths with a patient mortality of ten percent and an operative procedure mortality of nine and one-half per cent (Table 2). One patient with a left sided stroke died the day following his operation from a right sided cerebral hemorrhage. The other patient expired about three weeks following his operation with a diagnosis of acute coronary thrombosis.

The time between the stroke and surgery varied from one day to two months or more (Table 3). Approximately half of the patients died in each category except the seven

to thirty day group which had a twenty-nine percent mortality (Table 4).

At the time of followup there were twelve patients (60%) still living. Seven of the eleven cases (63%) in which contact was made had some neurologic deficits (Table 6). One patient had a decrease in vision and memory loss, another patient only had a decrease in vision, three patients had paresis, another had paralysis, a further stroke, memory loss and decrease in vision, and the last patient had paralysis, further stroke and memory loss (Table 7).

Causes of death in the postoperative period have already been mentioned. In long term results there were two patients who died from basilar artery thromboses, one patient expired in congestive heart failure, another with a coronary occlusion and two patients had no autopsy.

Of those patients who died, the average survival from the time of operation to their death was about two years. Of the patients now dead, one patient (12%) did not improve after operation, five patients (63%) still had some neurologic deficits and two patients (25%) had no deficits.

Group 2 - Treated series with no circulation established.

Eleven patients had endarterectomies in this group. Again all had complete occlusions of the carotid arteries. There were eleven operations performed. Blood flow was not reestablished.

There were no operative deaths with no patient mor-

tality or operative procedure mortality (Table 2).

The time between the stroke and operation ranged from one day to two months (Table 3). No patient survived in the one to seven day category but over half of the patients lived in the other groups (Table 4).

There six patients (55%) surviving at the time of followup. Five of the five patients with whom contact was made had neurologic deficits (Table 6). One patient had paralysis, further stroke, decrease in vision and memory loss, three had paralysis and memory loss and another had paresis only.

Long term deaths in this group were all cardiovascular related. Three patients died of myocardial infarcts, one with congestive heart failure and another patient expired with a pulmonary embolus.

Again the average survival from the time of operation to death was approximately two years. Three patients did not improve after surgery and the results of the other two patients are not known.

Group 3 - Untreated series.

In this group there were thirteen patients who remained untreated. Eleven patients did not have a thrombosis of their carotid artery while two patients did have a thrombosis.

At the time of followup there were eight patients (61%) living. Both patients who had thromboses were among

the survivors. Five of the five patients who were not lost to followup had neurologic deficits. Three patients had only a memory loss, another had paresis, memory loss and decrease in vision, while the last one had paresis.

The causes of death were varied. One patient died of congestive heart failure, another died of a cerebral thrombus, one patient expired due to a pulmonary embolus, another died from a ruptured abdominal aortic aneurysm and the last patient died of emphysema. The average survival of those now dead from the onset of their stroke to the time of their death was approximately one and one-half years.

TABLE 1

AGE RANGE

	Group 1	Group 2	Group 3
Total number in the study	49-71	60-71	38-75
30	0	0	1
40	1	0	0
50	4	0	2
60	13	10	4
70	2	1	6
Living in 1966	54-77	69-78	41-79
40	0	0	1
50	3	0	0
60	0	3	2
70	9	3	5
Dead in 1966	52-72	61-71	56-73
40	0	0	0
50	1	0	1
60	4	2	2
70	3	3	2

TABLE 2

OPERATIVE MORTALITY

(30 days following operation)

	Group 1	Group 2
Number of patients operated	20	11
Number of operations	21	11
Number of operative deaths	2	0
Patient Mortality	10%	0
Operative Procedure Mortality	9.5%	0

TABLE 3

TIME BETWEEN STROKE AND OPERATION

	Group 1	Group 2
1-7 days	2	1
8-30 days	7	7
1-2 months	4	3
2 months or more	7	0

TABLE 4

RESULTS OF TIME FROM STROKE TO OPERATION

	Group 1	Group 2
Living		
1-7 days	1/2 (50%)	0/1 (0%)
8-30 days	5/7 (71%)	4/7 (57%)
1-2 months	2/4 (50%)	2/3 (67%)
2 months or more	4/7 (57%)	no cases
Dead		
1-7 days	1/2 (50%)	1/1 (100%)
8-30 days	2/7 (29%)	3/7 (43%)
1-2 months	2/4 (50%)	1/3 (33%)
2 months or more	3/7 (43%)	no cases
Neurologic Deficits (living)		
1-7 days	0	0
8-30 days	4	3
1-2 months		2
2 months or more	3	
No Neurologic Deficits (living)		
1-7 days	1	no cases
8-30 days		no cases
1-2 months	2	
2 months or more	1	no cases

TABLE 5

SURVIVORS AT TIME OF FOLLOWUP

	Group 1	Group 2	Group 3
Successful	12 (60%)	6 (55%)	8 (61%)
Right	7 (58%)	2 (33%)	2 (25%)
Left	5 (42%)	4 (67%)	6 (75%)
Stroke Victims Living as Compared to Original Number of Strokes			
Right	7/14 (50%)	2/5 (40%)	2/6 (33%)
Left	5/7 (71%)	4/6 (67%)	6/7 (86%)

TABLE 6

NEUROLOGIC DEFICITS AT TIME OF FOLLOWUP

	Group 1	Group 2	Group 3
Neurologic Deficits (contact made and not dead)	7/11 (63%)	5/5 (100%)	5/5 (100%)
Neurologic Deficit and Stroke Side			
Right	5/14 (36%)	2/5 (40%)	2/6 (33%)
Left	2/7 (29%)	3/6 (50%)	3/7 (43%)

TABLE 7

NEUROLOGIC DEFICITS

(at time of followup or death)

	Group 1	Group 2	Group 3
Living Patients			
Paralysis	2	4	1
Paresis	3	1	1
Further Stroke	2	1	0
Decrease in Vision	4	1	1
Memory Loss	3	4	4
Dead Patients			
Paralysis	1	1	0
Paresis	1	0	0
Further Stroke	0	0	0
Decrease in Vision	0	0	0
Memory Loss	1	0	0

TABLE 8

CAUSES OF DEATH
(followup group)

	Group 1	Group 2	Group 3
Cardiac	3	4	1
Cerebral	3		1
General Arteriosclerosis			1
Pulmonary Embolus		1	1
Emphysema			1
Etiology Unknown	2		

DISCUSSION

The clinical picture of cerebrovascular insufficiency is varied. Insufficiency of the carotid system tends to be unilateral in its manifestations affecting the retina, the frontal lobe, portions of the parietal and temporal lobes, the corpus striatum and the internal capsule. The method of presentation will pertain to the clinical situation of this disease. Symptomatology may vary widely in severity and mode of onset. The four clinical areas considered: 1) completed stroke; 2) progressive stroke; 3) transient cerebral ischemia; 4) asymptomatic.

Completed Stroke. Surgical indications for acute completed strokes have been and still are controversial. It has been generally considered that following a complete occlusion within twenty-four to forty-eight hours the thrombus extends into the intracranial portion of the carotid artery and firmly adheres to the arterial wall. In view of this fact reestablishment of blood flow is thought to be impossible. [28] When discussing acute stroke several factors are essential and must be evaluated and considered in every case. One factor is the element of time which according to many authors is very critical.

Papadopoulos [28] and his group indicate that surgery has a place in treating strokes that are less than twenty-

four to thirty-six hours old. Five thromboendarterectomies were performed within this stated time and restoration of blood flow was observed in three patients. There were two improvements and three unimprovements. Hohf [19] and his associates feel that endarterectomies are warranted in patients with complete occlusion of their carotid artery. Their series shows that in ten of the twelve patients under consideration the condition improved after surgery. However, they contend that these stroke victims are benefited only if surgery is performed soon after the onset of symptoms. In addition, they feel that carotid circulation can be reestablished even if there is inadequate retrograde blood flow at the time of operation. Lougheed [23] demonstrated that with early operation, less than three days, flow was restored in two-thirds of his cases. Late operation, over three days, reestablished blood flow in one-quarter of the cases. D.S. Cole [5] reported in his study three patients with acute stroke. One patient died immediately postoperatively, one had no symptoms and the other was improved. The patient who died had been operated on at about forty-eight hours after onset of symptoms, while the other two were operated on in less than twenty-four hours following onset. Yashon [44] and his group had forty-two patients with completed stroke. Eleven patients have died, eight were asymptomatic, six were improved and fifteen were unchanged in their followup study. Of the four patients operated on

within twenty-four hours after symptoms began, one patient died postoperatively and three have only minimal neurologic signs as residua. Garamella and associates [13] reported twenty-seven patients with total occlusion of the extracranial internal carotid artery. Restoration of blood flow was accomplished in twelve patients. In the twelve successful cases the time from onset of total occlusion to time of operation ranged from eight hours to twenty-one days. Follow-up to twenty-five months showed that seven are working and four are walking. These authors are more optimistic than most and feel that restoration is possible if the duration of occlusion is within three to four weeks. Tytus et al [39] had three patients who were operated upon within fourteen hours following the onset of the stroke. Two had excellent results and the third improved considerably. A fourth patient whose operation was delayed seventy-two hours made no recovery. This group feels that endarterectomy can be effective if undertaken within a matter of hours following onset of symptoms. Another series [38] showed reestablishment of blood flow in thirty-nine of one hundred occluded carotid arteries. Thompson and his group stated that all their operative deaths were in patients with acute stroke. Long term results showed that thirty-two percent were normal, fifty-seven percent were improved, seven percent were the same and four percent were worse if both carotid arteries were open. If only one carotid artery were open and no

blood flow was established, fifty percent were the same and fifty percent were improved. They believe that best anatomic results can be obtained in patients operated upon within six to twelve hours of onset. Operations of two weeks duration or more drop the chances of blood flow restoration to twenty percent. In a previous study by Thompson [37] there were one hundred thirty-five patients with frank stroke. Followup of two to eight years showed fifty-nine survivors with fifty percent improved, nineteen percent normal, twenty-eight percent the same and three percent worse. The earliest study of carotid endarterectomies in 1962 by Thompson [18] had sixty-two patients with complete stroke. Long term survival of four years revealed that forty-nine were surviving and of these survivors, forty-five were improved and four were the same. DeBakey and associates[8] showed in their report of one to eleven year results that of three hundred seventy-seven patients, thirty-six percent improved, forty-four percent were asymptomatic, thirteen percent had no change and seven percent were worse. Their study indicated a progressive improvement of the patients with time following operation. However, they feel that time is critical and early intervention is indicated. Others also contend that surgical exploration of occlusions are worthwhile. Blaisdell [2] states that good results can usually be expected if the intracranial portion of the thrombus is able to be removed. In his series of fifteen

patients, eight were successful postoperatively and long term results showed four of the eight patients to then be unsuccessful.

Even though many reports are in the literature of favorable attitudes toward indications for endarterectomy of complete strokes, many authors disagree with such treatment. Young and his associates [45] state that operation is not indicated in such patients. In their series of fourteen, blood flow was not established in arteries with complete occlusion for more than twenty-four hours. Blood flow was established in four out of six patients with symptoms less than twenty-four hours. Javid [21] feels that the complete occlusion of the carotid artery is not an operable lesion. Hardin [16] has reported sixteen patients with completely occluded internal carotid arteries. Eight of these patients had complete remission of symptoms, while the other eight improved but had some remaining neurologic sequelae. Harrison [18] stated that the prognosis of operating on a totally occluded artery after twenty-four to forty-eight hours was very poor. Gunning [14] in his series of fifteen patients showed that blood flow was established in five patients but three of these five subsequently thrombosed with no clinical improvement following treatment. Movius [25] views surgical intervention as having no value. He feels that the mortality is high and the results are poor. His results varied from four months to seven years.

Another study has rated carotid endarterectomy in this particular category under discussion as discouraging. Fourteen patients were considered with complete occlusion. Eight of the fourteen patients died soon after the operation, one died in the month following, and four of those living had minor to major neurologic deficit while one is asymptomatic. [31] Kleinsasser and associates [22] feel that any operation for complete occlusion of the carotid artery is contraindicated except for denervation of the carotid sinus or unless a few hours have elapsed from the onset of symptoms. They indicate that even with successful blood flow restoration, cerebral infarction can be a complication. Wylie and Adams [42] stated that six of their twelve patients died from hemorrhagic infarct following operations to restore blood flow. Operations were performed eight hours to two days following onset of symptoms. They point out the hazard and risk involved in perfusing ischemic brain tissue with blood at normal pressure. [43] Egan and his group [11] feel that with complete occlusion mortality risk is small but clinical improvement is poor. In their series of twelve patients, four died in the followup period with no postoperative mortality, five patients have improved and two patients have no change in the long term followup. However, they feel that the late clinical improvement observed is no more than one would anticipate with nonsurgical therapy and an intensive program of rehabilitation.

Progressive Stroke. This category of patients has not been evaluated by many authorities in the area concerning the treatment of carotid artery insufficiency. Minimal information is not due to lack of interest in these patients but rather that there are few patients of this type and therapy as in completed stroke is still under considerable debate.

Kleinsasser and associates [22] believe that the patient with advancing stroke needs arteriography and then perhaps surgery which is governed by the rate of progression of symptoms. To them the patient with the progressive stroke appears to be the most hazardous group to treat and must be evaluated carefully. Parrott [29] feels that patients with progressive cerebral infarction are difficult to manage. He contends that if the patient is improving an operation can be attempted. Cole [5] in his study had five patients with a stroke of the progressive type. Two had no symptoms at two and one half and three years respectively, one was improved and two were unimproved by their operation. One of the unimproved patients died several months later after incurring a further stroke. In an early study by DeBakey [7] twenty-eight patients were included in the progressing stroke category and of these twenty-six were alive to be further analyzed. Late results showed that one had died, five patients were improved and twenty patients were asymptomatic. DeBakey and his group [8] in another study three years later

had thirty-four patients and long term results up to eleven years showed thirty survivors. Of these survivors, twenty percent died, seven percent were worse, seven percent had no change, thirty-three percent were improved and fifty-three percent were asymptomatic. They feel that these patients are better surgical candidates and have lower mortality rates than those patients with acute stroke. Papadopoulos [28] has included in his study of twenty cases, two patients with progressive stroke and for whom operation was performed. One patient died with no improvement and the other patient had improved only moderately. Movius [25] and associates believe that carotid endarterectomies for chronic stroke patients are questionable. In their series of fourteen patients, seven had improved. However, four of these patients required such a long time for improvement that such benefit could not be necessarily attributed to surgery. They do feel that perhaps surgical intervention may have inhibited any further stroke in these patients.

Transient Cerebral Ischemia. It is the patient in this category that neurosurgeons universally agree are the ideal candidate for carotid endarterectomy. It is the patient who has little or no neurologic deficits. However, it is also difficult to evaluate the incidence of catastrophic abnormalities which may occur in the absence of surgical intervention or how soon such abnormalities may occur with time. There is not enough information at the present time

to really adequately conclude with accuracy how effective surgery may be in preventing further attacks.

DeBakey and his group [8] in their study of three hundred twenty-four of whom three hundred eight survived to be included in long term results had eighty-six percent asymptomatic, three percent were improved, five percent were worse and six percent had no change. They contend that these patients obtain the best surgical results and deserve endarterectomy. Movius and associates [25] state that carotid endarterectomy is of real value in the patient with transient ischemic attacks. Their study was a seven year followup period. Hohf et al [19] in their six months to four and one half years followup study had twelve patients with transient attacks. Results showed and over all improvement of ninty-two percent. They concur with others that patients with such attacks or mild persistent neurologic deficits seem to be the best candidates for surgery. Lougheed and associates [23] in their group of twenty-eight cases in whom blood flow was restored or improved had an arrest of any symptoms in eighty-six percent of the patients. The length of followup time was ten years. They too feel that the best surgical results are obtained in this group of patients. Raskind [31] concludes that patients with transient attacks due to stenosis of the extracranial carotid distribution be treated with endarterectomy. His study included thirty-three patients with follow-

up being over a six year period. Two patients died and none was made worse by their operation. Murphey and Maccubbin [27] also concur with others that those patients having transient and reversible attacks are the most favorable surgical candidates. However, they warn that the degree of involvement of the artery, pertaining to stenosis or occlusion, must be considered in establishing criteria for surgery. Papadopoulos [28] had nine patients in his study and had very good results. He states that those patients with transient attacks and have incomplete occluding lesions are the best candidates for surgery. He feels that endarterectomy is the proper management of the disease. A study in 1962 by DeBakey [7] encompassed an eight month to eight year followup period. There were one hundred sixty-nine patients with nine deaths, one hundred forty-seven asymptomatic, four improved, eight no change and one worse. Cole [5] studied in a five year period with followup thirty-six patients with transient ischemia. His results showed that twenty-one were free of symptoms, seven were considerably improved and two had no change. He too agrees with the role of endarterectomy in the treatment of these patients. He further emphasizes the prevention of progression of a stenotic lesion to a complete thrombotic occlusion which is then accompanied by a major stroke. Yashon and his group [44] had one hundred twenty-one patients. Followup of six to sixty months showed that fifty-two were asymptomatic,

fourteen were improved, nineteen had no change and three were worse. Their group believes that "correction of a severely stenotic arterial channel in the extracranial portion of the brachiocephalic system decreases the likelihood of a stroke." Kleinsasser and associates [22] feel that patients with an incipient or intermittent stroke should be evaluated and surgery should be performed as early as possible for partial occlusion of over fifty percent. According to his data forty percent of strokes are transient and it is this category of patients that benefits most from surgery. Foreign literature reveals the same ideas on surgical candidates for endarterectomy. Paparelli [40] states that endarterectomy is the treatment of choice for extracranial lesions, especially arterial stenoses that do not become complete obstructions. His data indicates excellent results for patients with carotid stenosis with transient ischemic attacks. Bialostozky [1] in his study of patients with cerebral vascular insufficiency had best results in those with transient cerebral ischemia and feels that endarterectomy on such patients is mandatory. A study by Parrott [29] had twenty-four patients and results for fourteen months showed that two have died, twenty-one are normal and one had no change. Thompson and associates [37] had one hundred fifty-one patients in their series with an eight year followup. Results showed one hundred twenty-nine survivors and of these eighty-eight percent were

normal, seven percent were improved, one percent were the same and four percent were worse. They believe that endarterectomy is effective in lowering the incidence of transient ischemic attacks. Edwards et al [10] had seventy-five patients with transient attacks and arterial occlusion of fifty percent or more. Long term results of five to nine years revealed that fifty-one percent were alive and normal, twenty-seven percent had some symptoms, seven percent had completed strokes and died. The remainder of the patients had transient attacks but later recovered completely. Harrison [18] and Hardin [16] both show excellent results in their groups of patients and feel that surgery is indicated and worthwhile. Murphey [26] states that the best surgical results are obtained in those patients with the capacity to get worse, those with transient ischemic attacks, and thus advocates surgery.

Asymptomatic. Review of the literature indicates that little work and followup has been done in this area of classification of patients. Since these patients have no neurologic symptoms, they are not diagnosed routinely. The true incidence of extracranial carotid lesions is not known. Such lesions are only diagnosed by arteriography.

Cole [5] had a small number in his study and obtained excellent results. There were six patients and of these two had no symptoms and four had no change in the followup period. The two patients that had no symptoms had com-

plained previously of mild transient attacks. DeBakey and his associates have had two separate studies of the surgical treatment for asymptomatic patients. The first study [7] had twenty-four cases and late results showed that one patient had died and twenty-three were normal. The latest study [8] was an eleven year followup of their patients. There were forty-six patients and results revealed that forty-five were asymptomatic and one was worse. Papadopoulos [28] had four patients with asymptomatic stenosis. Blood flow and normalcy were reestablished in all of the patients. He feels that patients with more than fifty percent arterial occlusion and even though asymptomatic deserve a prophylactic operation. Murphey and Maccubbin [27] advocate endarterectomy in cases of severe stenosis, even those discovered during a routine or unrelated workup. Movius and his group [25] had no deaths and no complications in their series of five patients. Although their results are good, they do not advocate endarterectomy for asymptomatic patients since they feel that hypertension may precipitate a stroke. However, they do state that this group does well and that possibly the asymptomatic patient should be operated upon since all carotid artery endarterectomies are prophylactic operations.

CONCLUSION

Thirty-one patients have had thirty-two carotid endarterectomies and the results studied. All the patients were hospitalized and treated at the Omaha Veteran's Administration Hospital during the time interval from 1959 to 1961. All the patients in this study can be classified in the completed or progressive stroke category. All lesions of the carotid artery were complete occlusions of the vessel.

On the basis of the results of this study, it seemed that patients with such lesions of their vessels were not ideal candidates for elective operative procedure. The study did show that the mortality and risk of this operation are not great. Results also showed that early operation might not increase the probability of improving neurologic deficit. There is the risk of perfusing devitalized brain tissue with blood at normal pressure with the result of hemorrhage into that area. This unfortunate event probably was the reason for one of the deaths in this study. The results also revealed that the number of strokes increase with age but that any age group was susceptible. The surgical group when compared with the non-surgical group had approximately the same outcome. However, these results tended to indicate that perhaps those patients in

whom circulation was established at the time of operation had better chances of recovering partly or completely.

When this series of patients was collected and the therapy initiated, there were not many such studies in progress.. Therefore, it is unique in that it was one of the earlier studies in this particular disease and can be considered as pioneer work. It is unpublished data of one neurosurgeon's work and experience. It concluded that patients with occlusive carotid artery disease were not ideal candidates for such operation and poor results could be expected. Later studies which are now published agreed with this conclusion.

Cerebrovascular insufficiency is usually secondary to arteriosclerosis. There are two characteristic patterns of involvement of this extracranial disease. The areas include a proximal and a distal form. [6] In the proximal form the lesion usually is at the origin of the branches of the aortic arch. In the latter, the area involved is the bifurcation of the common carotid arteries or origin of the internal carotid arteries and in the vertebral arteries at the origin from the subclavian arteries. There may be complete or partial occlusion.

The patient with this disease may present with neurologic symptoms and signs ranging from minimal to major manifestations or may be asymptomatic. However, before any diagnosis is possible arteriography must be instituted in

each patient. DeBakey and his group [9] strongly urge and emphasize the importance of arteriography for diagnosing precise anatomic location of lesions.

It has been found that the clinical manifestations of neurologic deficits do not always portray the exact nature, site and extent of the stenotic or occlusive lesion. There are two reasons for such a discrepancy of correlation. One reason is multiple involvement and the other is collateral circulation. Consequently, when considering viability and function of cerebral tissue, it is necessary to evaluate fully the collateral circulation to the area involved. Even with reduction in cerebral blood flow secondary to partial or complete occlusion of a vessel or vessels, there may be a rich source of collateral circulation. However, any further involvement of vessels may reduce the blood flow below the critical level and thus the patient develops neurologic symptoms. Viability of the tissue may always be maintained even though the ischemia prevents normal function of the tissues. With restoration of circulation normal function may be returned.

As presented previously, in the discussion, there are four categories in which patients can be grouped. The objective of surgery in each is different. In a completed stroke, if operation is performed, the goal should be to improve neurologic status. In the progressive stroke, the objective is to improve mentation and prevent strokes.

With transient ischemic attacks, therapy should direct itself to the relief of symptoms and prevention of complete stroke. The goal for the asymptomatic patient is purely prophylaxis.

It is obvious that the best results are obtained in incomplete arterial lesions for both restoration of blood flow and improvement from symptoms. Patients with incomplete occluding lesions, manifested by transient attacks of cerebral ischemia, represent the best possible candidates for surgery. Egan [11], Gurdjian [15], Bloodwell [3] and many other authors all share the feeling that endarterectomy of stenosed vessels is highly successful.

Long term outlook in untreated cerebrovascular insufficiency from all causes appears to be poor. Hardy [17] and Robinson [32] each have a study which shows that these patients' mortality is considerably increased in contrast to the general population adjusted for age and sex. Most of these patients suffer recurrent cerebrovascular disease or other vascular disorders.

In spite of the seriousness of this problem, there is no general agreement as to the best approach to the diagnosis, management or treatment. This lack of agreement is due chiefly to insufficient knowledge of the natural history and results of treatment in carefully studied patients. The indications for operation are still not uniformly accepted or employed since agreement on the outcome of the

various clinical categories has not been established. What is needed for an agreement are adequate control studies of the natural course of strokes and what occurs in patients with angiographic abnormalities without treatment. If results are to improve and approach an ideal goal, coinciding with a parallel dimunition in the number of strokes, then perhaps surgery should not only be performed for established or symptomatic disease but also for the asymptomatic lesions.

BIBLIOGRAPHY

1. Bialostozky, L.: Tratamiento Quirurgico de la Insufficiencia Aretial Cerebral. Archivos del Instituto de Cardiologia de Mexico, 37: 775, 1967.

2. Blaisdell, F.W., Hall, Albert D., and Thomas, Arthur N.: Surgical Treatment of Chronic Internal Carotid Artery Occlusion by Saline Endarterectomy. Annals of Surgery, 163: 103, 1966.

3. Bloodwell, R.D., Hallman, G.L., Keats, A.S., and Cooley, D.A.: Carotid Endarterectomy without a Shunt. Archives of Surgery, 96: 644, 1968.

4. Cadwallader, Williams B.: Unilateral Optic Atrophy and Contralateral Hemiplegia Consequent on Occlusion of the Cerebral Vessels. JAMA, 59: 2248, 1912.

5. Cole, D.S.: Surgery in Extracranial Cerebrovascular Disease. British Journal of Surgery, 52: 892, 1965.

6. DeBakey, Michael E.: Concepts Underlying Surgical Treatment of Cerebrovascular Insufficiency. Clinical Neurosurgery, 10: 310, 1964.

7. DeBakey, Michael E., Crawford, E.S., Morris, Jr., G.C., and Cooley, D.A.: Arterial Reconstructive Operations for Cerebrovascular Insufficiency due to Extracranial Arterial Occlusive Disease. Journal of Cardiovascular Surgery, 3: 12, 1962.

8. DeBakey, Michael, E., Crawford, E.S., Cooley, Denton A., Morris, Jr., G.C., Garrett, H. Edward, and Fields, W.S.: Cerebral Arterial Insufficiency: One to 11-Year Results Following Arterial Reconstructive Operation. Annals of Surgery, 161: 921, 1965.

9. DeBakey, Michael, E., Crawford, E.S., Morris, Jr., G.C., and Cooley, Denton A.: Surgical Considerations of Occlusive Disease of the Innominate, Carotid, Subclavian and Vertebral Arteries. Annals of Surgery, 154: 698, 1961.

10. Edwards, W. Sterling, Wilson, Thomas A.S., and Bennett, Austen: The Long-term Effectiveness of Carotid Endarterectomy in Prevention of Strokes. Annals of Surgery, 168: 765, 1968.

11. Egan, Richard W. and Upson, James F.: Carotid Artery Surgery for Cerebral Vascular Insufficiency. Angiology, 16: 698, 1965.

12. Fisher, M.: Occlusion of Carotid Arteries. Archives of Neurology and Psychiatry, 72: 187, 1954.

13. Garamella, Joseph J., Lynch, Michael F., Jensen, Nathan K., Sterns, Laurence P., and Schmidt, W. Robert: Endarterectomy and Thrombectomy for the Totally Occluded Extracranial Internal Carotid Artery. Annals of Surgery, 164: 325, 1966.

14. Gunning, A.J. and Russell, R.W.R.: Surgery in Complete Occlusion of the Internal Carotid Artery. Circulation, 24: 1305, 1961.

15. Gurdjian, E.S., Hardy, W.G., Lindner, D.W., and Thomas, L.M.: Results of Endarterectomy in the Treatment of Cerebrovascular Disease. Angiology, 15: 88, 1964.

16. Hardin, C.A.: Extracranial Internal Carotid Artery Occlusion. Archives of Surgery, 85: 514, 1962.

17. Hardy, W.G. et al: Anticipated Clinical Course in Carotid Artery. Archives of Neurology, 6: 138, 1962.

18. Harrison, J.H. in discussion on Thompson, J.E. and Austin, D.J.: Surgical Treatment of Arteriosclerotic Occlusions of the Carotid Artery in the Neck. Surgery, 51: 74, 1962.

19. Hohf, Robert P., Watts, David R., Tarkington, Joseph A., and Crampton, Arthur R.: Late Results of Surgical Treatment for Carotid Insufficiency. Surgery, Gynecology and Obstetrics, 123: 319, 1966.

20. Hunt, J. Ramsey: The Role of the Carotid Arteries in the Causation of Vascular Lesions of the Brain with Remarks on Certain Special Features of the Symptomatology. American Journal of the Medical Sciences, 147: 704, 1914.

21. Javid, H.: Surgical Management of Cerebrovascular Insufficiency. Archives of Surgery, 80: 883, 1960.

22. Kleinsasser, LeRoy J., Ellis, Paul R., and Lamm, Edwin: The Surgical Treatment of Extracranial Occlusions Causing Cerebrovascular Insufficiency. Southern Medical Journal, 55: 821, 1962.

23. Lougheed, W.M., Elgie, R.G. and Barnett, H.J.M.: The Results of Surgical Management of Extracranial Internal Carotid Artery Occlusion and Stenosis. Transactions of American Neurological Association, 91: 283, 1966.

24. Moniz, E., Lima, A. and DeLacerda, R.: Hemiplégies par Thrombose de la Carotide Interne. La Presse Médicale, 10: 977, 1937.

25. Movius, Herbert J., Zuber, William F. and Gaspar, Max R.: Carotid Thromboendarterectomy. Archives of Surgery, 94: 585, 1967.

26. Murphey, Francis and Maccubbin, Don A.: Carotid Endarterectomy. Journal of Neurosurgery, 23: 156, 1964.

27. Murphey, Francis and Maccubbin, Don A.: Carotid Endarterectomy: A Long-term Follow-up Study. Clinical Neurosurgery, 13: 291, 1965.

28. Papadopoulos, Constantin D.: Surgical Treatment of Cerebrovascular Insufficiency. International Surgery, 48: 69, 1967.

29. Parrott, John C.: Internal Carotid Artery Insufficiency. American Journal of Surgery, 108: 777, 1964.

30. Rainer, W. Gerald, Feiler, Ernest M., Bloomquist, Charles D. and McCrory, Charles B.: Surgical Approach to Carotid Arterial Insufficiency. The Annals of Thoracic Surgery, 2: 640, 1966.

31. Raskind, Robert and Doria, Alberto: Carotid Endarterectomy. Vascular Surgery, 1: 1, 1967.

32. Robinson, Roger W. et al: Life-table Analysis of Survival after Cerebral Thrombosis- Ten-year Experience. JAMA, 169: 1149, 1959.

33. Savory, William: Obliteration of the Main Arteries of the Upper Extremities and Left Side of Neck. Medico-Chirurgical Transactions, 39: 205, 1856.

34. Shimizu, Kentaro and Sano, Keiji: Pulseless Disease. Journal of Neuropathology and Clinical Neurology, 1: 37, 1951.

35. Smyth, G.E.: Thrombosis of the Internal Carotid Artery. Postgraduate Medical Journal, 32: 122, 1956.

36. Strully, Kenneth: Thrombo-endarterectomy. Journal of Neurosurgery, 10: 474, 1953.

37. Thompson, J., Kartchner, Mark, Austin, Dale J., Wheeler, Clarence G. and Patman, Ralph D.: Carotid Endarterectomy for Cerebrovascular Insufficiency (stroke): Follow-up of 359 Cases. Annals of Surgery, 163: 751, 1966.

38. Thompson, Jesse E., Austin, Dale J., and Patman, R.D.: Endarterectomy of the Totally Occluded Carotid Artery for Stroke. Archives of Surgery, 95: 791, 1967.

39. Tytus, John S. and Hill, Lucius D.: Cervical Carotid Artery Disease. Northwest Medicine, 64: 832, 1965.

40. Ugarte, Horacio Paparelli et al: Cirugia de la Carotida. Archivos del Instituto de Cardiologia de Mexico, 36: 581, 1966.

41. Williamson, R.T.: British Medical Journal, 1: 1515, 1898.

42. Wylie, E.J. and Adams, J.E. in discussion on Young, J.R. et al: Extracranial Cerebrovascular Disease Treated Surgically. Archives of Surgery, 89: 848, 1964.

43. Wylie, E.J., Hein, M.F. and Adams, J.E.: Intracranial Hemorrhage following Surgical Revascularization for Treatment of Acute Strokes. Journal of Neurosurgery, 21: 212, 1964.

44. Yashon, David, Jane, John A. and Javid, Hushang: Long Term Results of Carotid Bifurcation Endarterectomy. Surgery, Gynecology and Obstetrics, 122: 517, 1966.

45. Young, J.R., Humphries, A. W., DeWolfe, V.G., Beven, E.G. and LeFevre, F.A.: Extracranial Cerebrovascular Disease Treated Surgically. Archives of Surgery, 89: 848, 1964.