Emergency carotid endarterectomy

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A retrospective review of carotid endarterectomies performed by the Neurosurgical Service at Massachusetts General Hospital from July, 1976, through December, 1985, disclosed 64 procedures that were performed on an emergency basis. The patients included 40 men and 24 women, with a mean age of 64 years (range 32 to 87 years). Correlation of angiographic findings with outcome revealed that of the 27 patients with severe stenosis, usually with delay in blood flow, 25 (93%) were the same or improved postoperatively; of the 11 patients with stenosis and an intraluminal filling defect (six of whom had an intraluminal clot), eight (73%) were the same or improved after surgery; of the 16 patients with complete occlusion, 14 (88%) were the same or improved (backflow was established in all cases); and of the 10 patients with moderate to severe stenosis and/or severe ulceration (including three with transient ischemic attacks who were receiving heparin), eight (80%) were the same or improved.

Pre- and postoperative clinical status were graded into five categories: intact; mild deficit; moderate deficit (significant impairment but able to perform activities of daily living); severe deficit (requiring assistance for daily activities); and death. Of the 36 patients who preoperatively were intact or had mild deficits, 33 (92%) were the same or improved postoperatively, three were worse, and there were no deaths. Among 15 patients presenting with moderate deficits, 12 (80%) were the same or improved, two were worse, and one died. Of the 13 patients with severe deficits, 10 (77%) were the same or improved and three died. Two patients with sudden severe deficits associated with loss of contralateral bruit were operated on without angiography and were intact postoperatively. Of the four deaths in the total series, two were attributed to cardiac causes and two to unrelated disease processes. The indications for emergency carotid endarterectomy are discussed.

Key Words · Carotid artery · Carotid endarterectomy · Emergency surgery

Carotid endarterectomy has become an established procedure for the treatment of patients with transient ischemic attacks (TIA's) associated with severe stenosis and/or ulceration in the proximal portion of the internal carotid artery (ICA) in the neck.22,23,28,31,33 The indications for emergency carotid endarterectomy are less well defined.

Over the past two decades, the philosophy of the Neurosurgery and Neurology Services at the Massachusetts General Hospital has been to try to establish a definitive diagnosis for all stroke patients at the time of admission. This has allowed us the opportunity to consider emergency carotid endarterectomy, and we have previously reported on our experience prior to this study.22,23 This report summarizes a further experience, reviews the relevant literature, and outlines the indications we presently accept for this operation.

Clinical Material and Methods

Patient Evaluation

The records of the Neurosurgical Service at the Massachusetts General Hospital from July, 1976, through December, 1985, were reviewed retrospectively. Sixty-four operations were classified as an "emergency carotid endarterectomy" because they had not been scheduled electively and were performed on an emergency basis as soon as possible following angiography or an acute clinical event. An attempt was made to classify these patients into the following three clinical categories: 1) TIA's, including classic TIA's, the recurrence of TIA's when the patient is being treated with heparin, and crescendo TIA's (attacks abruptly increasing in frequency up to at least several a day); 2) stroke in evolution (neurological deficits that fluctuate or progress over hours or days); and 3) acute stroke with apparently stable deficit (either the acute onset of a spontaneous neurological deficit of mild, moderate, or severe degree which persists, or the acute onset of a deficit or during angiography).

In many patients with acute neurological deficits it was difficult to determine from the history whether the deficit was stable, progressive, or fluctuating because the time interval between onset and treatment did not allow this assessment. We have therefore classified the
preoperative neurological status in terms of deficits alone as intact, mild, moderate, or severe. Patients with an intact status had a history of TIA's. Mild deficits were those that caused only slight impairment of normal activity. Moderate deficits significantly impaired the patients' functions but allowed them to perform activities of daily living (aphasic patients were considered to have at least a moderate deficit). Severe deficits were recorded when there was major loss of neurological function that would significantly impair daily activities. Postoperatively, the outcomes of patients were reclassified at the time of their discharge from the hospital according to the same scheme (using deficits alone) and additionally as improved, unchanged, or worse (including those who had died). The patient could be improved or worse without necessarily changing their deficit class. Many of the patients subsequently showed improvement, but this analysis gives a picture of the immediate effects of surgery.

All except three patients had angiograms demonstrating lesions in the carotid territory appropriate for their symptomatology. Two of the three patients who did not have angiography developed neurological deficits with loss of a carotid bruit while in the hospital undergoing evaluation, and the other patient had a positive noninvasive test and a sudden severe event while awaiting angiography. Emergency endarterectomy was performed on three patients with varying degrees of stenosis, but with recurrent TIA's while on therapeutic doses of heparin. Overall, the preoperative angiographic findings in the 61 cases studied were classified as follows: 1) severe stenosis with marked delay in flow in 27 patients (the corrected lumen diameter was less than 1.5 mm or a "pseudo-occlusion" was found in 26 of these patients); 2) moderate stenosis with a 1.5- to 2-mm residual lumen in six patients; 3) stenosis with intraluminal filling defect, compatible with clot in the lumen in 11 patients; 4) severely ulcerated plaque in one patient; and 5) complete occlusion, assumed to be acute given the setting of a recent sudden neurological event in 16 patients.

Notation was made of a prior medical history of diabetes mellitus, hypertension, coronary artery disease, peripheral vascular disease, or smoking.

Statistical analysis of the data was performed using the Ed-Sci statistics programs for the Apple II microcomputer.* One-way analysis of variance and chi-square and unpaired t-test analyses were used.

**Technical Aspects**

The details of our technique for carotid endarterectomy have been reported previously.22,23 When the operation is being performed as an emergency, great care must be taken to be sure that a stable blood pressure is maintained at all times. Electroencephalographic (EEG) monitoring was used in many operations. If there was a complete occlusion of the ICA or if the EEG apparatus was not immediately available, this monitoring was not utilized.

During exposure of the area of the carotid bifurcation, the ICA is disturbed as little as possible. In patients with complete occlusion, no occlusion clamp or clip is placed on the ICA in order to avoid breaking up a thrombus should it be present. On rare occasions, elective shunting of the external carotid artery may be indicated if this is an important source of collateral supply. When a thrombus is encountered in the ICA, every effort is made to withdraw it gradually. If it is not spontaneously extruded by back pressure, a smooth-ended suction catheter is tried, and if this fails, a balloon embolectomy catheter is gently passed to the base of the skull.13 Care must be taken to avoid injury to the distal ICA with subsequent development of a carotid-cavernous fistula. Unless the thrombus has emerged cleanly and there is excellent backflow, an intraoperative angiogram is recommended to document the status of the artery. If good backflow or satisfactory angiography cannot be achieved, the ICA is plicated in such a way as to avoid a blind pouch at its origin.20 Prior to closure, the endarterectomy of the distal common and proximal external carotid arteries is completed.

At the end of the operation, heparin is not reversed. Patients are usually given a course of aspirin. In the postoperative period it is important to control blood pressure carefully, usually keeping the systolic pressure between 110 and 160 mm Hg. An intravenous antihypertensive medication or vasopressor is utilized as necessary until long-acting medications become effective.

**Results**

The mean age of the patients undergoing emergency surgery was 64 years (range 32 to 87 years). The mean age and clinical characteristics for the 40 men and the 24 women were not significantly different. Medical histories revealed that 64% were hypertensive, 42% were smokers, 33% had a history of coronary artery disease, 16% had peripheral vascular disease, and 9% had diabetes mellitus.

Intraoperative EEG monitoring was used in 42 patients. Four patients required vascular shunting in response to significant EEG changes. Six patients without EEG monitoring had shunts placed: two had not undergone angiographic studies, and in the other four there was concern about collateral circulation. One of these patients had an external carotid artery shunt.

In all patients with ICA occlusion, backflow from the ICA was restored by the operative procedure. Of the 27 patients with severe stenosis with delay in flow, 11 were found to have an acute clot at operation. Six of the 11 patients with an intraluminal filling defect were found at operation to have a clot present. The others had atheromatous material projecting into the arte-

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rial lumen causing the observed filling defect. Of the 14 patients with complete angiographic occlusion for whom the surgeon’s operative notes addressed the issue, 11 had clot occluding the lumen and extending into the distal ICA at the time of endarterectomy, which supported the interpretation that these occlusions were acute. The other three were found at operation not to have total occlusion.

**Correlation of Outcome With Clinical Presentation**

Table 1 summarizes the results at the time of discharge in 64 patients. The final clinical condition was very closely correlated with the presenting status (p < 0.0000001) but not with any other identified variable (sex, age, handedness, side of operation, year of operation, angiographic classification of the lesions, or use of an intraoperative shunt). Overall, 11 (17%) of the patients remained intact; of those not intact preoperatively, 35 (55%) were improved, nine (14%) were unchanged, five (8%) were worse, and four (6%) died. There were 13 minor complications. Seven patients (of whom four were receiving intravenous heparin) developed wound hematomas; one of those receiving heparin required evacuation of the hematoma. Other complications included (one patient each): an abscess at an arterial line site; a urinary tract infection; wound cellulitis; septic thrombophlebitis at an intravenous site; recurrent laryngeal nerve palsy; and an episode of hemodynamically benign arrhythmia. The patients with uncomplicated postoperative courses were discharged on postoperative Day 5 to 7.

Twelve patients were intact prior to operation and all had TIA’s (Table 1). The reason for operation was a severe stenosis with marked delay in flow in 10, one of whom continued to have TIA’s after receiving heparin; stenosis with a filling defect in the lumen in one patient who had crescendo TIA’s while receiving heparin; and a 1.5-mm ICA stenosis in one patient whose opposite ICA was occluded. Eleven patients were intact at discharge. The one patient with crescendo TIA’s had a moderate deficit, and the postoperative angiogram did not disclose a cause.

Twenty-four patients had a mild persistent deficit before operation (Table 1). In 19 the primary indication for surgery was the angiographic finding: severe stenosis and marked delay in flow in 10; severe stenosis and intraluminal filling defect in five; and complete ICA occlusion in four. In the other five the indications for surgery included: a fluctuating deficit while receiving heparin in two, an acute deficit associated with moderate stenosis in two, and a severely ulcerated plaque in one. Many of the patients had a history of TIA’s. The preoperative deficit was usually acute but had been present for several days in a few patients. At discharge, 15 patients were improved, five of whom were intact; seven were the same; and two were worse (one with a slight increase in a mild deficit and one with a moderate deficit). This last patient had a significant episode of postoperative hypotension with the onset of hemiparesis, and angiography showed ICA occlusion.

Fifteen patients had a moderate deficit preoperatively (Table 1). Thirteen had the onset of symptoms outside the hospital and two became worse during or shortly after angiography. One patient had a fluctuating speech deficit and a complete occlusion of the left ICA which extended intracranially and was not thought amenable to surgery; a severe stenosis of the right ICA which supplied the left hemisphere was also present. The emergency operation was carried out on the right side in that patient. At discharge 11 of these patients were improved, two of whom were intact, one was the same, and two were worse. There was one death in a 69-year-old man who developed an acute moderate deficit at angiography and was taken immediately to the operating room. Although initially neurologically improved, he suffered an intraoperative myocardial infarction, developed staphylococcal pneumonia, and died of cardiopulmonary arrest on postoperative Day 10.

Thirteen patients had a severe neurological deficit prior to operation (Table 1). Only three were not alert, all of whom developed their deficit in connection with angiography. The absence of other patients in the series who were drowsy with a severe deficit reflects our previously published policy regarding such patients. In the group of 10 patients who were alert, two had the sudden onset of a severe neurological deficit with loss of carotid bruit while in the hospital. Both were taken immediately for operation and both made a full recovery; one had occlusion of the ICA with thrombus, while the other did not have total obstruction. A third patient had a similar sudden deterioration without a change in her bruit; she was neurologically unchanged at discharge. Five patients had the sudden onset of severe deficits outside the hospital and, after appropriate angiographic evaluation showed either occlusion or severe stenosis, underwent an emergency operation. Three continued to have severe but improved deficits, and the other two patients died. Prior to death neither of the latter two showed clinical change. One, a 43-year-old woman, ultimately died from complications of previously undiagnosed ulcerative colitis necessitating post-neurosurgical total colectomy; the other, a 77-year-old man who had a complete occlusion with good retro-

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**TABLE 1**

Results of emergency carotid endarterectomy

<table>
<thead>
<tr>
<th>Preop Deficit*</th>
<th>Status at Discharge</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved</td>
<td>Same</td>
</tr>
<tr>
<td>intact</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>mild</td>
<td>15</td>
<td>7</td>
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<tr>
<td>moderate</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>severe (alert)</td>
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<td>1</td>
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<tr>
<td>severe (not alert)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>total cases</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>% cases</td>
<td>55</td>
<td>31</td>
</tr>
</tbody>
</table>

* See text for definitions of deficits.
grade flow on the angiogram, succumbed to a cardio-
 pulmonar y arrest 1 month postoperatively. The third
 patient in the group of alert patients with severe deficit
 who died was a 73-year-old man who had a radical
cystectomy and creation of an ileal loop; upon awak-
ening from anesthesia he was found to be aphasic and
hemiplegic. Angiography showed a less than 2-mm
lumen in the left ICA and no filling of the left A1
portion of the anterior cerebral artery. Following emer-
gency endarterectomy, his neurological condition im-
proved slightly over the next 5 days; he then deterio-
rated with signs of an acute abdominal condition and
died of intraoperative cardiac arrest during a laparot-
omy which revealed a devitalized colon and ileal loop.
The last patient in the group of alert patients developed
a severe deficit associated with angiography to evaluate
TIA’s. He improved to a moderate disability.

Correlation of Outcome With Angiographic
Findings

Another way to analyze the results is by classifying
the patients according to angiographic findings. Table
2 shows that 25 of 27 patients with severe stenosis and
delay in flow were intact or had a mild or moderate
deficit. In these patients the primary indication for
surgery was usually concern that the patient would
develop a more serious deficit from progression of the
stenosis to occlusion. No patient in this group died and
25 of the 27 were the same or improved after surgery.
Table 3 shows the operative results in patients in whom
the indication for emergency endarterectomy was the
finding of an intraluminal filling defect at angiography.
Only six of these patients were found at surgery to have
an intraluminal clot; in the rest the defect was due to
atheromatous material. In this group, nine improved
or were unchanged and two died; one due to compli-
cations following intraoperative myocardial infarction
and one following emergency colectomy. Table 4 gives
the operative results in 16 patients undergoing surgery
for presumed acute complete occlusion. In a few cases
the finding proved to be a pseudo-occlusion. 26 Flow
through the ICA was established by endarterectomy in
all cases. In this group, 14 patients were unchanged or
improved by surgery, one was worse, and one died from
a cardiopulmonary arrest on postoperative Day 24.
There were nine patients with moderate to severe ste-
nosis without delay in flow and one patient with a
severely ulcerated plaque; these 10 patients underwent
emergency endarterectomy because of the onset of an
acute fixed or fluctuating neurological deficit or because
of persistence of TIA’s in spite of adequate hepa-
rinization (Table 5). There was one death from com-
plications unrelated to neurological causes, and eight
patients were unchanged or improved.

Summary of Results

Intact patients and those with mild deficits preoper-
atively did not differ significantly in age, year of oper-
ation, outcome, survival, the use of EEG, or the use of
an intraoperative shunt. In this group, 92% were the
same or improved following surgery. Among patients
with a moderate initial deficit, 80% were the same or
improved postoperatively. For patients with severe def-
cits, 77% were the same or improved. There were no
deaths among the patients who were intact or had only
mild deficits preoperatively. One patient (7%) with a
moderate deficit died, and three (23%) of 13 patients
with severe deficits died. Of the four deaths, two were
attributed to cardiac causes and two to complication of
an unrelated disease process. No deaths were recorded
after 1980. Six patients developed their acute deficit in
connection with angiography; all four with a severe
deficit that improved to moderate disability; the other
two had a moderate deficit, with improvement in one
and death in the other.

Discussion

Scientific Basis for Emergency Carotid
Endarterectomy

Laboratory investigations using different animal
models of temporary middle cerebral artery occlusion
have provided a rationale for emergency revasculariza-
tion. 5,6,13,19,20,29,31 These studies have shown that several
hours of reduced cerebral blood flow can be tolerated
without permanent infarction and that variations in the
time of tolerated ischemia depend to a great extent on
collateral circulation.
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Natural History of Acute Stroke

The natural history of patients with acute stroke and/or angiographic findings that might be considered indicative of emergency carotid endarterectomy is hard to define. The prognosis is influenced by collateral circulation and systemic factors that alter the cerebral circulation. In the Joint Study of Extracranial Arterial Occlusion, patients with acute stroke, with and without altered consciousness, and with stenosis and occlusion were all collected in one group; the natural history of patients in these different categories was not studied separately.1

In a report of 130 patients who were intact or had a mild deficit and had angiographically proven ICA occlusion and who were followed for 5 years, Furlan, et al.10 reported a stroke rate of 3% per year (2% related to the occluded side). Cote, et al.,4 reviewed a similar group of 47 patients followed for 3 years and showed a stroke rate of 5% per year (3.3% related to the occluded side). In their report of 23 patients with a severe neurological deficit and ICA occlusion, Grillo and Patterson19 reported that five died of the infarct within 2 weeks, one died of pneumonia secondary to stroke, and five died of myocardial infarction. Of the 12 survivors, nine had a residual mild to moderate deficit. From a review of the literature, Meyer, et al.,19 have concluded that, of patients with acute carotid artery occlusion and profound neurological deficits, 2% to 12% will make a good recovery, 40% to 69% will have a profound deficit, and 16% to 55% will have died by the time of follow-up review.

Initial Evaluation and Treatment

When a patient presents with an acute stroke, the history including presence of previous cerebrovascular symptoms and serious medical illness is obtained. The baseline neurological status is assessed, with evaluation of superficial temporal pulses and auscultation for carotid bruits. Blood pressure is monitored. Electrocardiographic and laboratory studies are carried out. A computerized tomography (CT) scan is obtained to demonstrate any brain hemorrhage or infarction. When carotid disease is suspected, the patient is alert, and the CT scan does not show evidence of acute infarction or hemorrhage, emergency angiography is performed.

During this period of initial evaluation there are some things that can be done medically to help the patient. Wood and Kee24 have summarized the attempts to enhance cerebral perfusion by manipulating rheological factors. Prospective nonrandomized evaluation of low molecular dextran or 5% serum albumin solutions in patients with acute stroke has demonstrated a fall in hematocrit which correlated with a diffuse improvement in regional cerebral blood flow and improvement in the EEG findings. Infusion rates were adjusted to keep the hematocrit at about 33% and to maintain the central venous pressure between 8 and 12 cm H2O. A prospective randomized clinical evaluation in patients with acute ischemia of less than 48 hours' duration confirmed the value of hemodilution in acute stroke.27

Clinical Series

In 1965, Hunter, et al.,11 reported 21 patients with acute neurological deficits due to severe stenosis or occlusion in the proximal ICA, who had an emergency operation. It was concluded that those who had less than a severe deficit and had stenosis should be operated on immediately because of the risk of disease progression, while those patients who had a severe deficit and a complete ICA occlusion were not helped by surgery. In 1969, Rob25 reported his experience with 91 patients “operated on for an acute completed stroke.” He had initially been encouraged by a few “spectacular successes” but reported that he had then discontinued the routine use of emergency surgery in these patients and also in cases of progressing stroke because only a small number were improved and there was a significant incidence of postoperative intracerebral hemorrhage. Subsequently, it has been shown that most intracerebral hemorrhages that occur after carotid endarterectomy are related to hypertension. When careful attention was paid to control of blood pressure in the immediate postoperative period, there seemed to be a much lower incidence of postoperative brain hemorrhage.3,22,23 None has been noted in our series.

In 1971, Najafi, et al.,21 reported 10 patients who underwent emergency carotid thromboendarterectomy


table 4

Operative results in 16 patients with presumed complete occlusion

<table>
<thead>
<tr>
<th>Preop Deficit*</th>
<th>Status at Discharge</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved</td>
<td>Same</td>
</tr>
<tr>
<td>mild</td>
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<td>3</td>
</tr>
<tr>
<td>moderate</td>
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<td>1</td>
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<tr>
<td>severe (alert)</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>severe (not alert)</td>
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<tr>
<td>total cases</td>
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<td>5</td>
</tr>
<tr>
<td>% cases</td>
<td>57</td>
<td>31</td>
</tr>
</tbody>
</table>

* See text for definitions of deficits.


table 5

Operative results in 10 patients with moderate to severe stenosis and/or severe ulceration

<table>
<thead>
<tr>
<th>Preop Deficit*</th>
<th>Status at Discharge</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
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<tr>
<td>severe (alert)</td>
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<td>0</td>
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<tr>
<td>% cases</td>
<td>60</td>
<td>20</td>
</tr>
</tbody>
</table>

* See text for definition of deficits.
for spontaneous stroke. Five patients were in the hospital being evaluated for cerebrovascular disease and developed a stroke with disappearance of the carotid artery bruit. They generally did well. This has also been the experience of other surgeons.\textsuperscript{8,19,22} The other five patients did not have such a good outcome. It was concluded that emergency operation was contraindicated in patients with a fixed deficit unless the operation could be performed within 2 hours of the onset of symptoms. In their discussion of this paper,\textsuperscript{21} Thompson and Imperato agreed with the author's conclusions, as did Hafner and Tew.\textsuperscript{13} Several surgeons have reported benefit from emergency operations in some patients with acute carotid artery occlusions occurring after angiography or after carotid endarterectomy when the operation was carried out within 1 to 2 hours of the occlusion.\textsuperscript{8,9,13,16,17,19,21,22,30,32} However, Meyer, \textit{et al.},\textsuperscript{19} found that the correlation between the duration of symptoms before flow was reestablished and outcome was not as good in patients who had acute carotid occlusion and profound neurological deficits.

In 1975, we reported our experience with 36 patients subjected to emergency carotid endarterectomy.\textsuperscript{23} The patients with crescendo TIA's and severe stenosis did well. We found nine patients with sudden partial deficit: seven improved and in two there was no change. Patients with complete occlusion who had flow reestablished did much better than those in whom the ICA occlusion could not be reopened. It was found that patients with sudden severe deficit had a significant mortality rate. These findings were confirmed in a subsequent report.\textsuperscript{22} Several other authors have concluded that surgery is not indicated in patients with severe fixed neurological deficits, especially when the patient also has a depressed level of consciousness.\textsuperscript{7,11,13,24} However, Meyer, \textit{et al.},\textsuperscript{19} reported emergency carotid endarterectomy in 34 patients with acute carotid artery occlusion, often with altered consciousness, all but one of whom developed a profound neurological deficit while in the hospital. In this group, nine (26.5%) returned to normal, four (11.8%) had a minimal deficit, 10 (29.4%) had a moderate hemiparesis, four (11.8%) were hemiplegic, and seven (20.6%) died.

In 1980, Goldstone and Effeny\textsuperscript{11} reported on 28 patients who had TIA's or stroke-in-evolution without severe deficits or depressed level of consciousness and who had a 95% or greater stenosis of the ICA or the presence of an intraluminal thrombus. Shunts were used in four of the 10 patients with crescendo TIA's and in all 18 with evolving deficits. All but one patient recovered completely, and that patient developed a brain-stem stroke on the 3rd postoperative day. Mentzer, \textit{et al.},\textsuperscript{18} in 1981 reported 24 patients with TIA's or fluctuating deficits who were treated with emergency surgery. Seven patients with crescendo TIA's were operated on and all remained normal. In the 17 patients with stroke-in-evolution there was one death, 24% remained unchanged, and 70% had complete recovery or only a mild deficit.

Some surgeons have recommended that surgery be delayed for up to 4 to 6 weeks in patients with mild to moderate fixed deficits. However, Dosick, \textit{et al.},\textsuperscript{9} found that during this waiting period there was a 21% incidence of recurrent stroke. They advocated that these patients should undergo CT scanning, and if the scans are normal (which they were in 70% of their patients) angiography and surgery should be performed without delay. Pistolese, \textit{et al.},\textsuperscript{28} also suggested that "preocclusive" lesions of the ICA were an indication for emergency surgery.

\textbf{Indications for Emergency Surgery for Acute Stroke}

Our recommendations for emergency surgery are based on our experience and on a review of the literature. An emergency operation may be indicated to restore neurological function, to treat angiographic findings suggesting that the patient is at high risk for further neurological deterioration, or both. We currently consider the following to be indications for emergency surgery: 1) the sudden onset of a neurological deficit with loss of a previously noted appropriate carotid artery bruit; 2) the sudden onset of a deficit from proven carotid artery occlusion during angiography; or 3) the presence of TIA's or an acute spontaneous mild, moderate, or (in special circumstances, see below) severe neurological deficit with one of the following angiographic findings: a) severe stenosis in the proximal ICA with a marked delay in flow, b) stenosis in the proximal ICA and the presence of an intraluminal filling defect, or c) complete occlusion of the ICA.

Most of the patients with sudden onset of a neurological deficit with loss of a carotid artery bruit will already be hospitalized. Angiography is not needed. The patient should be taken immediately to the operating room. Usually a complete or nearly complete occlusion of the ICA is found and flow can be promptly restored. This group of patients has a very good prognosis.

Patients with the sudden onset of a deficit with ICA occlusion during angiography are also taken immediately to the operating room. In general, these patients have done well unless there has been an associated middle cerebral artery embolus.

Patients with TIA's or an acute mild or moderate stable deficit are usually considered for emergency surgery because of the angiographic indication, since their overall prognosis is good. When there is severe stenosis at the ICA origin and marked delay in flow, the patients are at significant risk for further ischemia. The results are good in these patients. Our data suggest that those patients with an intraluminal thrombus should also be considered for surgery to prevent neurological worsening. However, the rate of surgical morbidity in these patients has been high in other series and therefore caution must be exercised.\textsuperscript{2}

Patients with a severe deficit are more difficult to
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evaluate. Clearly, some patients benefit with dramatic improvement in their deficit, but selection of these patients is often problematic. Drowsy patients with severe deficits who were operated on in this series all had the acute onset of these symptoms at or shortly after angiography and were immediately taken for operation; all improved. However, if there is a significantly reduced level of consciousness associated with a demonstrated infarct, acute revascularization will usually not be of benefit and is associated with an increased risk of mortality. Emergency surgery may be of benefit in some patients with a severe deficit who are alert and without evidence of significant infarction, as evidenced in our series as well as that of Meyer, et al. It is not known if the drowsy patient with an acute stroke and a normal CT scan can be helped by emergency restoration of ICA flow.

References

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