# Microvascular Anastomosis for the Treatment of Seizures in Patients with Cerebrovascular Ischemia: A Report of Five Cases

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The authors report five patients who had either generalized or focal seizures in association with occlusion of the internal carotid artery. Two of them developed a motor deficit after having had several seizures. The other three did not develop a fixed neurological deficit, but their seizures had continued in spite of anticonvulsant treatment. After an extracranial to intracranial (EC-IC) bypass, the seizures either stopped or became less frequent. Based on our experience with these patients and our review of the literature, we think that seizures may be the initial or at least an early manifestation of cerebrovascular insufficiency in some patients. An EC-IC bypass may be of help when angiographic evidence of cerebrovascular occlusive disease is found. (Neurosurgery 13:646–649, 1983)

Key words: Cerebral ischemia, Extracranial to intracranial bypass graft, Focal seizure, Generalized seizure, Internal carotid artery occlusion, Microvascular anastomosis, Motor deficit

Waddington, in a study of 100 patients with seizures of cerebrovascular origin, found 46 cases of occlusion of major intracranial vessels. She encouraged neurosurgeons to perform microvascular anastomosis to increase cerebral flow in the injured cerebral cortex before irreparable damage occurred (10). However, we have not found reports of patients with cerebrovascular occlusive disease and seizures who have been treated by revascularization procedures. In this paper, we report 5 patients (Table 1), from our group of 41 cases of cerebral revascularization, who presented with seizures as the first symptom of occlusion of the internal carotid artery. After extracranial-intracranial (EC-IC) bypass grafting, the seizures either stopped or diminished in frequency in all patients.

# CASE REPORTS

## Case 1

A 57-year-old man who smoked one pack of cigarettes and drank 1 litre of wine per day was in good health until July 1978, when he had the sudden onset of clonic movements in his right hand. Some days later he developed a focal seizure involving his right upper arm and the right side of his face, with loss of consciousness. He was treated with phenytoin, but he continued to have right-sided focal seizures. He was admitted to our neurosurgical department in November 1978 after one of these attacks. Neurological examination showed only a hypalgesia in the right arm.

Routine laboratory investigations were normal. An electroencephalogram (EEG) and a computed tomographic (CT) scan were also normal. Bilateral carotid angiography showed a complete occlusion of the left internal carotid artery (ICA) at its origin.

In December 1978, a left EC-IC anastomosis was performed. The patient has had no seizures since his operation and a postoperative arteriogram has shown patency of the anastomosis. When last examined in October 1982, the patient had no symptoms and the EEG continued to be normal. He stopped drinking and smoking, and he has not been on

anticonvulsants since the day of operation. He is being treated with aspirin, 500 mg every 8 hours.

### Case 2

This 65-year-old hypertensive man smoked about 25 cigarettes a day. In March 1980 he had the sudden onset of clonic movements in his left hand. Two days later he had several jacksonian seizures in his left limbs without loss of consciousness. In the following days, he showed similar episodes in spite of treatment with phenytoin and phenobarbital. Consequently, he was admitted to our neurosurgical service.

On neurological examination, the only neurological deficit was an increase in the tendon reflexes in the left limbs. His blood pressure was 180/112 mm Hg; an EEG and a CT scan were normal. A bilateral carotid angiogram showed complete occlusion of the right ICA at its origin.

On April 25, 1980, a right EC-IC anastomosis was performed. A right carotid angiogram 3 months later showed a patent anastomosis. Since then, the anticonvulsant treatment has been stopped and he has had no other seizures. He takes aspirin, 500 mg every 8 hours.

# Case 3

This 47-year-old man smoked more than one pack of cigarettes and drank almost 2 litres of wine a day. In May 1980, while sleeping, he had a right focal seizure for a few seconds. After that, he noticed difficulty in speaking for 3 hours. In July, he had a new focal attack and he was started on phenytoin. In September, he suffered two new episodes and, therefore, was admitted to our service.

The medical and neurological examinations were normal, as were the EEG and the CT scan. A bilateral carotid angiogram showed total occlusion of the left ICA at its origin. On October 31, 1980, an EC-IC bypass was performed; since then, the patient has remained asymptomatic. He stopped drinking and smoking, and the only medication he is taking is aspirin, 500 mg every 8 hours.

### Case 4

This 53-year-old man smoked two packs of cigarettes and drank 1 litre of wine per day. In March 1979, he experienced

TABLE 1
Summary of the Five Clinical Cases

Case	Symptoms	Signs	<b>EEG Findings</b>	CT Findings	Angiography Findings
1	Clonic movements of the right hand; sei- zures involving the right arm and the right side of the face	Slight hypoalgesia of the right arm	Normal	Normal	Total occlusion of the left carotid artery at the cervical bifurcation.
2	Left jacksonian seizures	Increased tendon re- flexes in the left limbs	Normal	Normal	Total occlusion of the right carotid artery at the cervical bifurcation
3	Right focal seizures	Asymptomatic	Normal	Normal	Total occlusion of the left carotid artery in the neck
4	Clonic movements of the right hand; right hemiparesis and mo- tor aphasia	Right hemiparesis	Theta rhythm in the left hemisphere	Low density lesion in the left tempo- rooccipital region	Total occlusion of the left carotid artery in the neck
5	General seizures; weak- ness in the right limbs and motor aphasia	Right hemiparesis and major motor aphasia	Slow wave activity in the left hemi- sphere	Low density lesion in the left parietal region	Total occlusion of the left carotid artery in the neck

clonic movements in his right hand 4 or 5 times a day for 2 days. The clonic movements stopped without specific treatment. In May 1979 he again noticed the same movements in his right hand for 10 hours. Afterward, he noticed slight weakness in his right leg. His motor deficit disappeared in 12 hours, but 10 minutes later he had a right focal seizure and he developed a right hemiparesis and dysphasia, which gradually resolved.

In June 1979 he was admitted to our neurosurgical department because of a new focal seizure. On neurological examination he was found to have expressive aphasia and right hemiparesis. The aphasia disappeared in 48 hours, but the hemiparesis persisted. An EEG showed a theta rhythm in the left hemisphere and the CT scan showed a low density lesion in the left temporooccipital region.

On June 15, 1979, the patient underwent an EC-IC anastomosis. By March 1980, the EEG had returned to normal. By December 1982, his right hemiparesis had resolved. The anticonvulsant drugs were stopped after several EEGs were normal, and he has been free of seizures for 1 year. He stopped drinking after his operation, and the only treatment that he is currently receiving is aspirin, 500 mg every 8 hours.

### Case 5

This 56-year-old man smoked a pack of cigarettes and drank 1 litre of wine per day. In October 1978, he noticed episodes of amaurosis fugax in his left eye and dysesthesias in his right hand. Eight months later, he had a generalized seizure with loss of consciousness. He continued having generalized seizures for 2 days until he developed a right hemiparesis and expressive aphasia.

An EEG showed slow wave activity in the left hemisphere, and a CT scan showed a low density lesion in the left parietal region. Bilateral carotid angiography showed total occlusion of the left ICA at its origin. In September 1979, an EC-IC anastomosis was performed. The postoperative angiogram 3 months later showed a patent anastomosis. The patient was last checked in November 1982. At that time he had only a minor right hemiparesis. He has never had any other seizures. The anticonvulsants were stopped 1 year after the operation. He also stopped drinking and smoking after his operation. His only current treatment is aspirin, 500 mg every 8 hours.

### DISCUSSION

The relationship between seizures and cerebral ischemia has been known for a long time. In 1864, Jackson called attention to this matter, particularly in patients with embolic cerebrovascular occlusion (4). Aring and Merrit in 1935 (1) and Dodge and coworkers in 1954 (3) reported autopsy studies in which they correlated the occurrence of seizures and nonembolic cerebral infarctions. Louis and McDowell studied 1000 patients with stroke and found that 77 had epileptic seizures, either during the acute phase of the stroke or subsequently (6). Jensen, in 1964, studied 1008 adult patients with epileptic seizures; in 88 cases (8.7%) he thought that the seizures were of cerebrovascular origin (5). He also showed that this incidence increased with age so that, in patients whose seizures started after age 50, a cerebrovascular etiology was suspected in 69.2%. More recently, Rohmer and coworkers found that, in a group of 1003 patients with cerebrovascular abnormalities, 107 patients (10.7%) had focal or generalized epileptic attacks (8). Cocito and colleagues investigated 141 patients with angiographically proven ICA or middle cerebral artery (MCA) occlusion; epileptic seizures occurred in 17.3% of the patients with ICA occlusion and in 10.8% of the patients with MCA occlusion (2).

Penfield and Jasper stated that, in older adults, the most common causes of epilepsy are head injury, cerebral neoplasms, and cerebrovascular disease (7). White et al. studied 107 patients who had the onset of epilepsy after the age of 50 and found that cerebrovascular disease was the cause of seizures in 46% of the cases, whereas only 11% were related to cerebral tumors (11).

In all of these reports, cerebrovascular disease occupies an important position as a pathogenetic factor in adult epilepsy. However, in most of these articles there is a lack of information about the angiographic studies and the type of cerebrovascular lesion. Such diverse causes as cerebral thrombosis, embolism, hemorrhage, or aneurysm are lumped together, and this makes it difficult to examine the importance of each specific disease process. Many authors comment on the appearance of seizures during or after a stroke, but few mention that the seizures may precede the stroke and have significance as a warning sign of future stroke (9). Rohmer et al., among

their 491 patients with cerebral infarction, found only 3 cases in which the seizures preceded a stroke (8). However, Louis and McDowell, in their group of 33 patients with seizures, found that in 13 the seizures preceded the stroke (6). In another report, epilepsy was the presenting symptom in 6.7% of the patients with carotid occlusive disease (2).

In our small group of five patients, three presented with seizures without motor deficit, but in the other two cases the seizures were a warning of a stroke to come.

Dodge et al. indicated that, when seizures occur after cerebral infarction, the infarct has to involve the sensorimotor cortex (3). In our first three cases, we could not detect the presence of a major cerebral infarct by EEG, CT scan, or clinical criteria. These patients could possibly have had an embolic infarction that was too small to be detected by EEG and CT scan. However, the fact that they had no further seizures after EC-IC bypass suggests that their symptoms could have been due to functional hemodynamic changes in the brain tissue as a result of low flow without major structural damage. These patients, who had suffered from seizures for several weeks without any benefit from different anticonvulsant drugs, have been completely free of attacks since their EC-IC bypass procedure.

In Cases 4 and 5, a motor deficit developed after several seizures. In these cases the seizures could have resulted from episodes of transient ischemia. In both of these patients, the CT scan showed a low density lesion compatible with the diagnosis of infarct. In Case 4, there was a complete recovery, but in Case 5 the recovery was incomplete.

All of our patients except one were heavy smokers and drank between 1 and 2 litres of wine a day. It is possible that these factors played an important role in the genesis of their cerebrovascular disease as well as their seizures. Because they have not been drinking since the time of operation, it could be argued that this is indeed the reason that the seizures stopped. We think, however, that this explanation is too simplistic, particularly in view of the fact that some had already stopped drinking because of the seizures before operation and in spite of this had continued to have seizures until the time of operation.

The evolution of our patients seems to indicate that seizures in patients with cerebrovascular disease could be provoked not only by a cerebral infarction, but also probably by low blood flow without irreversible changes. We do not have the benefit of blood flow studies to prove that the patients did have low flow regions, but it would be interesting to have this information in the future. Wider experience is necessary before EC-IC bypass procedures can be generally recommended for patients with seizures and cerebrovascular occlusive disease. This report is designed to stimulate others to study further the relationship between seizures and cerebrovascular insufficiency.

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### **COMMENTS**

This is an interesting but difficult paper. The authors have made a case for seizures being a manifestation of cerebrovascular disease. The issue, however, needs to be developed a bit more clearly. When seizures result from a fixed infarction, they tend to be acute and self-limited at the time of the infarction in approximately 4% of strokes (and require no specific therapy), or they develop late as a fixed epilepsy and are easily managed with anticonvulsants in another 4% of strokes. The issue of seizures as a manifestation of ongoing, transient ischemia—and therefore potentially treatable by preventing recurrent ischemia (e.g., by EC-IC bypass)—is much more controversial. This is a very important issue that needs further examination, as it may lead to the widespread use of carotid endarterectomy or EC-IC bypass for the treatment of seizures in patients with cerebrovascular disease.

The "heavy" alcohol consumption by the patients, the cessation of drinking, and the resolution of the seizures make it likely that the cessation of drinking is the cause of the cure, not the EC-IC bypass. The authors properly emphasize this issue, but interpret it differently. I would like to see a similar study of "nonalcoholic" seizure patients before coming to even the tentative conclusion arrived at by the authors.

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The authors present five patients who came to medical attention because of seizures and who were found to have occlusion of an internal carotid artery. In four of these patients, epilepsy had been the initial symptom and, in the fifth, the seizures were preceded by transient ischemic attacks. The former four patients had focal seizures and in each case the occluded carotid artery was ipsilateral to the involved hemisphere. Each patient was treated with an EC-IC bypass and, in all, the seizures stopped in spite of discontinuation of anticonvulsant treatment at variable times after the operation. As the authors point out, four of these patients were heavy drinkers and all stopped drinking: therefore, it is possible that the cessation of the seizures was related to this fact rather than to the bypass procedure.

The value of this paper lies not in the implication, which the authors do not make, that epilepsy can be treated by revascularization, but rather in the questions that it opens about the cause of epilepsy. Three of the patients reported in this paper had normal EEGs and CT scans, which suggests, but of course does not prove, that their seizures occurred in the absence of cerebral infarction. We all accept that seizures can occur as a consequence of cerebral infarction, especially when the cause is embolic. Can seizures, however, be a manifestation of cerebral ischemia without definitely established parenchymal infarction? There is at least experimental

support for the notion that increased neuronal activity and seizure discharges can occur as the regional cerebral blood flow falls, provided that it does not fall below the threshold where electrical silence is expected (3). Can epilepsy be the presenting symptom in patients with cerebrovascular occlusive disease? Indeed, this paper, as well as others (1, 4-10), suggests that it can and that this is not such a rare phenomenon, a fact that seems to be better recognized in European centers (1, 2, 8, 10). Finally, is there a role for surgery in the "treatment" of epilepsy associated with cerebrovascular occlusive disease? Certainly, when the seizures are due to infarction from thromboembolism originating in a stenotic carotid plaque, endarterectomy is of obvious value to prevent further damage (7). However, if the problem is not embolic infarction but rather functional "ischemia," can revascularization help? This paper offers at least anecdotal affirmative evidence to this effect.

The publication of this paper will only be of value if, as hoped by the authors, it will "stimulate others to study further the relationship between seizures and cerebrovascular insufficiency."

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