THE EC/IC BYPASS STUDY was a randomized study evaluating the prophylactic value of a superficial temporal artery to middle cerebral artery (MCA) bypass in patients with TIA or non-devastating stroke due to atherosclerotic bilateral occlusion of the middle cerebral artery (MCA) trunk before entering the trial. Nine patients were found to have bilateral occlusion of the MCA trunk before entering the study and were subsequently followed. This paper presents the clinical, radiologic and follow-up data of these 9 patients; to the best of our knowledge, no series of patients with bilateral MCA occlusion has been published previously.

Methods and Case Reports
Nine of 1,377 patients from the EC/IC Bypass Study were found to have bilateral occlusion of the MCA trunk, from the origin of the MCA to the origin of the first branch of trifurcation. To enter the EC/IC Bypass Study, all patients had to have had a TIA or a non-devastating stroke within three months of entry. In order to study only patients with atherosclerotic vascular disease, patients with severe strokes, fibromuscular dysplasia, arteritis, blood dyscrasia and heart disease as a source of cerebral emboli or decreased cerebral perfusion were excluded. The follow-up procedure included a neurological re-evaluation every three months, with evaluation of delayed stroke, TIA, functional disability and death.
During follow-up, special attention was paid to the control of risk factors, such as hypertension or diabetes.

**Case 1**

This 34-year-old, smoking (20 cigarettes/day for 15 years), hypertensive, diabetic, black male construction worker experienced, in 1980, a transient (3 minute) episode of brachiocephal weakness on the right side, which occurred 4 months later. Two months later, the same symptoms recurred and persisted. On examination 6 weeks later, minimal weakness with increased tendon reflexes were noted in the right arm and leg. Blood pressure was 110/60 mm Hg, with regular pulsations (74/min.); general examination was normal. A CT scan showed a lucent area in the head of the caudate nucleus extending towards the white matter of the frontal lobe, on the left side. Angiography (bilateral carotid and right vertebral) showed occlusion of both MCAs at their origin with good retrograde collateral filling from the anterior and posterior cerebral artery branches. The intracranial segment of the right ICA was mildly stenosed. Standard blood clotting studies and an ECG were normal. He was randomized to medical treatment alone. During a 50-month follow-up period, he did not suffer any further cerebrovascular events. His medical treatment included initially Aspirin 325 mg. q.i.d., but this was discontinued by the patient after a few weeks. At 18 months, he suffered generalized seizures in the context of acute alcohol ingestion. At the end of follow-up, he had been able to resume his usual activities without difficulty and his sole disability was related to a moderate diabetic polyneuropathy.

**Case 2**

This 44-year-old Japanese male in 1975 suffered a stroke in the right hemisphere with sudden onset of speech disturbance, left-sided motor weakness and sensory changes. An angiogram done at that time disclosed an occlusion of the right MCA trunk. A left carotid angiogram was not performed. The patient rapidly recovered, with persistence of a moderate weakness in the left arm; two months after the stroke he underwent a superficial temporal artery to MCA bypass on the right side. Four and a half years later, in 1980, he experienced progressive numbness in the right upper limb with speech disturbance, which stabilized after one day. On examination 3 weeks later, he had a mild motor dysphasia, a left hemiparesis with increased tendon reflexes, Babinski’s sign (sequela of the 1975 stroke) and normal sensation. Blood pressure was 110/70 mm Hg, with a regular pulse of 80/min. Bilateral carotid and vertebral angiography showed occlusion of the left MCA at origin and of the right MCA just after the origin of the ganglionic branches. Good retrograde collateral supply was provided by the distal leptomeningeal branches of the anterior and posterior cerebral arteries. The internal carotid arteries were normal. A CT scan showed a small lucency lateral to the head of the caudate nucleus on the left and a larger parieto-occipital hypodense area on the right. Standard blood tests and an ECG were normal. The patient was randomized to medical treatment alone and regularly took Aspirin 325 mg. q.i.d. He did not suffer any further cerebrovascular event during a 59-month follow-up period. At 18 months, he had a generalized seizure with a post-ictal transient increase in his left hemiparesis. At the end of follow-up, neurological examination showed a minor motor aphasia with a moderate hemiparesis which had not changed since entry into the EC/IC Bypass Study. The patient had been able to resume his previous activities, though with some difficulty.

**Case 3**

This 49-year-old hypertensive and hypercholesterolaemic Japanese housewife complained in early 1981 of a slight decrease in memory. Six months later, she woke up with a headache and motor weakness in the right upper and lower limbs, which disappeared within one hour. On examination 4 days later, only slight memory difficulties were noted. Blood pressure was 160/90 mm Hg, with a regular pulse of 90/min. Bilateral carotid and vertebral angiography showed bilateral occlusion of the middle cerebral arteries at their origins, with good collateral retrograde filling from the anterior and posterior cerebral artery leptomeningeal branches. The extracranial portion of the left ICA showed only moderate irregularity. The left MCA occlusion was just distal to an intracranial ICA occlusion. The right ICA showed a moderate stenosis at its origin from the common carotid artery and a moderate stenosis in its intracranial segment with a suspected ulcer. A CT scan showed a cortico-subcortical hypodense area in the left frontal lobe. Standard blood tests were normal, with the exception of a cholesterol level of 341 mg/dl. An ECG was normal. During a 41-month follow-up, the patient did not suffer any further cerebrovascular events. She was compliant to her antihypertensive medication but discontinued Aspirin because of gastrointestinal side effects. An ECG done in the third year of follow-up showed that she had suffered a silent myocardial infarct. At the end of follow-up, the neurological examination was normal and she had returned to her previous activities.

**Case 4**

This 69-year-old hypertensive male Chinese military officer suffered left-sided weakness and numbness of sudden onset in 1982. On examination, three days later, a left-sided facio-brachio-crural hemiparesis was present, with increased tendon reflexes; sensation was normal. Blood pressure was 140/90 mm Hg, with a regular pulse of 76/min. Bilateral carotid angiography showed bilateral occlusion of the MCA at their origins, with good collateral retrograde filling from the anterior and posterior cerebral artery branches. The left ICA showed a mild intracranial stenosis and the right ICA showed a mild stenosis at its origin. A CT scan showed a deep frontotemporal lucency on the right side. Standard blood tests were normal. An ECG showed signs of left ventricular hypertrophy. He was randomized to
medical treatment alone and was put on Aspirin 325 mg. q.i.d. After 26 months he suffered a smoothly progressive right carotid artery territory stroke, with marked increase in the left-sided weakness and mutism. He remained severely disabled and four months later he was observed to be comatose, with decerebrate posturing to painful stimulation and absent vestibulococular response, suggesting a vertebrobasilar stroke. He died three days later. No autopsy was performed.

Case 5

This 38-year-old white male mechanic experienced three episodes of right arm weakness in 1980 lasting 5 minutes. Four months later he suddenly experienced speech disturbances with right-sided motor weakness. The motor weakness cleared up within 5 minutes but the speech disturbance persisted. On examination six weeks later, a mild motor dysphasia and a slight right-sided facio-brachial weakness with increased tendon reflexes were noted. Blood pressure was 120/80 mm Hg, with a regular pulse of 80/min. Bilateral carotid angiography showed bilateral occlusion of the MCA at their origins. Late films to visualize the collateral circulation were not obtained. The intracranial segment of the ICA was mildly stenosed on the right and moderately stenosed on the left. Standard blood tests were normal. An ECG showed signs of left ventricular hypertrophy. The patient was randomized to surgical treatment and he underwent an EC/IC bypass with anastomosis of the anterior and posterior branches of the superficial temporal artery and a temporal branch of the MCA on the left side. He also received 1500 mg of Aspirin per day. The bypass was patent on angiography performed after one week, but the flow through the bypass was slow, with only slight retrograde flow in the MCA trunk. He had no peri-operative complications and did not suffer any further cerebrovascular events during a 53-month follow-up period. At 48 months, he was submitted to surgery for an acute occlusion of the right temporal artery. At the end of follow-up, he still had a very mild right-sided hemiparesis, but had been able to resume all his previous activities without difficulty.

Case 6

This 58-year-old hypertensive Japanese female who smoked cigarettes and who was a textile worker suffered a myocardial infarct in 1975. In 1981, she experienced left-sided weakness and numbness which progressed smoothly over five days, associated with left hemianopia and confusion. On examination one month later, a moderate left brachio-cranial hemiparesis with increased tendon reflexes, Babinski’s sign and hemianopia were present. Blood pressure was 150/80 mm Hg, with a regular pulse of 60/min. Carotid angiography showed occlusion of the ICA up to the skull. Right carotid angiography showed bilateral occlusion of the MCA at their origins with good retrograde collateral filling on the right from the leptomeningeal branches of the anterior and posterior cerebral arteries; no late films were obtained on the left side. An ECG showed a right parieto-temporal infarct. Standard blood tests and an ECG were normal. The patient was randomized to surgery and she underwent an EC/IC bypass with anastomosis between the anterior branch of the superficial temporal artery and a temporal branch of the MCA on the right side. There were no perioperative complications. The bypass was patent on angiography two weeks later, but retrograde flow as far as the MCA trunk was only slight. She was not compliant to Aspirin treatment but followed her antihypertensive therapy. During a 45-month follow-up period, no further cerebrovascular events occurred. At the end of follow-up, she had persisting left hemianopia and hemiparesis, but had been able to resume her previous activities.

Case 7

This 61-year-old diabetic (insulin-independent) male janitor from Mongolia experienced, in 1981, a
left hemiparesis with confusion just after waking up, which completely recovered within 40 days. Seven months later, he woke up with a right-sided weakness and speech disturbances, which persisted. On examination two months later, a minor motor dysphasia with emotional incontinence, a right-sided facio-brachio-crural hemiparesis and hypoesthesia with increased tendon reflexes were present. Blood pressure was 135/85 mm Hg, with a regular pulse of 80/min. Bilateral carotid and left vertebral angiography showed bilateral occlusions of the MCA at the origin of the artery on the right and at the trifurcation on the left, with retrograde collateral supply from the anterior and posterior cerebral artery branches; there was moderate extra- and intracranial stenosis of the right ICA with suspicion of an ulcer distally. A CT scan showed an old deep frontal infarct on the right side and a recent extra- and intracranial stenosis of the right ICA with retrograde collateral filling from the anterior and posterior cerebral arteries was present on both sides. A CT scan showed a large corticosubcortical infarct in the territory of the left MCA. Standard blood tests and an ECG were normal. The patient was randomized to surgery and underwent an EC/IC bypass with anastomosis between the posterior branch of the superficial temporal artery and the central branch of the MCA on the left side. He received Aspirin 375 mg. q.i.d. The bypass was patent on angiography two weeks later, with a good retrograde flow to the MCA bifurcation. There were no perioperative complications. Until his death 16 months later from a sepsis (urinary tract infection), the patient did not suffer any further cerebrovascular events. He had made little recovery from his presenting stroke and remained functionally disabled.

Case 9

A 47-year-old smoking male Chinese who worked as an engineer experienced in 1981 a two-hour episode of quadriplegia, with complete recovery. The following morning, he woke up with a right-sided weakness and numbness, which moderately improved over the following weeks. Examination three months later, a right-sided facio-brachio-crural hemiparesis and superficial hypoesthesia, with increased tendon reflexes, Babinski's sign and hemiplegic gait were present. Bilateral carotid and left vertebral angiography showed bilateral occlusion of the MCA trunk, in the preganglionic segment on the left and in the postganglionic segment on the right. Retrograde collateral filling from the leptomeningeal anastomosis of the anterior and posterior cerebral arteries was present on both sides. A CT scan showed two small infarcts in the left hemisphere, one in the internal capsule and one in the frontoparietal region. Standard blood tests and an ECG were normal. The patient was randomized to surgery and he underwent an EC/IC bypass with anastomosis between the posterior branch of the superficial temporal artery and the central branch of the MCA on the left side. He was also put on Aspirin 300 mg. t.i.d. There were no perioperative complications. The bypass was patent on angiography two weeks later, but no retrograde flow to the proximal segment of the MCA was visualized. During a 35-month follow-up period, he did not suffer any further cerebrovascular events. At the end of follow-up a right-sided hemiparesis with decrease in pain and temperature sensation was still present. The patient had been able to go back to work, though with some difficulty.

Clinical Evaluation at Time of Diagnosis

Five patients had only unilateral events (one had a silent contralateral infarct on CT): stroke in 2, TIAs and stroke in 2, and only TIAs in 1. Four patients had events on both sides, in one instance simultaneously: strokes on both sides in 3 (with unilateral TIAs in one), TIAs on both sides and a unilateral stroke in 1. Thus, 5 of the 18 MCA occlusions were asymptomatic and 13 were symptomatic (stroke in 7, TIA and stroke in 4, only TIA in 2).

Overall, eight patients suffered at least one stroke in the MCA territory: unilateral stroke in 2, unilateral stroke preceded by ipsilateral TIAs in 2, unilateral stroke preceded by ipsilateral and contralateral TIAs in 1, strokes on both sides in 2, strokes on both sides preceded by unilateral TIAs in 1. Five strokes were immediately completed and three had a smoothly progressing onset. Only one patient had isolated (unilateral) TIA, but on CT he had a small deep infarct appropriate to the symptoms. Overall, five patients experienced hemisphere TIAs, which involved both sides in only one case. The mean number of TIAs per patient was 2.4 ± 4 with a mean duration of 30 min (3-120). Four of these five patients went on to a stroke before entering the study, in one instance one day after the TIA, but in the other three cases more than three months after the onset of the TIAs.

Angiographic Features

Five patients had bilateral MCA occlusion at the origin. In 4, occlusion was in the preganglionic segment on one side and in the postganglionic segment on the other side. Late films evaluating the collateral circulation were obtained in 14 occlusions, with good retrograde filling from the leptomeningeal anastomosis with the anterior and posterior cerebral arteries in all instances; no difference was noted between the symptomatic and asymptomatic sides.

Associated disease of the ICA was present in 7 patients: bilateral mild to moderate stenosis in 3, occlusion on the symptomatic side and moderate stenosis on the other side in 1, mild stenosis on the symptomatic side in 1, occlusion on the symptomatic side in 1, mild stenosis on the asymptomatic side in 1. The intracranial segment of the ICA was involved in 7 instances and the extracranial segment in 4 instances. No associated lesion of the other intracranial arteries was observed.

Associated Risk Factors and Vascular Disease

Five patients had chronic hypertension, 4 were cigarette users, 2 had diabetes mellitus, and one had hypercholesterolaemia (>280 mg/dl). The mean number of the four risk factors per patient was 1.3 (0-3). One patient had suffered a myocardial infarct in the past and 3 showed evidence of left ventricular hypertrophy on ECG.
Follow-up

Five patients had an EC/IC bypass on the symptomatic side (one had a bypass on both sides) and four patients were put on medical treatment alone. The mean duration of follow-up was 45 months (51 months in the living patients, range 35–72 months). Two patients died, one as a result of a sepsis due to a urinary tract infection 16 months after entry into the study, and the other from a vertebrobasilar stroke 30 months after entry. This patient was the sole patient who suffered cerebrovascular events during follow-up: he had a severe stroke ipsilateral to one of the occluded MCA after 26 months, which was followed 4 months later by the fatal vertebrobasilar stroke. Two other patients had generalized seizures, which were related to a previous stroke in one and to acute alcohol consumption in the other. One patient had a silent myocardial infarct. Five of the 7 survivors had abnormal neurological findings other than the 3 employed patients.

Follow-up was similar in the operated (44 months) and the non-operated (45 months) patients. One patient died in each group. The patient who had strokes (two) during follow-up was in the non-surgical group. The sole case of vascular seizures occurred in the medical group.

Comments

This study on selected patients demonstrates that atherosclerotic bilateral MCA occlusion can present with rather minor symptoms and when it does so, it appears to have a reasonable long-term prognosis. During follow-up, only one patient suffered further cerebrovascular events; he was also one of the 2 patients who died. There was no cardiac death and only one patient had a myocardial infarct during follow-up, which was asymptomatic.

The predisposition of Asians to have more severe intracranial atherosclerotic arterial disease1,3,4 was confirmed, because 7 of the 9 patients were either Japanese or Chinese.

It is worth stressing that 5 patients had only unilateral symptoms: 5 of the 18 MCA occlusions were asymptomatic. The rather low severity of symptoms due to occlusion of the MCAs may probably be explained by the finding in all patients of a universally excellent collateral retrograde filling of the MCA branches through leptomeningeal anastomosis with the anterior and posterior cerebral arteries. This good flow from physiological collateral channels may explain why substantial retrograde flow was not seen after the EC/IC bypass in the 5 operated patients, although patency of the anastomosis was achieved in all of them.

We were able to find only one case of bilateral occlusion of the MCA trunk, related to subarachnoid hemorrhage, in the literature.2 This patient was admitted to hospital because of a ruptured anterior communicating artery aneurysm and it is not impossible that the occlusion of the MCA’s was related to vasospasm. The long-term prognosis is usually good for patients with unilateral MCA occlusion not due to cardiac embolism and for those who do not present with a devastating stroke.3 This was found also to be true for bilateral MCA occlusion in the present study. The number of patients is too low to judge the value of the EC/IC bypass done in 5 of them. The results of the Cooperative Study of Extracranial/Intracranial Arterial Anastomosis are analyzed elsewhere,4 and the EC/IC bypass does not provide any benefit in the reduction of delayed stroke, stroke and death, or functional outcome including the subgroup of patients with MCA occlusion. The quality of the retrograde MCA filling through leptomeningeal collaterals probably determines the severity of the presenting events; our study shows that in the patients with bilateral MCA occlusion presenting with TIAs or a minor stroke, delayed cerebrovascular events occur rarely and the long-term disability is at a reasonable level.

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