Surgical Considerations of Cerebral Infarctions after Brain Tumor Removal in Five Patients with Poor Outcome

Akira Fukamachi¹, Hidehito Koizumi¹, Hideaki Nukui¹, and Hideo Kunimine²

Departments of Neurosurgery, Yamanashi Medical College and Gunma University School of Medicine

Abstract: We encountered five patients whose operative outcomes were poor because of cerebral infarctions after brain tumor surgery. Their causative mechanisms were analyzed. In two patients with sphenoid ridge meningioma, the internal carotid artery (ICA) and middle cerebral artery (MCA) were injured during gutting the tumors with a loop electrode and a YAG laser. The arteries were occluded with clips. In one patient with craniopharyngioma, the origin of the MCA was torn after retraction of the frontal lobe and the ICA was also torn during a hemostatic maneuver. The rents were sutured but these vessels were eventually occluded. In another patient with craniopharyngioma, the root of a branch of the ICA was damaged by traction of the tumor and a Heifetz's encircling clip was applied for hemostasis. However the ICA was occluded postoperatively because of a distortion in the clip. In a patient with dermoid tumor in the Sylvian fissure, several small arteries buried in the tumor capsule around the bifurcation of the ICA were coagulated and then cut off. Postoperative computed tomography demonstrated that these small vessels had been the perforating arteries to the basal ganglia and internal capsule.

Key words: Postoperative complications, Cerebral infarctions, Arterial injuries

INTRODUCTION

Postoperative complications have often occurred after brain tumor removals using craniotomy¹–⁶. In 301 cases between August 1976 and April 1986, we reported the incidence and prognostic significance of the complications using computed tomography (CT) scans¹. In association with the complications, poor outcomes and death occurred in the following frequencies: intracerebral hemorrhage, 4% (deaths, 2%); cerebral infarction, 1.7% (deaths, 0.7%); cerebral edema, 0.7% (deaths, 0.7%); simple intraventricular hemorrhage, 0.7% (no deaths); tension pneumocephalus, 0.7% (no deaths)¹.

Thus, from the point of view of incidence, postoperative cerebral infarctions can result in the poorest outcome, next to intracerebral hemorrhages. However, there have been very few reports regarding the causes of infarctions in the literature. We believe that an etiological knowledge is very important in preventing such complications in the future. In this paper, we will discuss the causes of the arterial occlusions in the five patients who experienced poor outcomes in the above-mentioned cases.
CASE REPORTS

The five patients with the poor outcomes associated with the postoperative cerebral infarctions ranged from 15 to 52 years in age. There were three men and two women. Histologically there were two sphenoid ridge meningiomas, two craniopharyngiomas and one dermoid tumor in the Sylvian fissure. Occlusion in the intracranial internal carotid artery (ICA) in three patients, the middle cerebral artery (MCA) in one patient and the perforating arteries from the anterior cerebral artery (ACA) and MCA in one patient resulted in cerebral infarctions. The outcome was death in two patients and severe disability in the other three.

The outcomes were evaluated according to the Glasgow Outcome Scale at the time of discharge from the hospital. Poor outcome was defined as severe disability, persistent vegetative state and death. The level of consciousness was also evaluated according to the Glasgow Coma Scale (GCS).

Case 1: A 46-year-old woman exhibited a 2-year-history of headaches, vomiting, character change and generalized convulsive seizures. She had loss of the right olfaction, anisocoria (right > left), left homonymous hemianopia, slight left hemiparesis and left facial hypesthesia. A CT scan and carotid angiogram showed sphenoid ridge meningioma (clinoidal type) of 6 cm in maximum diameter (Fig. 1-A).

In 1979, she underwent a subtotal tumor removal via a right frontotemporal craniotomy. It was confirmed by the inspection of the chiasmal region that the right ICA had been completely encased by the tumor. Gutting was performed from the lateral side of the tumor. After the third and fourth cranial nerves were ascertained, the tumor was further removed with a monopolar loop electrode, and then profuse bleeding occurred. The ICA was confirmed to have been severed and it was eventually clipped. Cross filling was judged to be sufficient because of the pulsation of the ACA and MCA.

Immediately after the operation, she revealed a GCS score of 14 and an exacerbation of the left hemiparesis. The next day her GCS score fell abruptly to 3 and she died 5 days later. Postoperative CT scan showed a wide low-density area in the right cerebral hemisphere (Fig. 1-B).

Case 2: A 15-year-old man suffered from obesity, vomiting, stunted growth, polydipsia, polyuria, poor left visual acuity,
Fig. 2. Right preoperative (A) and postoperative (B) carotid angiograms of Case 2. The internal carotid artery was completely occluded 2 to 3 mm below a Heifetz's encircling clip.

Fig. 3. Postoperative carotid angiograms of Case 3. R: Right arteriogram shows a cross filling to the left side. L: Left arteriogram shows a complete occlusion of the left internal carotid artery just at the lower margin of a Heifetz's encircling clip. Distortion of the axes of the clip and the artery is shown.
optic atrophies and right hemiparesis for 4 years. He underwent a subtotal removal of a craniopharyngioma via a right subfrontal approach 1 year ago. In 1980, he abruptly showed a marked change in consciousness and vomited frequently. On admission to hospital he revealed a GCS score of 7 and bilateral pyramidal signs without any paresis of limbs. A CT scan demonstrated a recurrent craniopharyngioma that was 4.5 cm in maximum diameter with a remarkable ventricular enlargement. Immediately after his hospital admission, he underwent a right ventriculoperitoneal shunt and his GCS score became 14.

The recurrent tumor was removed subtotally via the same approach as the first tumor. After the removal of the lower half of the tumor from the subchiasmatic space, the frontal lobe was retracted by a spatula to inspect the upper part. At that time the originating portion of the MCA tore. The cisternal portion of the ICA was also torn by clip application to stop the massive arterial bleeding. Under a temporary clipping of the ICA for as long as 3 hours, the rents with irregular edges were sutured and a Heifetz's encircling clip was applied to the ICA. A superficial temporal-middle cerebral arterial anastomosis was not performed because of the lack of appropriate donor and recipient arteries.

After the operation, he showed GCS scores between 11 and 7 and had complete left hemiplegia. He contacted purulent meningitis from pseudomonas aeruginosa and died 3 months later. A postoperative CT scan revealed an infarction in the area supplied by the left MCA, and a carotid angiogram demonstrated a complete occlusion of the ICA at the lower margin of the clip. A distortion of the longitudinal axes of the ICA and clip was found (Fig. 3).

Case 3: A 38-year-old man exhibited a 3-month-history of left visual disturbance and headaches. He showed left optic atrophy and a visual field defect of the left temporal and lower quadrant. A plain craniogram and CT scan revealed a markedly calcified craniopharyngioma of 2 cm in maximum diameter.

In 1980, he underwent a subtotal removal of the tumor via a left frontotemporal craniotomy. After almost all of the tumor was removed from the subchiasmatic and left optico-carotid spaces, a hard part of the tumor near the sella floor was pulled out, and the maneuver resulted in a hemorrhage of the left ICA. It was thought that the root of a feeding artery was drawn out, and a Heifetz's encircling clip was eventually applied to the ICA after a temporary clipping for 30 minutes. The blood flow of the ICA was thought to be sufficient.

After the operation, he showed GCS scores between 13 and 10. In addition, he exhibited diabetes insipidus, complete right hemiplegia and aphasia. One and half months later, he was discharged from the hospital still suffering from the hemiplegia and aphasia. A postoperative CT scan revealed an infarction in the area supplied by the left MCA, and a carotid angiogram demonstrated a complete occlusion of the ICA at the lower margin of the clip. A distortion of the longitudinal axes of the ICA and clip was found (Fig. 8).

Case 4: A 52-year-old woman exhibited a 5-year-history of headaches, vomiting, dysphasia, a left visual disturbance and choked discs. A CT scan and carotid angiogram revealed a left sphenoid ridge meningioma of 5 cm in maximum diameter.

In 1982, she underwent a tumor removal via a left frontotemporal craniotomy. An inspection of the medial part of the tumor revealed that the first major branch of the left MCA was completely encased by the tumor. The tumor was removed piece by piece using a YAG laser.
and a loop electrode. The laser cut the first branch in the midst of maneuver. Hemostasis was achieved by clipping the branch at a site several millimeters distal to the MCA bifurcation. The other major branch of the MCA could be separated from the tumor, although its size became smaller.

After the operation she showed amnestic aphasia, memory disturbance, right hemiparesis and right hemihypesthesia. She was later discharged from the hospital still suffering from these ailments. A postoperative CT scan revealed an infarction of the area supplied by the left MCA. A carotid angiogram showed complete occlusion of the MCA at the M1 portion (Fig. 4).

Case 5: A 46-year-old man with a 15-year-history of generalized convulsive seizures and automatism showed disorientation and memory disturbance. A CT scan revealed a low-density mass in the left Sylvian fissure, which was later diagnosed as a dermoid tumor (Fig. 5-A).

In 1982, he underwent a tumor removal via a left fronto-temporal craniotomy. After the removal of a frail and keratinized content including a lot of hair, the capsule of the tumor was totally removed. The lower anterior part of the capsule was tightly adhered to the proximal portions of the MCA and ACA, and several small arteries entered or were buried in the capsule. After the coagulation and cutting of the small arteries, the capsule was separated from the major vessels.

After the operation he showed right hemiparesis, expressive aphasia, dyscalculia and agraphia. A postoperative carotid angiogram revealed that the MCA and ACA were patent, but a CT scan demonstrated an infarction of the left basal ganglia including the posterior limb of the internal capsule (Fig. 5-B).

**DISCUSSION**

Various complications\(^1\)\(^-\)\(^6\) can occur after brain tumor surgeries, and they are very
knowledge there are very few reports which have dealt specifically with the causes of the postoperative cerebral infarctions. Here we discuss the causes in our cases that experienced poor outcomes.

Cases 1 and 4 had sphenoid ridge meningioma and their major arteries were injured during the operations. The ICA in Case 1 and a major branch of the MCA in Case 4 were severed by a loop electrode and a YAG laser respectively. Hemostasis was achieved by clipping and occlusion of the arteries. The other branch of the MCA in Case 4 was eventually occluded. It was thought that the branch was occluded by postoperative exacerbation of vasospasm seen after the separation of the branch from the tumor or by the spread of thrombi formed in the cul-de-sac of the other clipped branch. Anyway, it was considered to be very dangerous to use a loop electrode or a YAG laser around the area where a major artery might be buried before its location can be confirmed with doppler sonography. Furthermore, it might be an important factor in arterial injury and infarction that the arterial wall embedded in a meningioma tends to be weak and easily injured.

In Case 2 with recurrent craniopharyngioma, retraction of the frontal lobe by a spatula caused a rent in the proximal portion of the MCA. The ICA was also injured during a hemostatic maneuver using a clip on the massive hemorrhage. Suturing the rents took a long time because of the irregular edges but the ICA was eventually occluded. A factor leading to the first hemorrhage might have been that originating portion of the MCA had been fragile due to compression and elongation by the recurrent tumor. Further the injury to the ICA might have made his outcome poorer.

In Case 3 with craniopharyngioma, ex-
traction of the firm part of the tumor caused the root of the feeding branch of the ICA to be extracted. The hemorrhage was eventually controlled by using a Heifetz's encircling clip; the blood flow of the ICA was thought to be sufficient at the time of the operation. However, a distortion of the clip resulting in the occlusion of the ICA was found on the postoperative angiogram. The distortion might have been caused by the return of the frontal lobe after the removal of a spatula. From this rare case we can note that the application of a firm encircling clip to a fragile and soft artery can cause a distortion of the clip and an occlusion of the artery when restoration of the brain occurs.

In Case 5 with a Sylvian dermoid tumor, it appears that the feeding arteries were coagulated and cut at the time of the separation of the tumor capsule from the main arteries. The former arteries were found to be the perforating arteries to the basal ganglia and internal capsule on a postoperative CT scan. It was thought that an important factor was the complete removal of the capsule as an operative goal for the surgeon. Furthermore, we must be aware that small arteries coming in or being buried in a tumor or a tumor capsule around the ICA bifurcation may be the perforating arteries and should not be sacrificed.

Considering the causes of the postoperative cerebral infarctions of these 5 patients, we feel that there were certainly unavoidable and unexpected infarctions in some cases. However more elaborate and precise maneuvers during operation could have prevented the arterial injuries and cerebral infarctions in all of the 5 cases. Furthermore, we believe that, if an arterial rent is made during an operation, suturing the rent in a short period of time or applying a metal shield to the rent should be tried first and, if they are not successful, an extra- and intracranial arterial anastomosis should be performed for the prevention of lethal or significant infarctions, although the anastomosis itself is now considered a controversial issue in reducing the risk of ischemic stroke.

REFERENCES