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Superficial Temporal Artery to Middle Cerebral Artery Double Bypass Via a Small Craniotomy

—Technical Note—

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Abstract

Frontotemporal craniotomy is usually necessary to perform superficial temporal artery (STA)-middle cerebral artery (MCA) double bypass for cerebrovascular occlusive disease. This report describes a less invasive technique of double bypass through a small craniotomy with minimum skin incision. Thirty-four consecutive patients underwent an elective STA-MCA double bypass via a small craniotomy from January 2006 to October 2009. The parietal and frontal branches of the STA were divided through a minimum linear or y-shaped skin incision, and these branches were anastomosed to the supra- and infrasylvian portions of the MCA. No periprocedural complication such as subdural hematoma or cutaneous necrosis occurred. Postoperative cerebral angiography within 6 months showed that the bypasses were patent in all 34 patients. Double STA-MCA bypass via a small craniotomy might be less invasive, especially for patients at high risk for postoperative hemorrhagic complication or cutaneous necrosis.

Key words: bypass, cerebral ischemia, less invasive technique

Introduction

The International Extracranial-Intracranial (EC-IC) Bypass Trial failed to show a benefit following surgery in patients with various degrees of angiographic internal carotid artery stenosis,[2] but other studies have suggested benefits in selected patients based on cerebral blood flow (CBF).[10,12,14] A recent systematic review indicated that patients with severe hemodynamic failure have higher risk of cerebral infarction and respond better to surgery than those with mild disease.[3] However, the indication for bypass is still controversial,[1,4,8,10–12,14] because no randomized trial has shown the beneficial effect of EC-IC bypass for cerebral ischemia. A randomized controlled trial, such as the Japanese EC-IC Bypass Trial (JET), will define the efficacy of this surgery in cerebrovascular occlusive disease with impaired CBF.[5,6] However, EC-IC bypass continues to be performed to prevent cerebral ischemic brain damage in various conditions that obstruct CBF, such as moyamoya disease, or parent artery occlusion to treat either a giant or large aneurysm.[11] When the superficial (M_4) segment of the middle cerebral artery (MCA) is chosen as a recipient artery, two types of craniotomy are available, regular frontotemporal craniotomy via a hairline skin incision and a small craniotomy via a minimum linear skin incision. The double bypass is theoretically useful if the MCA bifurcation is occluded or CBF in both the frontal and temporal lobes are impaired. However, this procedure requires a regular craniotomy to expose both superficial temporal artery (STA) branches, and postoperative scalp necrosis occurs more frequently.[7] To avoid this complication, a linear incision approach may be a better choice.

This report describes a less invasive STA-MCA double bypass technique through a small craniotomy.

Materials and Methods

Thirty-four consecutive patients, 24 males and 10 females aged 14 to 79 years (mean 65.5 ± 11.4 years), underwent elective STA-MCA double bypass via a small craniotomy with a minimum skin incision between January 2006 and October 2009. The indications for STA-MCA bypass were determined by the clinical symptoms and preoperative single photon emission computed tomography according to the inclusion criteria of the JET.[5,6]

Before the induction of general anesthesia, the courses of the parietal and frontal branches of the STA are marked on the skin using portable continuous-wave Doppler ultrasonography (Bidop Es-100V2; Hayashi Denki Co., Ltd., Kawasaki, Kanagawa). The patient is placed in the supine position with the head turned to the contralateral side and the ipsilateral shoulder raised with a mattress. The hair shaved to a width of 2 cm along the courses of the STA branches. A linear skin incision is made directly over the parietal branch, approximately 6 cm from the tragus to its distal portion (Fig. 1A). After dividing the parietal branch in the linear incision, the frontal branch is divided

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under the scalp, with careful pulling of the vessel. Thereafter, a small craniotomy is performed and the dura opened to inspect the recipient arteries. If the two candidate recipient arteries (supra- and infra-sylvian portions) are not exposed, the bone window is widened. If the frontal and parietal branches are long enough for a double bypass through this linear incision (Fig. 1C), the distal parts of both branches are cut as long as possible. If not, another short incision (2–3 cm) is made over the frontal branch, at least 1 cm from the original incision (Fig. 1B). Thereafter, the frontal branch is divided carefully (Fig. 1D), ligated and cut in this short incision, and withdrawn into the original incision through the subcutaneous tunnel between these two incisions. Usually, the shorter branch is anastomosed to the infrasylvian portion of the MCA and the longer branch to the suprasylvian portion. This small craniotomy, measuring approximately 3 × 4 cm in size, is usually sufficient for the double bypass. After division of the recipient artery, both branches of the STA are intermittently anastomosed to the infra- and suprasylvian M_4 branches in end-to-side manner using 10–0 nylon suture (Fig. 1E). After anastomosis, the patency of both branches is confirmed by Doppler ultrasonography (DVM4200P; Hayashi Denki Co., Ltd.), the anastomotic sites are covered with fibrin glue, the bone flap is fixed with titanium plates, and the wound is closed with absorbable sutures.

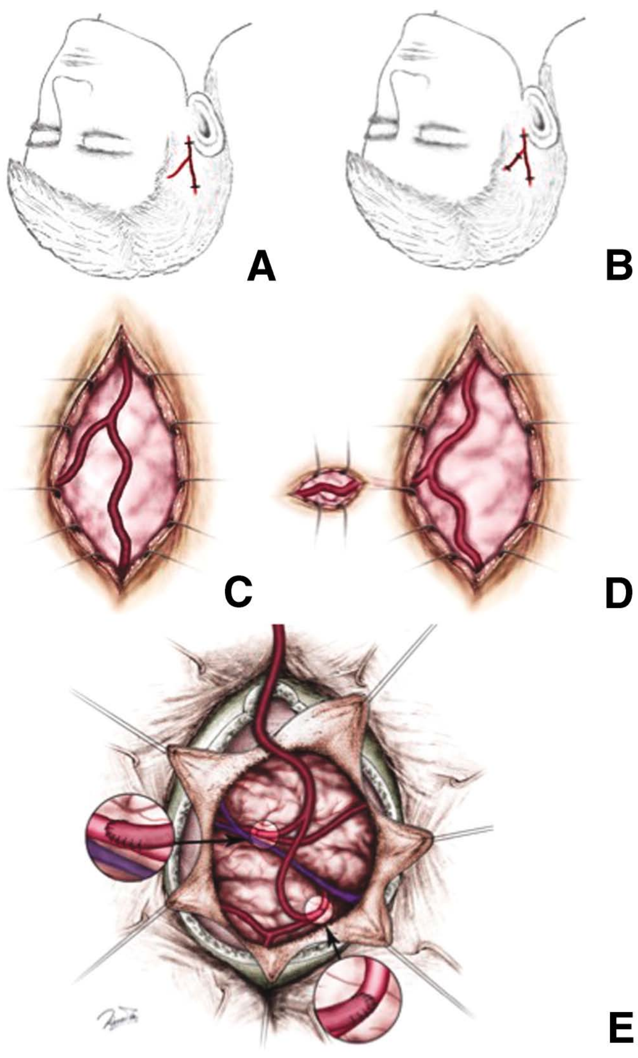

Fig. 1 Schematic drawings of the superficial temporal artery-middle cerebral artery (STA-MCA) double bypass via a small craniotomy. A: A linear incision made on the parietal branch of the STA. B: An additional incision is made on the frontal branch at least 1 cm from the original incision. C: Both the frontal and parietal branches are sufficiently long for a double bypass through this linear incision. D: The frontal branch is exposed in the original linear incision and an additional short incision is made on the frontal branch. E: The frontal and parietal branches of the STA are anastomosed to the superficial portions of the MCA, usually both the supra-sylvian and infra-sylvian portions, with 10–0 nylon suture.

Results

STA dissection was performed through a linear incision in

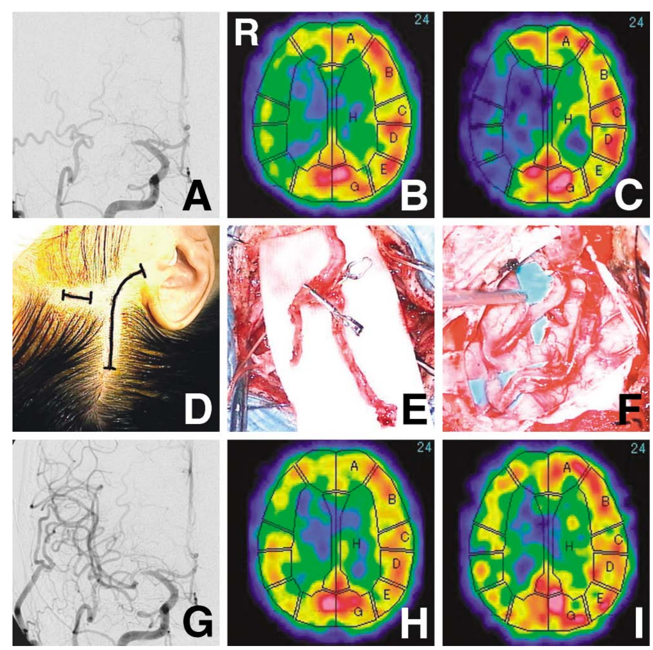

Fig. 2 Representative case. A 42-year-old male with left mild hemiparesis due to recent cerebral infarction was introduced to our clinic for cerebral revascularization. Right carotid angiogram disclosing occlusion of the right middle cerebral artery (MCA) origin (A). Single photon emission computed tomography (SPECT) scans showing severely decreased cerebral blood flow (CBF) in the resting state (B) and after Diamox challenge (C) in the right MCA territory. Photographs showing the y-shaped incision (D), dissection of both the frontal and parietal branches of the superficial temporal artery (STA) (E), and the double STA-MCA bypass via a small craniotomy (F). No postoperative events occurred, such as intracranial hemorrhage or cutaneous necrosis. Postoperative right carotid angiogram showing patency of both bypasses (G) and postprocedural SPECT scans revealing improvement of the CBF in the resting state (H) and after Diamox challenge (I) in the right MCA territory.

11 of the 34 patients and a y-shaped incision in 23 patients. The two branches of the STA were difficult to dissect in one of the patients because the frontal branch was hypoplastic. Therefore, the distal part of the STA was cut and anastomosed to the STA in end-to-side manner, and STA-MCA double anastomosis was performed.

All bypass procedures were performed uneventfully and no subdural hematoma or cutaneous necrosis occurred in this series. The craniotomy was widened via the same skin incision to expose the recipient arteries in 6 patients. Blood loss during the operation was 5 to 260 ml (mean 59 ± 54 ml). No periprocedural neurological complication occurred, but one patient developed wound infection, which was quickly cured by intravenous administration of antibiotics. No ischemic or hemorrhagic events were detected in the follow-up period from 6 to 50 months (mean 24.6 ± 13.8 months). Postoperative cerebral angiography was performed in all patients within 6 months and showed all bypasses were patent. A representative case of STA-MCA double bypass through a small craniotomy is shown (Fig. 2).

Discussion

The less invasive STA-MCA double bypass technique through a small craniotomy was effective in the present series, but some problems are discussed below.

Two types of skin incision can be made for preparation of the STA. Both the parietal and frontal branches of the STA can be exposed via a linear incision made on the parietal branch in almost half of all patients. However, an additional incision allows dissection of a longer section of the frontal branch. Therefore, the use of y-shaped incision is becoming routine, but we did not experience any cutaneous necrosis using this method. Additional incision of the frontal branch separate from the original linear incision on the parietal branch may be the key to avoid cutaneous ischemia. On the other hand, the two branches of STA were difficult to dissect in one patient of this series because of a hypoplastic frontal branch. Therefore, the distal part of the STA was cut and anastomosed to the STA trunk, and STA-MCA double bypass was performed. This method might be one of the options if two branches of the STA are difficult to obtain.

The two MCA branches may not be found in the small craniotomy. In the present series, the craniotomy was widened in 6 patients to expose the two recipient arteries and obtain sufficient space for bypass, but additional skin incision was not necessary in any patient. Double bypass could be performed in all the patients in the current study. Computed tomography (CT) angiography might be used to determine the appropriate position of craniotomy to obtain two recipient arteries before the operation. We are now trying to establish this method for more accurate determination of the craniotomy position using CT angiography and navigation systems such as the 'target bypass' for moyamoya disease.[9]

The necessity for double bypass should be discussed, as the procedure may not be essential in all patients. However, a single bypass was not sufficient to increase the CBF and failed to prevent ischemic events in some patients of our previous series, possibly due to limited selection of a single recipient in the small craniotomy. Therefore, we introduced the double bypass procedure, which seemed to improve impaired cerebrovascular reactivity in our preliminary study (data not shown). However, this result should be confirmed statistically by comparing the single and double bypass groups, because no significant difference was reported between these groups.[13]

In this series, intraoperative bleeding was minimum and no patient required a regular blood transfusion. The mean operating time was around 3.5 hours (212 ± 48 minutes). These results suggest that this surgical technique is relatively less invasive than the regular double bypass, performed by the so-called flap method.

This operation requires a bypass procedure in a relatively deep and narrow space. It is important to make the craniotomy in the appropriate position and to use small hooks to obtain wider and lower retraction of the scalp and the temporal muscle. Preparation of the MCA branches requiring an arachnoid incision should be performed after preparation of both STA branches to avoid brain sinking. If these critical procedures are appropriately performed, this operation is not difficult, as confirmed by the observation that all bypassed branches were patent on postoperative angiography.

The present less invasive method of STA-MCA double bypass through a small craniotomy may be effective to avoid some complications related to wider craniotomy such as cutaneous necrosis or hemorrhagic events. Further experience is necessary to determine if the double bypass is superior to a single bypass in patients with impaired CBF due to cerebrovascular occlusive diseases.

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