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Technique

# Extracranial-intracranial bypass surgery at high magnification using a new high-resolution operating microscope: technical note

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**Abstract**

**Background:** We report a precise technique for EC-IC bypass surgery using a stereoscopic high-resolution microscope at magnifications of 40× and 50×.

**Methods:** A stereoscopic operating microscope (Mitaka MM50 Surgical Microscope; Mitaka Kohoki Co, Tokyo, Japan) was used in STA-MCA anastomosis. This microscope has 2 optical systems, a standard zooming system, a newly developed high-magnification system, and 4 fixed working distances of 200, 250, 300 and 350 mm, with highest magnifications of 50.4× at 200 mm and 40.3× at 250 mm. High resolution is achieved by a new lens design in the optical system, which makes the image of the object very clear at high magnification. The magnification can be changed depending on the circumstances in a given procedure. The STA-MCA anastomoses were performed using this microscope.

**Results:** Very small vessels were observable, and arterial anastomosis could be performed precisely at high magnification. All anastomoses were patent on postoperative angiograms.

**Conclusions:** Use of the new microscope allows visualization and manipulation of small vessels at high magnification and high resolution and may be very useful in EC-IC bypass surgery.



*Keywords:* Extracranial-intracranial bypass; Superficial temporal artery–to–middle cerebral artery anastomosis; Operating microscope; Microvascular anastomosis

## 1. Introduction

In 1967, Yaşargil [16] performed the first successful STA-MCA anastomosis as surgical treatment for atherosclerotic steno-occlusive diseases of cerebral ischemia. Although the cooperative study of EC-IC bypass trial failed to demonstrate that this surgery reduced the risk of stroke in patients with cerebral ischemia in 1985 [1], EC-IC bypass is still an important procedure for treatment of complex intracranial aneurysms and tumors, moyamoya disease with ischemic symptoms, and atherosclerotic steno-occlusive diseases with hemodynamic cerebrovascular insufficiency [4,9,10,12,14]. Complete accomplishment of the surgical procedure is required for effective bypass, and neurosurgeons must be capable of performing microvascular procedures with high patency in the clinical setting. In microsurgery, appropriate observation and manipulation under the operating microscope are of paramount importance, and optimal organization of the operative field is required. Here, we describe a technique for visualization and manipulation of small vessels at high magnification using a new high-resolution stereoscopic microscope that may be of value in EC-IC bypass surgery.

## 2. Materials and methods

We have performed STA-MCA anastomosis at high magnification in 6 patients with atherosclerotic steno-

*Abbreviations:* EC, extracranial; IC, intracranial; MCA, middle cerebral artery; STA, superficial temporal artery.

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occlusive diseases with hemodynamic cerebrovascular insufficiency (5 cases) and moyamoya diseases (1 case) since November 2007. A new stereoscopic operating microscope (Fig. 1) with 40× and 50× magnifying power (Mitaka MM50 Surgical Microscope; Mitaka Kohoki Co, Tokyo, Japan) has been used in these procedures [2,7]. This microscope has 2 optical systems, a standard zooming system and a newly developed high magnification system, with a magnification changer in a binocular monoscope. This design permits high-resolution observation at high magnification at suitable working distances. The 4 fixed working distances are 200, 250, 300 and 350 mm; the zoom ratio of the microscope is 1:8; and the microscope stand has the ability to stop until 3 cycles against an external impact. The microscope allows 2 surgeons to see identical images and has a 300-xenon light source and a foot pedal for hands-free operation.

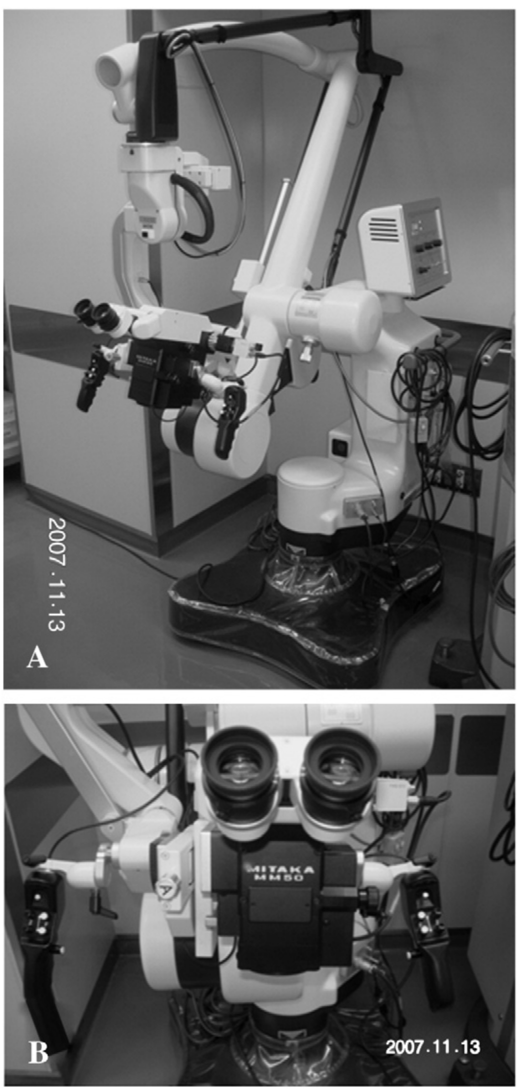


Fig. 1. The stereoscopic operating microscope. A: A view of the Mitaka MM50 Surgical Microscope with the floor stand. B: A closer view of the microscope.

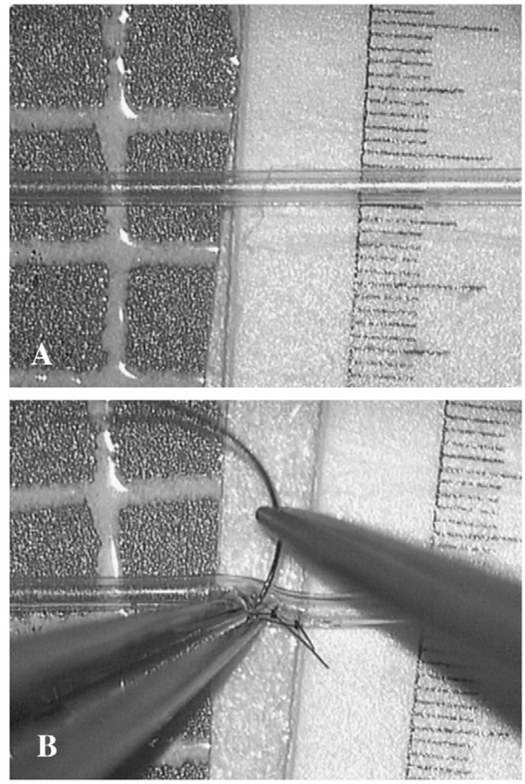


Fig. 2. Training before clinical application was performed using a very small silicone tube model at 50× magnification. A: The silicone tube has an external diameter of 0.3 mm and a wall thickness of 0.05 mm. One scale on the ruler is 0.1 mm. B: Suturing training was performed using a 12-0 monofilament nylon suture with a 50-$\mu$m needle. The tube, the microneedle, and sutures are very clear at high resolution (distinctiveness: 7-8 $\mu$m).

The final magnification is dependent on 4 factors: the focal length of the objective lens, the focal length of the binocular tube, the magnification of the eyepiece, and the magnification changer [16]. The magnification is calculated using the formula:

$$Vm = ft/fo \times \gamma \times Ve$$

where Vm is the final magnification (in this operating microscope), *ft* is the focal length of the tube (*ft* = 220 mm), *fo* is the focal length of the objective lens (*fo* = 200, 250, 300 or 350 mm), $\gamma$ is the magnification factor of the intraoperative magnification changer ($\gamma$ = 0.4 to 3.2 in the standard zooming system and 4.58 in the high magnifying system), and Ve is the magnification of the eyepiece (10×). At 200 mm from the objective lens, the highest magnification is theoretically 50.4×, and at 250 mm, the highest magnification is 40.3×. At 300 and 350 mm, the highest magnifications are 33.6 ×and 28.8×, respectively. The resolution for this new lens design is very high (a distinctiveness at 50× magnification of 7–8 $\mu$m), which produces a very clear image of the object. The magnification can be altered to match the requirements for a particular situation. The combination of the 10× eyepiece and the 200-