New Method

# Simple and Safe Cannulation Technique for Antegrade Selective Cerebral Perfusion

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**Antegrade selective cerebral perfusion (SCP) has proved to be a safe and reliable method of brain protection during operations of aortic arch aneurysms. Arch vessel cannulation is a crucial step in the institution of SCP that determines its success to a significant extent. A simple and safe cannulation technique along with a newly developed flexible perfusion cannula is described. (Ann Thorac Cardiovasc Surg 2001; 7: 186–8)**

**Key words:** antegrade selective cerebral perfusion, total arch replacement, aortic arch aneurysms, cerebral perfusion cannula

## Introduction

We have been using antegrade selective cerebral perfusion (SCP) since 1986 for prevention of cerebral ischemia during the complicated and time-consuming total arch replacement (TAR) operations for aortic arch aneurysms including acute aortic dissections and have obtained satisfactory clinical results.[1,2] However, despite its many advantages, SCP is still considered to be a rather cumbersome procedure when compared to profound hypothermia and circulatory arrest with or without retrograde cerebral perfusion. We had been working for the last few years to make the technique safer and simpler in use and in the process developed a new selective cerebral perfusion cannula.

## Materials and Methods

We developed a new balloon catheter for SCP (Fuji System Corporation, Tokyo, Japan) which is made from silicon rubber (Fig. 1). It has two lumina; one for blood perfusion and the other for pressure monitoring. A balloon at the tip prevents the cannula from slipping away when inflated after cannulation of the arch vessels (Fig. 2). The cannula also has a bending segment just proximal to the balloon which is supported by thin and flexible metallic plates. An 18 Fr size cannula is used for innominate artery (IA) perfusion and a 14 Fr one for left common carotid artery (LCCA) perfusion.

### Experimental study

As an experimental study, perfusion volumes through straight and angulated (90 degrees) cannulae of 14 Fr and 18 Fr sizes were assessed and compared at a perfusion pressure of 40 mmHg using a magnet pump, and 40% glycerin solution.

### Clinical study

Between May 1999 and April 2000, 28 consecutive patients underwent TAR with SCP using the newly developed perfusion cannula. The indications were acute dissection in 6 patients (21%), chronic dissection in 3 (11%), and atherosclerotic aneurysm in 19 (68%). The patients ranged in age from 26 to 82 years, and there were 20 males and 8 females.

The detail of SCP has been described previously.[1,2] As for the technique of cannulation, we took particular care to avoid the complications related to it. The arch vessel cannulation technique that we practice these days is as follows:

When the patient is cooled down to a rectal temperature of 22°C, both the IA and LCCA are completely transected either at their origins or at their intact portions where no atherosclerotic plaque or dissection is present. Then the arteries are cannulated through the

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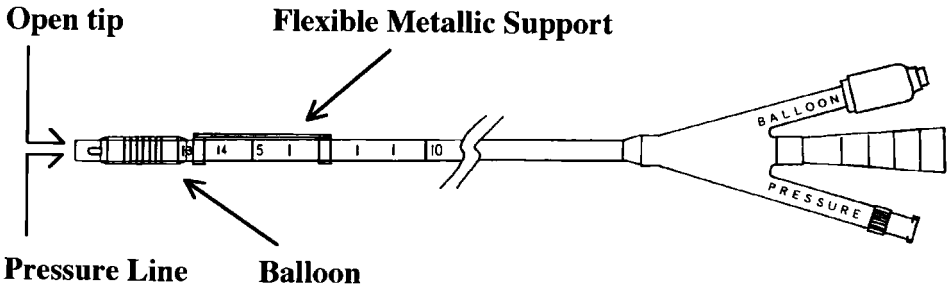


**Fig. 1.** Schematic drawing of the newly developed cerebral perfusion cannula indicating its different parts.

arteriectomies while the blood perfusion through the cannula is continued to get rid of air. The arch vessel is kept cross-clamped until just before the cannulation and as it is declamped for cannulation, the patient is placed in a Trendelenburg position and the central venous pressure is raised. These measures cause a retrograde flow of blood in the arch vessel and make it air-free. In the case of acute dissection in which dissection often extends to the arch vessels, the true lumen is cannulated after distinguishing it from the false lumen by visual inspection from inside the aortic arch. SCP is then started at the rate of 10 ml/kg/min. by a single roller pump separate from the systemic circulation.

When performing the arch vessel reconstruction, the cannula is kept in place until two-thirds of the circumferential anastomosis is completed. Then the cannula is removed, blood perfusion through the cannula is discontinued and the SCP volume is reduced to half the original volume. Then the rest of the anastomosis is performed which usually takes about a few minutes. The left subclavian artery is kept cross-clamped during SCP.

Real-time intraoperative monitoring of SCP is important to assess whether the perfusion is adequate or not. The right radial artery pressure and the bilateral catheter tip pressures are routinely monitored. Two-channel serial electroencephalography to monitor the cerebral electrical activity and two-channel Near Infrared Spectroscopy to estimate regional cerebral oxygenation are used. These techniques also assess discrepancies between the two cerebral hemispheres. Moreover, internal jugular venous oxygen saturation is used to monitor cerebral oxygen consumption.

**Fig. 2.** Photograph of the newly developed cerebral perfusion cannula bent at right angles with the help of malleable metallic support. The lumen is not compromised by the bending. The balloon at the tip is seen in an inflated state.

## Results

### Experimental study

There was no significant difference in perfusion volume between the straight and angulated cannulae of both 14 Fr and 18 Fr size.

### Clinical study

There was no in-hospital mortality, no permanent neurological deficit and a 3.6% temporary neurological dysfunction. There was no cannulation-related complication. The mean total pump time was 173.2±40.0 min, and mean SCP time was 79.2±16.0 min.

During SCP, the mean right radial artery pressure was 34±10 mmHg, catheter tip pressure of IA 50±10 mmHg, and catheter tip pressure of LCCA 45±9 mmHg.

## Discussion

SCP is an established method for brain protection during aortic arch operations. It basically does not have any time-limit in brain protection and therefore allows enough time for meticulous aortic arch reconstruction.

However, complications related to arch vessel cannulation such as cerebral embolization of dislodged atherosclerotic debris or air and malperfusion due to cannulation into the false lumen in dissection cases are concerns for some surgeons. As our experience shows, our refined cannulation technique can deal with these problems very effectively. By transecting the IA and LCCA at their intact portions and cannulating through the arteriectomies, we can minimize the risk of cerebral embolization of atherosclerotic debris.

Risk of air embolism too is reduced by allowing the blood perfusion through the cannula to continue during cannulation. In cases with aortic dissection, it is important to cannulate through the true lumen to avoid malperfusion and we take particular care to distinguish the true lumen from the false lumen. All these measures contribute significantly to the improvement of postoperative neurologic outcomes. The newly developed perfusion cannula also offers a number of benefits. The cannula, due to its flexible metallic support can be bent manually at the desired angle without causing any obliteration in the lumen. This in turn allows the surgeon to place the cannula toward the patient's head side so that it does not obscure the operative field. The angulation also contributes to prevent the cannula from slipping away.

Technique of SCP varies among institutes and so do the results with it. In our institute, we have found a distinct trend of improvement in the postoperative neurologic outcomes towards the later part of our experience with SCP. We think that the newly developed cannula and our cannulation technique made it easier for us to avoid the usual cannulation-related complications and improved the surgical results.

## References

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