Case report: Anesthetic management in 27-year-old woman with unruptured large cerebral aneurysm undergoing high-flow bypass with interposition graft

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Abstract

**Background:** In case of large or giant cerebral aneurysms, patients usually present with good level of consciousness and no neurological deficit. They may require a bypass procedure to improve cerebral blood flow during aneurysm management because the aneurysms are too large to be clipped. High flow bypass with interposition graft is the procedure that the surgeon harvested vessel graft from other sites or organs and use it to be a bypass for blood flow across aneurysm. There are complications in this procedure such as intraoperative aneurysm rupture, massive hemorrhage, and cerebral ischemia, etc. Neuroanesthetic goals in a high-flow bypass surgery are to protect brain during temporary occlusion and anastomosis, to increase ischemic tolerance, and to prevent cerebral ischemia. **Objective:** To report a case of anesthetic management in high flow bypass with interposition graft in unruptured large cerebral aneurysm. **Methods:** Medical and anesthetic records were reviewed. The references were searched from online literature. **Results:** A 27-year-old woman presented with sudden severe left-sided headache radiated to occipital area. She has no other neurological deficit. Her MRI brain revealed partially calcified P2 compartment of posterior communicating artery aneurysm size 23x14 mm. She was referred to Ramathibodi Hospital for further investigations and planned for high-flow bypass surgery with interposition graft. The patient was scheduled for surgery. Arterial line was inserted into right radial artery before induction. Central line was placed in left internal jugular vein. Bispectral index (BIS) for monitoring depth of anesthesia was established at her forehead. We cooled the patient down at 33-34°C via cooling mattress. When neurosurgeon was about to perform temporary clipping of cerebral vessel, the aneurysm was clipped.
we started thiopental continuous infusion with the use of vasopressor to maintain adequate perfusion pressure. After the completion of bypass procedure, doppler ultrasound and intraoperative cerebral angiogram were done to confirm good flow at anastomotic sites. Finally, the patient was retained endotracheal tube and transferred to the intensive care unit (ICU). Five hours later, patient developed left hemiparesis. The patient was immediately sent to do the Computered Tomographic Angiography (CTA). The CTA revealed total occlusion of STA-P3 bypass and multifoci of intraparenchymal hemorrhage with large surrounding edema. They were results from bypass graft occlusion. However, the patient had good consciousness and was extubated at postoperative day 3. The motor weakness was gradually recovered. Total length of hospital stay was 19 days. Conclusion: Systemic mild hypothermia and supplemental protective drug, such as barbiturates may be used as the brain protective strategies during high flow bypass in unruptured large cerebral aneurysm.

Keywords: anesthetic management, unruptured large cerebral aneurysm, high flow bypass with interposition graft
รายงานผู้ป่วย : การระงับความรู้สึกในการผ่าตัดแก้ไขหลอดเลือดสมองโป่งพองด้วยวิธีการ high flow bypass with interposition graft

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บทคัดย่อ:

บทนำ:
ผู้ป่วยที่มีภาวะหลอดเลือดสมองโป่งพองผิดปกติขนาดใหญ่และยังไม่แตกมักมีระดับความรู้สึกตัวปกติไม่มีการกระตุ้นที่ผนังหลอดเลือด ทำให้หลอดเลือดโป่งพองผิดปกติขนาดใหญ่เช่นนี้ไม่สามารถรักษาโดยการใช้clip ที่มีการคำสั่งเพื่อแก้ไขการระงับความรู้สึกได้ การผ่าตัดหลอดเลือดสมองขนาดใหญ่จากอวัยวะอื่นมาพาดผ่านจุดที่หลอดเลือดสมองโป่งพองผิดปกติเพื่อให้เลือดไปเลี้ยงสมองส่วนหลังกระหว่างการผ่าตัดหลอดเลือดสมองโป่งพองผิดปกติ ซึ่งเป็นเทคนิคทางการแพทย์ที่ช่วยให้การกระตุ้นสมองระหว่างการผ่าตัดหลอดเลือดสมองสามารถทำได้ รวมถึงเพื่อป้องกันไม่ให้สมองขาดเลือดในระหว่างการผ่าตัด ที่มีการสังเกตเห็นในผู้ป่วยได้ในภาวะการทำงานของสมองห่างจากผ่าตัด

วัตถุประสงค์:

เพื่อรายงานกรณีศึกษาเรื่องการระงับความรู้สึกในผู้ป่วยหลอดเลือดสมองโป่งพองผิดปกติขนาดใหญ่
ที่นำมาจากการตัดต่อหลอดเลือดดำ radial และเชื่อมต่อกับ parietal branch ของหลอดเลือดดำ superior temporal เมื่อส่งทะลุทุกจุดสิ้นแล้วคัดลอกทางที่การตรวจสอบการไหลของเลือดในจุดต่าง ๆ โดยใช้คลื่นเสียงความถี่สูง (doppler ultrasound) และการดูดผลการไหลของตอนของสมอง (cerebral angiogram) จนถึงผลาด และส่งสู่ฝีหูผ่าคู่ได้ ดังนั้นเนื่องจากผู้ป่วยที่มีอาการระบบหัวใจที่อาจจะเสียหายได้ 5 ชม. ต่อมา ผู้ป่วยได้ ทำตามที่ตั้งไว้ และมีการเข้ารับการรักษาได้ ดังนั้นผู้ป่วยที่ทำอีกหลอดกลับซึ่งมีผลความดันของหลอดเลือดสมอง (Computed Tomographic Angiography; CTA) พบ total occlusion of STA-P3 bypass และ multifoci of intraparenchymal hemorrhage with large surrounding edema ตรวจร่างกายผู้ป่วยเพิ่มเติมพบ contralateral homonymous hemianopia ซึ่งเป็นผลจากการอุดตันของ bypass graft อย่างไรก็ตามสามารถนับหลอดที่ผู้ป่วยได้ในวันที่ 3หลังผ่าตัด รามาการนำเข้าข้อมูลเข็มขัดเข็มให้ รามาการออกเร่งจุกข์ glowing ตลอดระยะเวลา นำเสนอรูปแบบหลังวันที่ 19 รามาการผู้ป่วยนั้น แสดงให้เห็นว่าการลดอุณหภูมิที่ต่ำกว่า 50 องศา คือ รามาการสูงสุดกับที่ประมาณ 33-34 °C และการใช้ยา thiopental สามารถช่วยปกป้องสมองจากการขาดเสียได้ระหว่างการผ่าตัดหลอดต่อสมองของ โปร่งกลับได้ภายใน 10 นาทีและยังไม่ได้ผล

คำสำคัญ: การระงับความรู้สึก, หลอดเลือดสมองโปร่งพองผิดปกติขนาดใหญ่และยังไม่แตก, high flow bypass with interposition graft
Introduction

A cerebral aneurysm is acquired outpouching of arteries in the subarachnoid space. Classification of a cerebral aneurysm according to their sizes are small aneurysms with a diameter of less than 13 mm, large aneurysm (diameter from 13 to 25 mm), giant aneurysms (diameter from 25 to 50 mm), and super-giant aneurysms (diameter over 50 mm). Most aneurysms are more prone to rupture when larger than 7 mm. The majority of patients who have unruptured cerebral aneurysm present with a headache. Some patients may come with other symptoms such as cranial neuropathy, visual loss, facial pain, motor weakness, seizure, or ischemic events related to emboli. Management of an unruptured aneurysm includes surgical clipping or endovascular treatment with coil embolization. Nevertheless, the anatomy of an aneurysm, location, durability of the reoccurrence rate, and surgeon’s experience play important roles in the decision making of treatment choice. In a case of unclippable large aneurysms, it may require a bypass procedure to improve the cerebral blood flow during vessel sacrifice for aneurysm management. Bypass vascular anastomoses can be described into 3 categories according to cerebral blood flow; high-flow bypass (100-140 ml/min), medium-flow (60-100 ml/min), and low-flow (20-70 ml/min). High-flow bypass uses the long saphenous vein or radial artery as bypass graft conduits. High-flow extracranial-to-intracranial bypass (HF EC-IC) is the method of choice when flow requirements are estimated significantly more than 30 ml/min. HF EC-IC bypass with conduit graft can increase flow to the hemisphere instantly, differ from low flow bypass which requires a period of time to supply adequate blood flow to the distal area. However, HF EC-IC bypass is a complex procedure and has more risk than low-flow bypass. Neuroanesthetic goals in a high-flow bypass surgery are to protect the brain during temporary occlusion, to increase ischemic tolerance, and to prevent cerebral ischemia.

Case report

A 27-year-old woman presented with sudden severe left-sided headache radiated to occipital area. She had no neurological deficit on physical examination. She had no known underlying disease and regular medication. Her body weight was 50 kg. MRI of the brain revealed partially calcified P2 compartment of posterior communicating artery aneurysm size 23×14 mm (Figure 1). She was referred to Ramathibodi Hospital for further investigations and planned for high-flow bypass surgery with interposition graft within 1-2 days. Her vital signs at the day before surgery showed high degree of systolic blood pressure ranged from 150 to 190 mmHg and diastolic blood pressure range from 90 to 110 mmHg, pulse rate was 70-100 beat per min, respiratory rate was 20 beat per min, and body temperature was 37°C. Preoperative lab results showed hemoglobin 11.4 g/dL, hematocrit 36.4%, platelet count 569,000/mm³, mild hyponatremia 134 mmol/L, other electrolytes and renal function were within normal limit. Her ASA classification was graded 3 due to hypertension and increased
intracranial pressure.

**Figure 1. MRI brain demonstrated calcified P2 compartment of posterior communicating artery aneurysm size 23×14 mm.**

The patient was scheduled for surgery. She was laid on the cooling mattress preparing for intraoperative mild hypothermia (34°C) for cerebral protection. After basic monitoring was placed to the patient, arterial catheter no.20G was inserted into the right radial artery. While we did this procedure, her blood pressure showed hypertension 170-180/90-100 mmHg. We titrated intravenous labetalol 5 mg each time with the total of 25 mg before induction. Finally blood pressure was 150/58 mmHg, so the patient was induced with thiopental 250 mg (5 mg/kg), atracurium 30 mg (0.6 mg/kg), and fentanyl 50 mcg (1 mcg/kg). After endotracheal tube no.7.5 was placed uneventfully, bispectral index (BIS) for monitoring depth of anesthesia was established at her forehead and distal esophageal temperature probe was placed for core temperature monitoring. We also opened peripheral intravenous access with catheter no.16G and 14G preparing for massive blood loss. As we predicted about hemodynamic instability and potential use of vasoactive drugs, we inserted a central line (triple lumen no.7) via left internal jugular vein. The intraoperative ventilator was set as volume controlled mode targeted end-tidal CO$_2$ around 29-31 cmH$_2$O, PIP 15-16 cmH$_2$O. We maintained anesthesia with O$_2$/air F$\text{I}_O$ 0.6, sevoflurane 1-2.5%, continuous infusion of atracurium 20 mg/hr and fentanyl 70 mcg/hr.

The patient was placed in supine position. The left radial artery was harvested for donor arterial graft. We cooled the patient down via cooling mattress since the operation had started. When neurosurgeon was about to perform temporary clipping of cerebral vessel, we started thiopental continuously infused rate 150 mg/hour (0.05 mg/kg/min or 3 mg/kg/hour). Dopamine was continuous infusion at 1 mcg/kg/min in a brief period prior to barbiturate coma. During this period, we kept BIS value below 40. Then, right P3 segment was anastomosed with radial interposition graft (end-to-end) under microscope. Radial interposition graft was also anastomosed with right parietal branch of superior temporal artery (STA). Total cerebral vessel occlusion time was 75 min. After doppler ultrasound checking for flow via anastomosis, right P2 fusiform aneurysm was clipped. Finally, doppler ultrasound and intraoperative angiogram showed total occlusion of an aneurysm and good flow of the graft.

Total dose of thiopental used in barbiturate
coma period was 1465 mg. Duration of thiopental infusion was 120 min. Intraoperative dose of fentanyl was 540 mcg. Total intraoperative blood loss was 1200 ml, urine output was 3200 ml. The total volume of intraoperative intravenous crystalloid was 6000 mL and packed red blood cells was 300 mL. Blood glucose was ranging from 160 to 200 mg/dL. The latest intraoperative arterial blood gas analysis showed pH 7.4, PCO$_2$ 30 mmHg, PO$_2$ 276 mmHg. Operative time was 9 hr 15 min. Cerebral vessel occlusion time was 75 min. The patient was light-sedated, retained endotracheal tube, and then transferred to Intensive Care Unit (ICU).

The patient was cared at ICU in postoperative period. After 5 hr in ICU, the patient was awaked. Her Glasgow Coma Score (GCS) was E3VTM6, pupil 3 mm react to light both eyes. Because her blood pressure showed 167/96 mmHg, she received nicardipine infusion. We titrated the dose of nicardipine infusion until systolic blood pressure ranges from 120 to 150 mmHg. At that time, she developed left-sided motor weakness, motor power graded 1. She was sent for an emergency Computed Tomographic Angiography (CTA) of the brain on post-op day 1. The CTA of the brain revealed total occlusion of right superficial temporal artery (STA)-P3 bypass, completely thrombosed right P2 aneurysm (Figure 2A), multifoci intraparenchymal hemorrhage at the right thalamus, posterior limb of the right internal capsule, right temporal lobe, and right occipital lobe with large surrounding edema. Cerebral angiogram also demonstrated that no contrast-filled right STA-P3 bypass and aneurysm at right P2 disappeared (Figure 2B and 2C). The patient developed contralateral homonymous hemianopia resulted from bypass graft occlusion. Although she had multifoci of intraparenchymal hemorrhage that caused her motor weakness, she was extubated at postoperative day 3 with full consciousness and left-sided motor power was gained to grade 3 at post-op day 8 then progressed to grade 4 at post-op day 11. We also consulted rehabilitation unit for her. The patient was discharged from hospital at post-op day 19.

Figure 2. (A) CTA of the brain revealed total occlusion of right superficial temporal artery (STA)-P3 bypass and completely thrombosed right P2 aneurysm.
Discussion

Anesthetic management in patients with the unruptured large cerebral aneurysm is quite challenging for all anesthesiologists. This patient who was undergone high flow bypass surgery risked for intracerebral hemorrhage, cerebral ischemia, and hemorrhagic transformation of ischemic brain resulted from brain retraction, graft occlusion, intraoperative hemorrhage, and aneurysm ruptured.² There have been many efforts to protect the brain from various results such as thiopental, etomidate, propofol, and systemic hypothermia. There was 2 prospective randomized trials published that mild hypothermia at 32-34°C was successfully to protect the brain against global ischemia after return of spontaneous circulation (ROSC) from cardiac arrest.⁴⁻⁵ On the contrary, Todd MM et al conducted IHAST study in 2005 and revealed that intraoperative hypothermia did not improve the neurologic outcome after craniotomy among good grade patients with aneurysmal subarachnoid hemorrhage.⁶ Hindman BJ et al analysed in temporary clipping group from IHAST study in 2010 and showed that neither systemic hypothermia nor supplement protective drug affected short- or long-term neurologic outcomes of these patients.⁷ However, no previous literature studied in brain protection strategy in unruptured aneurysm patients during surgery both cerebrovascular bypass and aneurysmal clipping. Several possible mechanisms may explain that mild systemic hypothermia improves the neurologic outcome after reperfusion. Mild hypothermia is thought to suppress many of the chemical reactions associated with reperfusion injury. However, the exact mechanism for cerebral protection in hypothermia is not clear. Adverse effects of hypothermia include arrhythmias, infection, and coagulopathy.

Barbiturates seem to protect the brain from focal and incomplete ischemia. Barbiturates reduce the cerebral metabolic rate of oxygen (CMRO₂) in a dose-dependent manner. Other reasons that can explain neuroprotective effect of barbiturates include

Figure 2. (B) and (C) Cerebral angiography revealed no contrast-filled right STA-P3 bypass. Aneurysm at right P2 also disappeared.
stabilization of lysosomal membranes, the attenuation of intracellular calcium concentrations, antioxidative and anti-excitotoxic processes. Barbiturates have adverse effects, include hypotension and a long recovery time. In this case, we used thiopental infusion rate 0.05 mg/kg/min and kept BIS value below 40. This regimen appeared to decrease raised intracranial pressure.

Thereby, we decided to apply systemic mild hypothermia at temperature 34°C during cerebrovascular bypass procedure and thiopental continuous infusion rate 0.05 mg/kg/min or 3 mg/kg/hour as an adjunctive agent for neuroprotection. This patient was nearly full conscious at ICU after an operation. Although she had motor weakness resulted from some degree of brain swelling and hematoma at the operative site, she gained her power rapidly. She was able to do her daily activity while she was in a recovery period. The overall postoperative condition of this patient indicated that she had no permanent neurological deficit resulted from cerebral ischemia in large area though the cerebral vessel was clamped for such a long time.

**Conclusions**

We need to prevent cerebral disaster during vessel sacrifice for intraoperative aneurysm management especially in unruptured aneurysm patients who have no neurological deficit before surgery. Systemic mild hypothermia and supplemental protective drug, barbiturates may be used as the brain protective strategies during high flow bypass in a large unruptured cerebral aneurysm. More case series or randomized trials are needed in the future to find out the best method to protect the brain during cerebral aneurysm surgery both cerebrovascular bypass and aneurysmal clipping.

**References**


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