

Autologous Transfusion of Blood Aspirated during Suction Decompression in Clipping of Large or Giant Cerebral Aneurysm

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Abstract

The suction decompression (SD) method, which proactively aspirates the blood flowing into the aneurysm and reduces the internal pressure of the aneurysm, is useful for clipping surgery of large and giant cerebral aneurysm. However, there has been little discussion on re-utilization of blood aspirated during SD. This study aimed to examine the safety, convenience, and usefulness of autologous transfusion of aspirated blood using a transfusion bag. At the time of craniotomy, the cervical carotid artery is fully exposed. An angiocatheter sheath was inserted into the carotid artery and placed in the internal carotid artery. In SD, blood was aspirated from the sheath at a constant speed and quickly stored in a blood transfusion storage bag. Blood aspiration was repeated with a new syringe; once the transfusion bag was full, the blood was re-administered to the patient. Changes in vital sign and hemoglobin/hematocrit values before and after SD were examined in five cases performed in this procedure. The aspirated blood volumes of five cases ranged from 130 to 400 mL, and all aspirated blood was successfully re-transfused. There was no critical change in vital sign, and no significant decrease in the hemoglobin/hematocrit value. No findings suggestive of complications of thrombus formation, infection, and hemolysis were noted. Re-transfusion of aspirated blood during SD using a transfusion bag is a simple and safe method, which can minimize potential risk of re-utilizing aspirated blood, and enables the safe and easy execution of SD regardless of aspirated blood volume.

Key words: large or giant aneurysm, clipping, suction decompression, autologous blood transfusion, surgical treatment

Introduction

Clipping surgery for large and giant cerebral aneurysm is often challenging, and surgeons may require specific techniques in their approach and procedure to treat such aneurysms. Although the parent artery typically needs to be temporarily blocked when treating such aneurysms, specific care to identify and preserve the critical vessels and perforating arteries during clipping is required. In addition, clipping for such aneurysm often warrants angioplastic clipping. Suction decompression, which involves suctioning

blood that flows into an aneurysm, is a useful method for proactively reducing internal pressure in an aneurysm to enable performing a clipping procedure in a safe and reliable manner.^{1–5} However, there has been little discussion on re-utilization of blood aspirated during suction decompression.

The volume of aspirated blood during suction decompression is 100 mL or less in some cases;^{3,6,7} however, the development of collateral routes and duration of suction decompression procedure can result in a blood loss of 400 mL or more.^{8–10} Such blood loss is associated with risks, such as intraoperative shock and progression of anemia. Therefore, some reports have described re-transfusion of aspirated blood to patients.^{6,8,11,12} However, there has been little mention of the specific details about the re-transfusion. It is often medically unsafe to re-transfuse blood removed from the patient's body in terms of risks

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such as thrombus formation, hemolysis, and contamination. We safely re-administered autologous blood to patients by storing the aspirated blood in an autologous blood transfusion storage bag to avoid the risks of intraoperative anemia and shock. Herein, we report the procedural details of autologous blood transfusion of the aspirated blood in suction decompression (Fig. 1) and discuss the safety and utility of this method.

Case Presentation

Case 3

The patient, a 70-year-old woman, had experienced progressively decreasing visual acuity in her right eye for the past 1 year (Table 1 and Fig. 2). When she visited her local ophthalmologist, the right visual acuity was 0.04 and atrophy of the right optic nerve was noted. At a neurosurgery clinic, she was found to have a large aneurysm in the right internal carotid artery (ICA) and was therefore referred to our hospital. On three-dimensional computed tomography angiography (3D-CTA), a 20-mm aneurysm was identified in the posterior wall of the C₂ portion of the ICA (Fig. 2A). The aneurysm seemed to be an ICA–superior hypophyseal artery aneurysm. Because the aneurysm neck was relatively narrow, we planned to perform clipping in combination with suction decompression. Right fronto-temporal craniotomy was performed, followed by opening of the Sylvian fissure to approach the aneurysm. The optic canal was unroofed, and the anterior clinoid process was removed to secure the proximal portion to the aneurysm neck. A superficial temporal artery to middle cerebral artery bypass was

also implemented in order to block off the ICA for a relatively long period of time. The carotid artery in the right cervical region was also exposed, and the ICA was secured. A 3.5-Fr angiocatheter sheath (RADIFOCUS Introducer, Terumo Co Ltd, Tokyo, Japan) was subsequently inserted into the ICA (Fig. 1). The heparinization (80 U/kg) was performed and the active clotting time reached over 200 s. The clip was placed over the proximal side of the ICA and the distal side of the aneurysm. Suction decompression was performed using a 20-mL syringe to aspirate blood from the sheath (Figs. 1, 2B and 2C). The uncontaminated aspirated blood in the syringe was rapidly injected into an autologous blood transfusion storage bag (Terumo blood bag CDPA for 200 mL, Terumo Co Ltd, Tokyo, Japan) (Fig. 1). Blood was repeatedly aspirated and stored to the blood bag using a new syringe in accordance with the surgeon's procedure for the aneurysm. Once the aneurysm collapsed, the optic nerve and anterior choroidal artery were separated from the aneurysm (Fig. 2C). Next, the aneurysm neck was secured (Fig. 2D), and angioplastic clipping was performed using two gentle curved clips (14 mm, No. 50; Sugita Clip, Titanium II, Mizuho, Tokyo, Japan) and two straight mini clips (6 mm, Nos. 81 and 96; Figs. 2D and 2E). Suction decompression and clipping were completed, and blood flow was restarted. Occlusion time of the ICA was 8 min and 30 s. The total volume of aspirated blood was 130 mL. All amount of collected blood was slowly retransfused to the patient during surgery (Fig. 1). There were no critical changes in blood pressure and heart rate before and after suction decompression (Table 1). No significant changes were noted

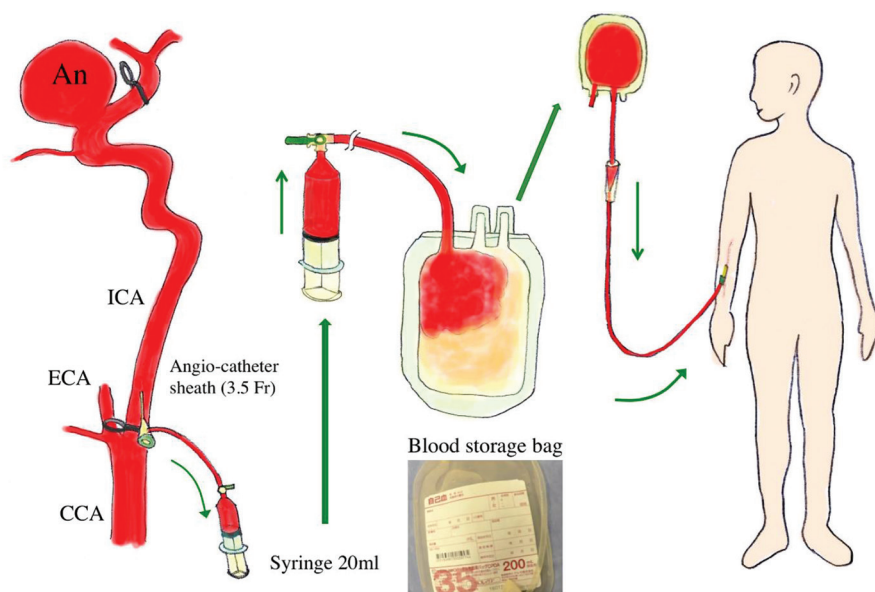


Fig. 1 Illustration of aspirated blood collection during suction decompression and re-transfusion to patient. The angiocatheter sheath (3.5 Fr) was inserted into the internal carotid artery (ICA), and the clip was placed over the proximal edge of the ICA and the distal edge of the aneurysm (An). Subsequently, blood was suctioned with a 20-mL syringe. The uncontaminated blood was successively collected in an autologous blood transfusion storage bag (200 mL bag). When the amount exceeded 200 mL, it was collected in a new bag. The collected blood was appropriately returned to the patient as autologous transfusion. ECA: external carotid artery, CCA: common carotid artery.

Table 1 Five cases of aspirated blood collection and re-transfusion using blood storage bag

Case	Age	Sex	Unruptured or ruptured	Location of aneurysm	Size (mm)	Additional procedure	Aspirated blood volume (ml)	SBP (mmHg)/HR (/min) before SD	SBP (mmHg)/HR (/min) after SD and ABT	Hb (g/dL)/Ht (%) before SD	Hb (g/dL)/Ht (%) after SD and ABT	Hb (g/dL)/Ht (%) before SD	Hb (g/dL)/Ht (%) after SD and ABT
1	57	Male	Unruptured	Rt.IC-PC	11	—	250	101/70	105/72	8.6/27.3	8.3/25.7	8.6/27.3	8.3/25.7
2	78	Male	Unruptured	Rt.IC-Ach	12	—	400	96/66	102/66	11.8/36.5	11.7/36.0	11.8/36.5	11.7/36.0
3	70	Female	Unruptured	Rt.IC-SHA	20	STA-MCA bypass	130	112/70	108/68	10.2/31.5	10.1/31.3	10.2/31.5	10.1/31.3
4	68	Female	Unruptured	Lt.IC-SHA	18	STA-MCA bypass	220	107/64	110/72	11.4/34.3	11.2/33.9	11.4/34.3	11.2/33.9
5	45	Female	Unruptured	Lt.IC-SHA	22	—	190	96/62	98/66	10.6/31.9	10.7/32.1	10.6/31.9	10.7/32.1

ABT: autologous blood transfusion, Ach: anterior choroidal artery, Hb: hemoglobin, HR: heart rate, Ht: hematocrit, IC: internal carotid artery, MCA: middle cerebral artery, PC: posterior communicating artery, SBP: systolic blood pressure, SD: suction decompression, SHA: superior hypophyseal artery, STA: superficial temporal artery.

in Hb and Ht after suction decompression (Hb/Ht before suction decompression: 10.2/31.5 → after suction decompression: 10.1/31.3; Table 1). She did not have complications such as fever and skin rash. No new neurological symptoms appeared after surgery, and the postoperative CT did not reveal any bleeding or infarctions (Fig. 2G). The findings on 3D-CTA showed that the aneurysm had disappeared (Fig. 2F). The right visual acuity had improved to almost 0.8 at 3 months following surgery.

Summary of cases

Same suction decompression method, in which the aspirated blood was stored in the blood bag, was performed in five cases (Table 1). The blood volume ranged from 130 to 400 mL. All aspirated blood was successfully re-transfused (Table 1). There were no critical changes in blood pressure and heart rate before and after suction decompression procedure for all cases. No significant decreases were noted in hemoglobin or hematocrit values before and after suction decompression procedure (Table 1). Moreover, no findings suggestive of hemolysis, thrombus formation and other complications such as fever and skin rash were noted.

Discussion

Direct neck clipping for large and giant aneurysms is relatively challenging. The parent artery typically must be temporarily blocked off. Suction decompression, which involves suctioning blood that flows into the aneurysm, is an efficient method of proactively reducing internal pressure in the aneurysm to enable the confirmation and preservation of the critical vessels and perforating arteries around the aneurysm and angioplastic clipping.¹⁻⁵⁾

This procedure was first reported by Flamm et al. as suction decompression involving a direct puncture of the aneurysm in six cases of giant cerebral aneurysms⁵⁾. Batjer et al.¹⁾ and Tamaki et al.⁷⁾ presented retrograde suction decompression, in which blood is suctioned in a retrograde manner after a direct puncture of the ICA, and this method is currently widely recognized. Scott et al.⁶⁾ reported on a suction decompression method in which a balloon catheter was inserted via a femoral artery rather than making an incision into the cervical region.

The amount of blood aspirated during suction decompression differs depending on the collateral route development and the suction decompression procedure time. There are no particular problems if the amount is 100 mL or less.^{3,6,7)} However, amounts of 400 mL or greater may be aspirated in some cases.⁸⁻¹⁰⁾ The aspiration of a large amount of blood

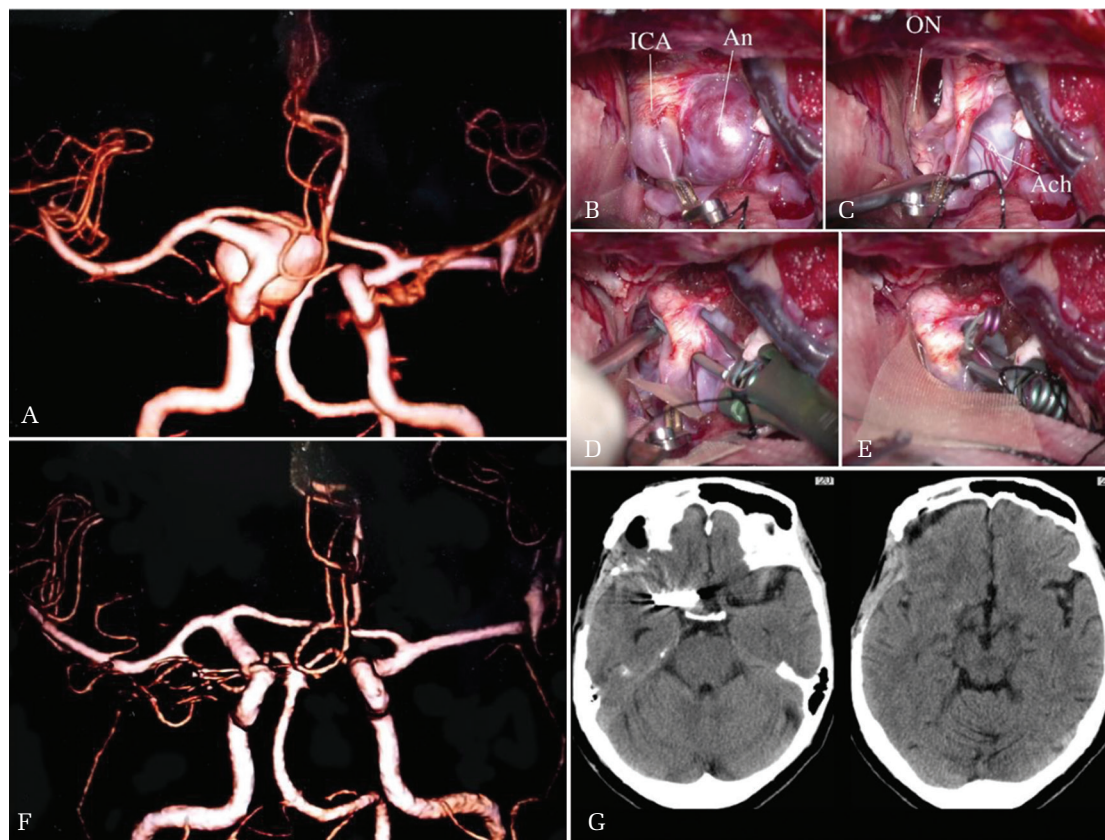


Fig. 2 (A) Preoperative three-dimensional computed tomography angiography (3D-CTA). An aneurysm (20 mm) was identified on the posterior wall of the C₂ portion of the right internal carotid artery (ICA) and the seemed to be an ICA–superior hypophyseal artery aneurysm (An). (B–E) Intraoperative photographs. (B) Image just before suction decompression. (C) Image during suction decompression. The optic nerve (ON) and the anterior choroidal artery (Ach) could be visually confirmed. They were then separated from the aneurysm. (D) Image during clipping. While executing suction decompression, clipping was performed not to damage the Ach and the ON. (E) Clipping image. Clipping was completed after suction decompression. (F) Postoperative 3D-CTA. The aneurysm had disappeared. (G) Postoperative CT. No new infarctions or bleeding were noted.

within a short time can cause intraoperative anemia and shock, and also interferes with the suction decompression procedure itself. This problem could be solved if it were possible to safely retransfuse the aspirated autologous blood. For safe retransfusion, we stored the aspirated blood acquired during suction decompression in autologous blood transfusion storage bags and gradually retransfused all of the blood into the patient. In our series, the amount of blood ranged from 130 to 400 mL, which was similar to that in previously reported cases. Regardless of the amount of aspirated blood, no significant changes were observed in vital sign and in Hb or Ht values, before and after suction decompression, in any of our patients.

Special care must be taken to avoid thrombus formation, infection, and hemolysis when re-utilizing the aspirated blood. The use of autologous blood transfusion storage bags can minimize these risks.

This storage system is a method certified as perioperative autologous blood transfusion and is a method that secures safety and ethical aspects. Once aspirated blood is stored, it is not necessary to quickly return it to the human body. It can be administered at an optimal timing, while observing blood pressure and Hb/Ht values in accordance with usual blood transfusion. In addition, this blood storage procedure is very simple, and we can concentrate on the suction decompression procedure. In usual preoperative autologous blood transfusion, blood is collected into the bags using an 18-G needle (internal diameter: 0.84 mm); the 3.5 Fr catheter that we use for suction decompression has a wide lumen, with an internal diameter of 1.2 mm. This further reduces the risk of hemolysis associated with aspiration.

The blood storage bag was used according to the product information (Terumo blood bag CDPA, Terumo

Co Ltd, Tokyo, Japan). This bag (for 200 mL) contains 28 mL of CDPA solution composed of sodium citrate hydrate 2.63, citric acid hydrate 0.327, glucose 2.9, sodium dihydrogen phosphate 0.251 and adenine 0.0275 (w/v%). If stored blood volume is a half or more (100 mL or more) of standard volume, all the blood can be returned without any problem. If less than a half volume, it is recommended to administer slowly or discard. An anticoagulant adjustable blood storage bag (Terumo blood bag CDPA with mini bag, BB-SCD200J81) is also available.

In terms of cost, although red blood cell transfusion 2 U costs approximately 8000 yen (71 US\$) in Japan, autologous blood 2 U is relatively cheap, costing only 3000 yen (27 US\$). Moreover, autologous blood storage and transfusion is calculated as 10,000 yen (89 US\$) in terms of medical care remuneration for medical facilities in Japan.

Thus, the use of blood aspirated during suction decompression using autologous blood transfusion storage bags makes it relatively safe and easy to re-transfuse, without the concern of the blood volume aspirated during suction decompression. The procedure, which is also highly economical, is a practical auxiliary method that enables safe suction decompression.

Conclusion

We reported a method of re-transfusing blood aspirated during suction decompression using autologous blood transfusion storage bags. This method is a simple and safe one, which can minimize potential risk of re-utilizing aspirated blood. It also makes it possible to concentrate on suction decompression procedure without concerns regarding the amount of blood aspirated during suction decompression. This practical auxiliary procedure, which is also highly economical, is useful and enables the safe and easy execution of suction decompression.

Author Contributions

Study conception and design: Murata. Data acquisition: All authors. Data analysis and interpretation: Matsuzawa and Murata. Manuscript drafting: Matsuzawa and Murata. Critical revision of the article: Murata. Reviewing submitted version of manuscript: All authors. Approval of the final version of the manuscript on behalf of all authors: Murata.

Ethical Approval

This method has been approved by the blood transfusion committee of our facility and is eligible for

coverage by public health insurance for autologous blood transfusion in Japan.

Informed Consent

Informed consent for the autologous blood transfusion is obtained from all the patients. The patient has provided permission to publish these features of their cases, and the identity of the patient has been protected.

Conflicts of Interest Disclosure

The authors report no conflicts of interest concerning the materials or methods used in this study or the reported findings.

References

- 1) Batjer HH, Samson DS: Retrograde suction decompression of giant paraclinoid aneurysms. Technical note. *J Neurosurg* 73: 305–306, 1990
- 2) Eliava SS, Filatov YM, Yakovlev SB, et al.: Results of microsurgical treatment of large and giant ICA aneurysms using the retrograde suction decompression (RSD) technique: series of 92 patients. *World Neurosurg* 73: 683–687, 2010
- 3) Fahlbusch R, Nimsky C, Huk W: Open surgery of giant paraclinoid aneurysms improved by intraoperative angiography and endovascular retrograde suction decompression. *Acta Neurochir (Wien)* 139: 1026–1032, 1997
- 4) Fan YW, Chan KH, Lui WM, Hung KN: Retrograde suction decompression of paraclinoid aneurysm—a revised technique. *Surg Neurol* 51: 129–131, 1999
- 5) Flamm ES: Suction decompression of aneurysms. Technical note. *J Neurosurg* 54: 275–276, 1981
- 6) Scott JA, Horner TG, Leipzig TJ: Retrograde suction decompression of an ophthalmic artery aneurysm using balloon occlusion. Technical note. *J Neurosurg* 75: 146–147, 1991
- 7) Tamaki N, Kim S, Ehara K, et al.: Giant carotid-ophthalmic artery aneurysms: direct clipping utilizing the “trapping-evacuation” technique. *J Neurosurg* 74: 567–572, 1991
- 8) Imai H, Watanabe K, Miyagishima T, et al.: The outcome of a surgical protocol based on ischemia overprotection in large and giant aneurysms of the anterior cerebral circulation. *Neurosurg Rev* 39: 505–517, 2016
- 9) Takeuchi S, Tanikawa R, Goehre F, et al.: Retrograde suction decompression for clip occlusion of internal carotid artery communicating segment aneurysms. *World Neurosurg* 89: 19–25, 2016
- 10) Xu BN, Sun ZH, Romani R, et al.: Microsurgical management of large and giant paraclinoid aneurysms. *World Neurosurg* 73: 137–146; discussion e17, e19, 2010

- 11) Hoh DJ, Larsen DW, Elder JB, Kim PE, Giannotta SL, Liu CY: Novel use of an endovascular embolectomy device for retrograde suction decompression-assisted clip ligation of a large paraclinoid aneurysm: technical case report. *Neurosurgery* 62: ONSE412–ONSE413; discussion ONSE413–ONSE414, 2008
- 12) Matano F, Mizunari T, Kominami S, et al.: Retrograde suction decompression of a large internal carotid aneurysm using a balloon guide catheter combined with a blood-returning circuit and

STA-MCA bypass: a technical note. *Neurosurg Rev* 40: 351–355, 2017

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