



One-Way Valve Method for Achieving Effective Flow Reversal on Carotid Artery Stenting

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Objective: We report a simplified method of manual transfusion with a one-way valve during carotid artery stenting (CAS) with flow reversal.

Case Presentation: A 77-year-old man with cervical internal carotid artery stenosis who developed vulnerable plaques was scheduled for CAS using flow reversal. Blood flow reversal was naturally caused by the arteriovenous pressure gradient, and a method with a one-way valve, which enables simplified manual transfusion using a syringe technique, was used for the patient. CAS was completed without distal embolization.

Conclusion: Manual transfusion can be simplified using a one-way valve in cases of flow reversal during CAS, which often require complicated procedures.

Keywords ▶ carotid artery stenting, carotid artery stenosis, flow reversal

Introduction

For carotid artery stenting (CAS), a method to simultaneously block the common and external carotid arteries and convert internal carotid artery blood flow to retrograde flow to prevent distal embolism (flow reversal method) is sometimes used to treat soft plaques, markedly stenotic, false-occlusive, and markedly flexed lesions. This was reported as Parodi's method,¹⁾ in which a route is prepared after venous puncture and connected with arterial blood flow, and arterial blood is transfused to the venous route through spontaneous blood flow utilizing arteriovenous pressure differences. In some cases, blood is aspirated/excreted at an appropriate time

through manual syringe operations, such as cancellation of arterial blockage/lesion passage, in addition to spontaneous blood flow related to arteriovenous pressure differences. This procedure is useful, but set-up and route preparation may be complex in comparison with standard CAS combined with distal protection. Furthermore, the methods vary among institutions or supervisory physicians, but no study has examined the improvement of operability related to this complex procedure. In this study, we report a method in which the attachment of a one-way valve, which we devised, to both ends of a three-way stopcock facilitates simple manual syringe operations for blood aspiration/excretion.

Parodi's method

Parodi et al. reported the flow reversal method in which the common and external carotid arteries are blocked, and arteriovenous pressure differences are utilized using a Parodi Anti Emboli System (ArteriA, San Francisco, CA, USA) as a method to prevent distal embolism related to CAS. Regurgitating blood foreign bodies are removed through a filter connected with a transfusion circuit and the blood is transfused into the body (**Fig. 1**).

One-way valve method devised by the author

This one-way valve is used to prevent blood reflux into a transfusion route during frequent blood pressure measurement (**Fig. 2A** and **2B**). Two valves are used in front and behind of the syringe-connected three-way stopcock of

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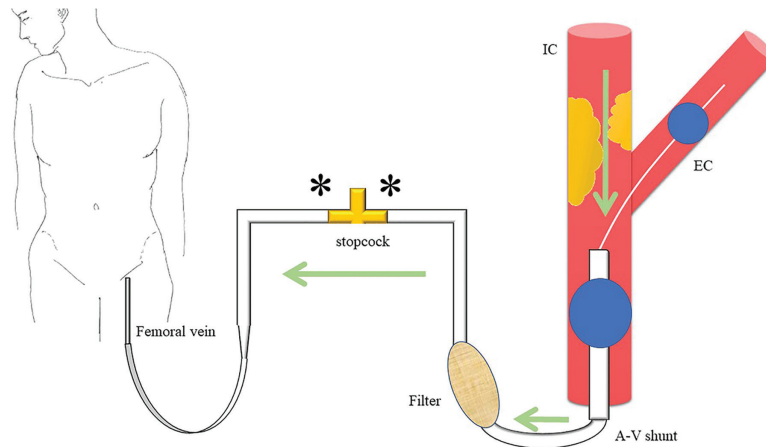


Fig. 1 Parodi's method. IC: internal carotid artery; EC: external carotid artery; Asterisk: site of one-way valve attachment; Arrow: blood flow

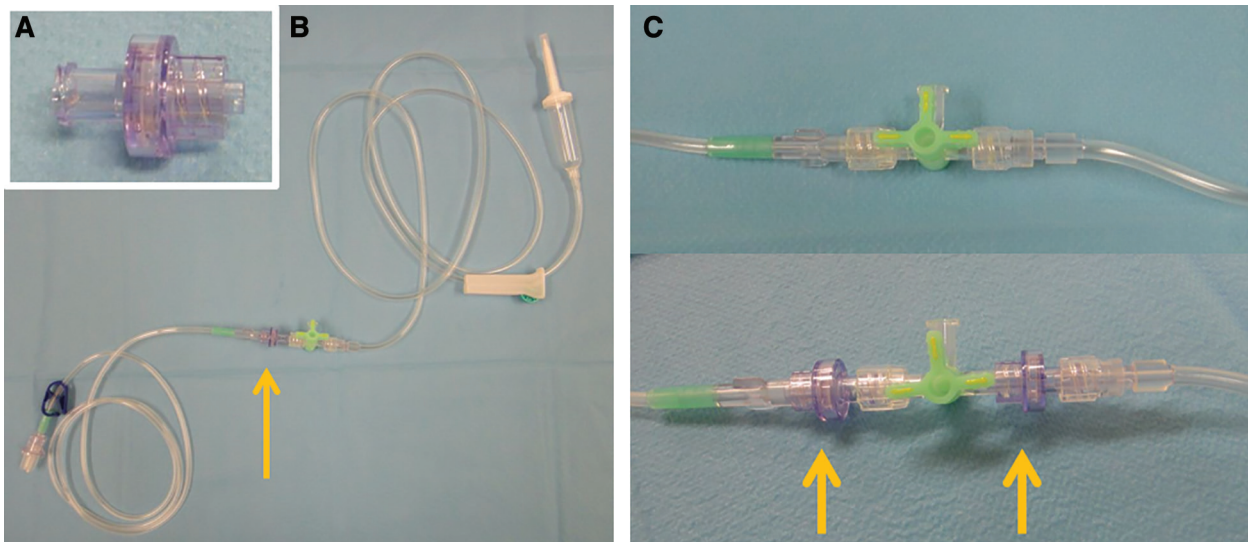


Fig. 2 Arrow: one-way valve. (A) One-way valve and (B) standard usage method. Reflux into a line for drip infusion is prevented. (C)

One-way valve method: two valves are connected with the front and behind of a three-way stopcock.

the transfusion line (**Fig. 2C**). When syringe operations are absent, the two valves do not function, resulting in anterograde blood flow (**Fig. 3A**). When one valve functions, only blood on the carotid artery side is aspirated through syringe aspiration (**Fig. 3B**) and excreted to the venous side in the absence of reflux to the carotid artery side through syringe excretion (**Fig. 3C**). Therefore, syringe aspiration/excretion operations alone facilitate accurate and simple manual transfusion. In general, these syringe operations require putting the three-way stopcock down, but attachment of this one-way valve makes this unnecessary.

Case Presentation

A 77-year-old man had cervical internal carotid artery stenosis and unstable plaques. Under general anesthesia, a 9Fr sheath was inserted into the right femoral artery and a 6Fr sheath was inserted into the left femoral vein. CAS was performed using the flow reversal method with a Mo. Ma Ultra (Medtronic, Minneapolis, MN, USA). Manual transfusion using a one-way valve was conducted on microwire passage at the stenotic site and cancellation of arterial blockage. Neurologically, there was no new deterioration or distal embolism; safe CAS was performed.

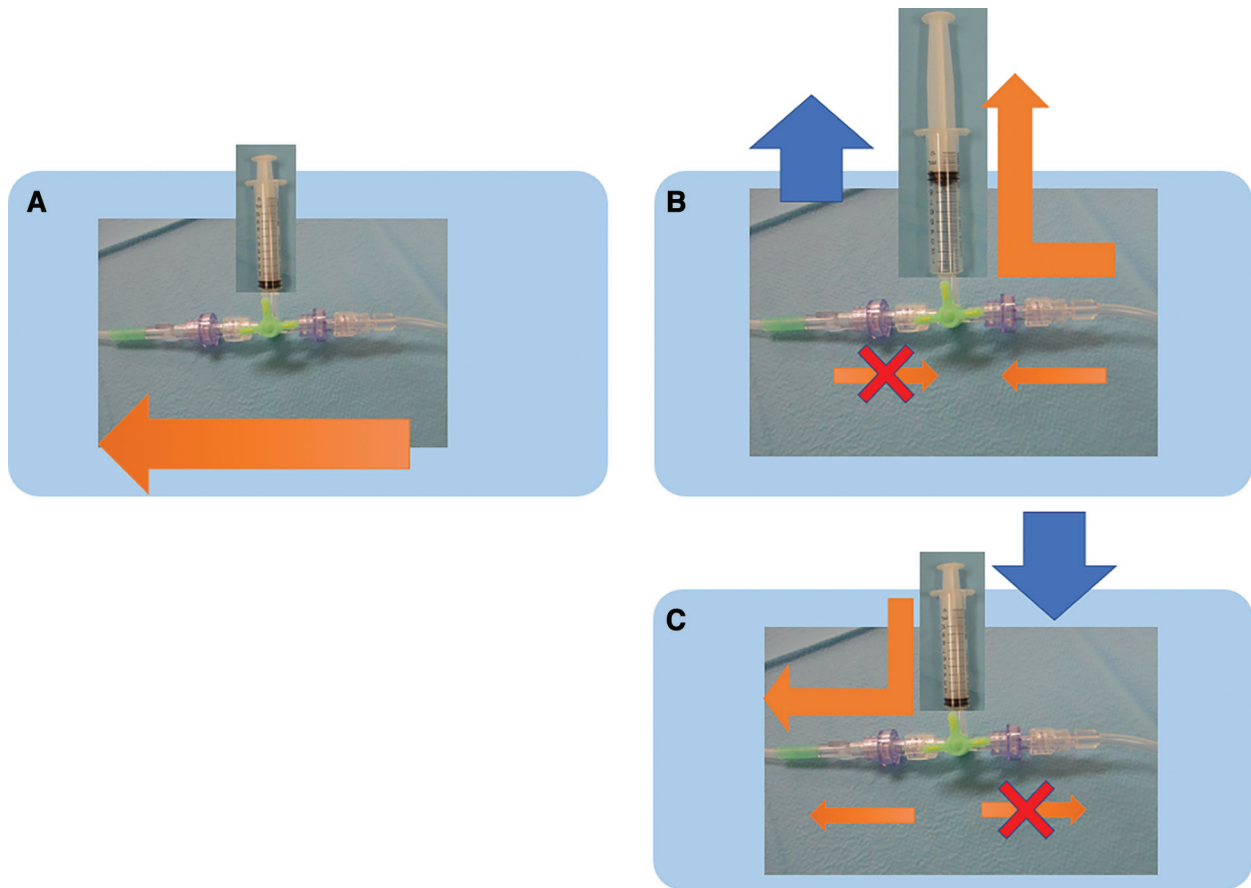


Fig. 3 The arrow indicates blood flow. The right side of this figure represents the carotid artery side and the left side represents the venous side. **(A)** In the absence of syringe operations, the two valves do not function and anterograde blood flow is observed. **(B)** On

syringe aspiration, the valve on the venous side functions and blood is aspirated from the carotid artery side alone. **(C)** When the syringe is pushed, the valve on the carotid artery side functions and blood is transfused to the venous side alone without lesion reflux.

Discussion

The usefulness of Parodi's method/modified Parodi's method was previously reported,¹⁻³⁾ but the procedure differs among institutions, being complex. When surgeons consider only transfusion utilizing arteriovenous pressure differences insufficient, manual transfusion may be performed at an appropriate time to prevent distal embolism. Manual transfusion using the one-way valve devised by the author does not require three-way stopcock action, and blood aspiration/excretion by the syringe alone facilitate accurate transfusion. Furthermore, human errors, such as mistakes in three-way stopcock operations, can be managed, and this method may be particularly useful when frequent syringe operations are required.

Surgeons sometimes feel anxious about the continuous flow reversal method with arteriovenous pressure differences in Parodi's method. For example, intra-circuit blood flow is invisible and it is difficult to confirm reflux of spontaneous blood flow. There is a method to confirm dripping using a

drip chamber for drip infusion in a route, but the chamber must be established such that air does not migrate into the route. In addition, it is impossible to continuously pay attention to the chamber during the procedure. Furthermore, the presence of the superior thyroid artery makes complete blood flow blockage impossible in some cases. Manual transfusion operations by surgeons can be performed at any point during the procedure and unexpected troubles, such as balloon damage, may be managed; therefore, such operations may be useful for distal-embolism prevention or trouble-shooting.

Furthermore, large-volume syringes may be frequently used for manual transfusion operations, possibly targeting an increase in the aspirated blood volume per session and a decrease in the frequency of standard three-way stopcock operations. If the syringe volume is reduced, frequent three-way stopcock operations may be necessary. As manual transfusion operations with this one-way valve devised by the author do not require three-way stopcock operations, the syringe volume is not related. When the volume of an aspiration syringe is large, hand resistance at the time of aspiration is low, making

force adjustment difficult. At our hospital, 10-mL aspiration syringes are used and the aspiration force is adjusted.

Manual transfusion using this one-way valve is simple and it may be useful for manual transfusion on flow reversal. Furthermore, we have performed CAS using this method on 16 patients without complications. Assistants who are not acquainted with the procedure are also able to understand it and we believe that a CAS team facilitates the procedure. However, in the future, the clinical efficacy, timing of manual transfusion operations, and transfusion volume should be examined, in addition to the subjective assessment of its usefulness.

Conclusion

Manual transfusion with a one-way valve can be simply introduced, and it may help simplify operability on flow reversal during CAS.

Disclosure Statement

The authors declare no conflict of interest.

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