

Parent Vessel Occlusion via the Balloon-Assisted, Dual Microcatheter Technique

Abstract

Endovascular parent vessel sacrifice is an established technique used to treat vascular pathology and tumor infiltration of blood vessels. In high-flow vessels, such as the carotid artery or vertebral artery, distal coil migration and embolization are concerns. A method to mitigate this risk would improve the safety profile of the procedure. Five patients undergoing parent vessel sacrifice were retrospectively identified (from June 2018 to May 2019) for the purpose of illustrating this high-flow parent vessel occlusion technique. The technique utilizes a proximal dual-lumen balloon microcatheter inflated for blood flow arrest. The balloon-assisted, dual microcatheter technique is useful for occlusion of high-flow parent arteries. Because it utilizes both flow arrest and a tethered coil backstop, precise occlusion of a vessel can be achieved.

Keywords: Balloon occlusion, coiling, embolization, endovascular, technique

Introduction

Endovascular parent vessel occlusion is an established treatment option for a variety of neurovascular pathologies, including vessel dissection,^[1] carotid-cavernous fistula,^[2] aneurysm,^[3,4] and tumor infiltration,^[5] among others. Techniques for vessel occlusion vary depending on anatomy and operator, with proximal flow arrest and coils being the main tenants of the procedure. Even with proximal flow arrest during coiling, distal embolization can occur when the balloon is deflated, particularly in high-flow vessels. Distal migration of coils is also a concern during embolization, particularly when high packing density is desired, large diameter coils are typically used, and the coiling catheter is immobile as a result of proximal balloon inflation. The concern for distal migration is magnified when preservation of a nearby branch vessel(s) is critical. In order to achieve a more accurate parent vessel sacrifice with decreased risk of distal embolization, we developed a balloon-assisted, dual microcatheter technique, used in five cases thus far [Table 1].

Case Report

There are several key steps to parent vessel occlusion using the balloon-assisted,

dual microcatheter technique [Figure 1]. Control angiography and working views are established to delineate the distal most aspect of vessel occlusion, taking into consideration any branch vessels that demand patency. Next, a guide catheter is introduced into the proximal vessel, such as the vertebral artery or carotid artery. The guide catheter should be large enough to accommodate two microcatheters and have residual lumen volume to perform control angiography, if desired. The compatibility of a guide catheter to accommodate a balloon microcatheter alongside another microcatheter varies depending on the manufacturer and models selected. In general, a 6 French guide catheter or larger is required for this method. Alternatively, a smaller guide catheter can be used and control angiography can be performed via collateral circulation when available, such as the contralateral vertebral artery. A dual-lumen balloon microcatheter (e.g., Scepter C or Scepter XC, Microvention, Aliso Viejo, CA, USA) is then advanced through the guide catheter into a position proximal to the site of desired occlusion. A coiling microcatheter (second microcatheter) is then advanced past the balloon microcatheter to the distal most desired site of vessel occlusion. After the

**Gregory Glauser,
Brian Patrick
Walcott^{1,2}, Omar
Aftab Choudhri**

Department of Neurosurgery, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, ¹Department of Neurosurgery, NorthShore University HealthSystem, Evanston, ²Section of Neurosurgery, Department of Surgery, University of Chicago Pritzker School of Medicine, Chicago, IL, USA

Address for correspondence:

Dr. Omar A Choudhri,
3400 Spruce Street, 3rd Floor
Silverstein, Philadelphia,
PA 19104, USA.
E-mail: omar.choudhri@pennmedicine.upenn.edu

Video Available on:
www.asianjns.org

Access this article online

Website: www.asianjns.org

DOI: 10.4103/ajns.AJNS_153_20

Quick Response Code:



How to cite this article: Glauser G, Walcott BP, Choudhri OA. Parent vessel occlusion via the balloon-assisted, dual microcatheter technique. *Asian J Neurosurg* 2020;15:726-9.

Submission: 10-Apr-2020 **Revised:** 02-May-2020
Accepted: 26-Jun-2020 **Published:** 28-Aug-2020

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Table 1: Patient characteristics

Age	Sex	Pathology	Target vessel occlusion	Catheters	Angiographic outcome
57	Female	Vertebral artery aneurysm (ruptured)	Vertebral artery (V4 segment)	Scepter C/ Echelon	Vertebral artery occluded; posterior inferior cerebellar artery origin preserved
25	Male	Carotid artery-cavernous sinus fistula	Right ICA	Scepter XC/SL-10	Right ICA occluded, near-complete obliteration of fistula; no distal coil embolization/migration
27	Female	Tumor	Right ICA	Scepter XC/SL-10	Right ICA occluded; no distal coil embolization/migration
62	Female	Tumor	Vertebral artery (V3 segment)	Scepter XC/SL-10	Right vertebral artery (V3 segment) occluded; no distal coil embolization/migration
16	Male	Carotid artery aneurysm (giant, unruptured)	Left ICA	Scepter XC/SL-10	Left ICA occluded, aneurysm obliterated; no distal coil embolization/migration

ICA: Internal carotid artery

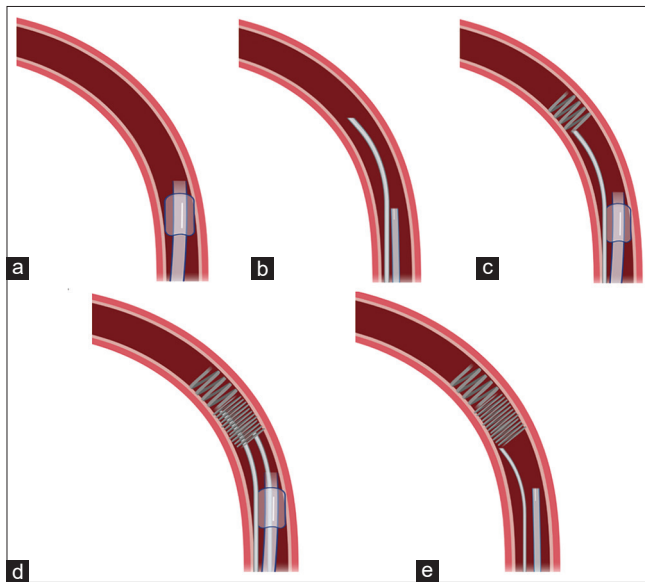


Figure 1: Dual microcatheter balloon occlusion coiling technique. (a) Step 1: Placement of dual-lumen balloon (balloon test occlusion can be completed, if desired). (b) Step 2: Placement of microcatheter at distal occlusion limit (balloon deflated). (c) Step 3: Placement of distal defining coil (not detached, balloon inflated). (d) Step 4: Coiling proximally through dual-lumen balloon microcatheter (multiple coils detached). (e) Step 5: Deflate balloon. If no movement of coil mass, then distal defining coil is detached

balloon is inflated, a framing coil is deployed through the second microcatheter to define the distal most aspect of the vessel occlusion. This coil is not immediately detached. Then, further coils are deployed through the balloon microcatheter to achieve a relatively high packing density in the parent vessel. Of note, there are no coil delivery markers on the Scepter, so care must be taken to deliver the coils under close fluoroscopic guidance. Because there are no coil detachment markers, the operator needs to visually identify when the coil is outside the distal tip of the catheter. For most coils, the coil itself is more radiopaque than the pusher wire it is connected to, allowing for this distinction. If preferred by the operator, other dual-lumen balloon microcatheters are available that do have coil delivery markers, such as the Eclipse 2L dual-lumen balloon catheter (BALT USA, Irvine, CA, USA).

During this time, the attached coil deployed from the second microcatheter serves as a backstop and provides additional security against distal migration of the coils. As the procedure progresses, control angiography can be performed with the balloon deflated. In addition, the balloon microcatheter can be repositioned more proximal, and further coil embolization can be performed to increase the length of the occluded segment. With any balloon inflated, the feedback and natural flexibility of a catheter as a response to coil delivery is altered. This can make it more difficult to “guide” coils into different shapes and configurations. However, this is less of a concern when performing parent vessel occlusion because the shape of the coils delivered does not need to conform to a specific shape, as in the case of an aneurysm. After the vessel is completely occluded, the balloon is deflated and the stability of the coil construct is assessed. When there is no flow through the vessel and the coils are stable, the first coil is detached and the microcatheters are removed under fluoroscopy. Two illustrative cases utilizing this technique are presented [Figures 2, 3 and Video 1].

Discussion

There are many techniques for endovascular parent vessel occlusion, with the overarching principle being proximal flow arrest and coil embolization. The described balloon-assisted, dual microcatheter technique is a novel iteration of this principle that is possible as a result of the dual-lumen balloon microcatheters that are now available in clinical practice. A major advantage of this technique is that large-lumen balloon guide catheters are no longer needed to achieve proximal flow arrest, as it is readily achieved with the balloon microcatheter. Further, the dual microcatheter approach also allows for the procedure to be performed via radial artery access, if desired.

Although not described above as part of the procedural steps, the technique can seamlessly integrate a balloon test occlusion into the workflow.^[6] Because the balloon microcatheter results in flow arrest, a balloon test occlusion can be performed prior to definitive parent

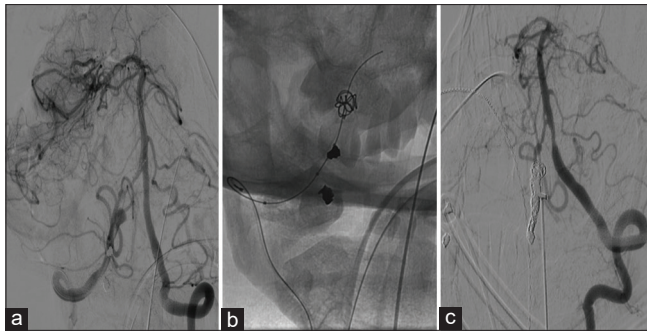


Figure 2: Illustrative case, posterior circulation. A middle-aged female who presented with high-grade subarachnoid hemorrhage. Angiography demonstrated a wide-necked aneurysm located proximal to the origin of the posterior inferior cerebellar artery (a). Treatment options possible for this patient include direct aneurysm clipping or aneurysm trapping. Because the aneurysm was not at a branch point and the parent vessel was somewhat irregular, the underlying pathology was believed to be a vessel dissection, favoring vessel occlusion or sacrifice as a definitive treatment. As the patient had a robust left vertebral artery and the aneurysmal segment was proximal to the posterior inferior cerebellar artery, a right vertebral artery occlusion was planned. The operative technique described above was utilized for this patient, with a working view of the posterior inferior cerebellar artery origin selected (b). After following the steps listed previously, the aneurysmal segment was not densely coiled initially and was still filling despite dense coiling of the more proximal vertebral artery. With the balloon inflated, the distal defining coil was detached, the coiling microcatheter was brought back a few millimeters, and a few more soft coils were placed into the aneurysmal segment of the vertebral artery. The balloon was deflated, and control angiography demonstrated complete right vertebral artery occlusion, no filling of the aneurysm, and preservation of the posterior inferior cerebellar artery (c). Postoperative magnetic resonance imaging demonstrated no ischemia, and the patient went on to make an uncomplicated recovery

vessel sacrifice. Once the patient has “passed” the balloon test occlusion, there is no need for catheter exchanges or substitutions, and the embolization procedure can proceed immediately.

Variations of this technique are also possible, and operators can choose to augment their constructs with liquid embolic agents^[7] or intravascular plug-type devices,^[8] as both are compliant with the Scepter balloon microcatheter. As the embolization procedure proceeds, there is also flexibility in repositioning the balloon microcatheter to a more proximal location without the fear of distal embolization. The ability to extend the length of the embolization construct in this manner prevents “pushing” of previously detached coils distally or over packing of a fragile diseased vessel segment, which can be possible with the traditional balloon guide catheter/microcatheter approaches.

Limitations to this technique include the possibility of retrograde filling distal to the occlusion through collateral flow. This is seen in the case illustrated above, with retrograde filling of the distal segment of the aneurysm via the contralateral vertebral artery. As seen in the illustrative case, this requires further coiling via the distal microcatheter. This additional step may potentially increase the risk of distal embolization or coil migration, although this was not seen in the case presented here.

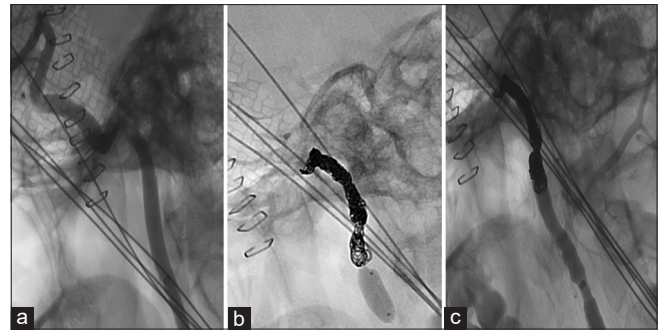


Figure 3: Illustrative case, anterior circulation. A young female with a middle fossa tumor causing invasion of petrous segment of the right internal carotid artery, who required a balloon test occlusion followed by coil sacrifice. (a) Preoperative imaging demonstrating the involved carotid artery. (b) Intraoperative imaging, showing vessel occlusion with coil placement with the proximal balloon inflated. (c) Postoperative imaging showing coils in place and complete parent vessel occlusion with removal of balloon microcatheter and coiling microcatheter

Conclusion

The balloon-assisted, dual microcatheter technique is a new tool for parent vessel occlusion. Anecdotal experience suggests that there is improved protection against distal embolization or migration of coils compared to traditional techniques. The technique allows for a very precise parent vessel occlusion, which can be particularly helpful when preservation of segments that give rise to a branch vessel mandates.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Halbach VV, Higashida RT, Dowd CF, Fraser KW, Smith TP, Teitelbaum GP, *et al.* Endovascular treatment of vertebral artery dissections and pseudoaneurysms. *J Neurosurg* 1993;79:183-91.
- Gemmete JJ, Ansari SA, Gandhi DM. Endovascular techniques for treatment of carotid-cavernous fistula. *J Neuroophthalmol* 2009;29:62-71.
- Elhamady MS, Wolfe SQ, Farhat H, Ali Aziz-Sultan M, Heros RC. Carotid artery sacrifice for unclippable and uncoilable aneurysms: Endovascular occlusion vs. common carotid artery ligation. *Neurosurgery* 2010;67:1431-6.
- Hallacq P, Pötin M, Moret J. Endovascular occlusion of the posterior cerebral artery for the treatment of p2 segment

- aneurysms: Retrospective review of a 10-year series. *AJNR Am J Neuroradiol* 2002;23:1128-36.
5. Lawton MT, Spetzler RF. Internal carotid artery sacrifice for radical resection of skull base tumors. *Skull Base Surg* 1996;6:119-23.
6. Walcott BP, Babadjouni R, Yim B, Mack WJ. Balloon test occlusion. In: *Intracranial Aneurysms*. Cambridge, Massachusetts, USA: Elsevier; 2018. p. 387-95.
7. Chalouhi N, Starke RM, Tjoumakaris SI, Jabbour PM, Gonzalez LF, Hasan D, *et al.* Carotid and vertebral artery sacrifice with a combination of Onyx and coils: Technical note and case series. *Neuroradiology* 2013;55:993-8.
8. Mithon F, Agrawal A, Nimjee SM, Ferrell A, Zomorodi AR, Smith TP, *et al.* Enhanced, rapid occlusion of carotid and vertebral arteries using the AMPLATZER Vascular Plug II device: The Duke Cerebrovascular Center experience in 8 patients with 22 AMPLATZER Vascular Plug II devices. *World Neurosurg* 2015;83:62-8.