ADAPT: A Direct Aspiration First Pass Technique

A versatile, fast, and cost-effective approach to thrombectomy for acute ischemic stroke.

BY ALEJANDRO M. SPIOTTA, MD; KYLE M. FARGEN, MD, MPH; IMRAN CHAUDRY, MD; RAYMOND D. TURNER, MD; AND AQUILLA S. TURK, DO

The past year has been a truly historic year for the treatment of acute ischemic stroke. Five prospective randomized clinical trials have demonstrated the superiority of endovascular thrombectomy over medical management for the treatment of acute ischemic stroke.[1-5] These trials largely demonstrated the benefit of thrombectomy over medical management, as their design addressed limitations learned from previous trials.[6] Most notably, these trials required imaging to verify emergent large vessel occlusion (ELVO) and then proceeded to thrombectomy as quickly as possible, whereas previous trials did not require ELVO verification.

The technical maturation of stroke devices and techniques during this time period also played a significant role, as safer, faster, and more effective treatments could be performed. In several trials, a specific thrombectomy device was mandated, but some trials were designed to allow physicians to choose which device(s) was used for thrombectomy. The majority of thrombectomies performed in the trials were performed with stent retrievers, which has led many to believe that they represent the gold standard of thrombectomy devices. Some centers utilized balloon guide catheters in conjunction with stent retrievers to achieve proximal flow arrest to mitigate the likelihood of distal emboli, while others placed a large-bore aspiration catheter immediately adjacent to the deployed stent retriever (ie, the "Solumbra" technique) and removed the stent retriever into the catheter under aspiration to minimize the chance of fragmentation.

A more recent modification of the Solumbra technique involves removing the thrombus with aspiration alone through the catheter; if this not successful, a stent retriever would then be utilized (Figure 1), culminating in a more streamlined, cost-effective, and faster recanalization strategy.[7]

DIRECT ASPIRATION

Although the majority of stroke thrombectomy data focus on stent retrievers as the primary revascularization device (as reflected by the new American Heart Association/American Stroke Association guidelines[7]), there are also data demonstrating that an aspiration-first strategy is at least as effective as retrievable stents, while being safer, faster, and cheaper.

Aspiration is a revascularization technique that has long been utilized in the heart and periphery, and, more recently, intracranially.[8-12] For acute ischemic stroke, this technique has historically been limited by the lack of catheters large enough to provide adequate aspiration force to remove the thrombus, yet flexible and soft enough to safely navigate the cerebral vasculature. This shortcoming has been overcome with new generations of dedicated devices, and there are now high-performance aspiration catheters that can be quickly and safely delivered to the intracranial circulation.

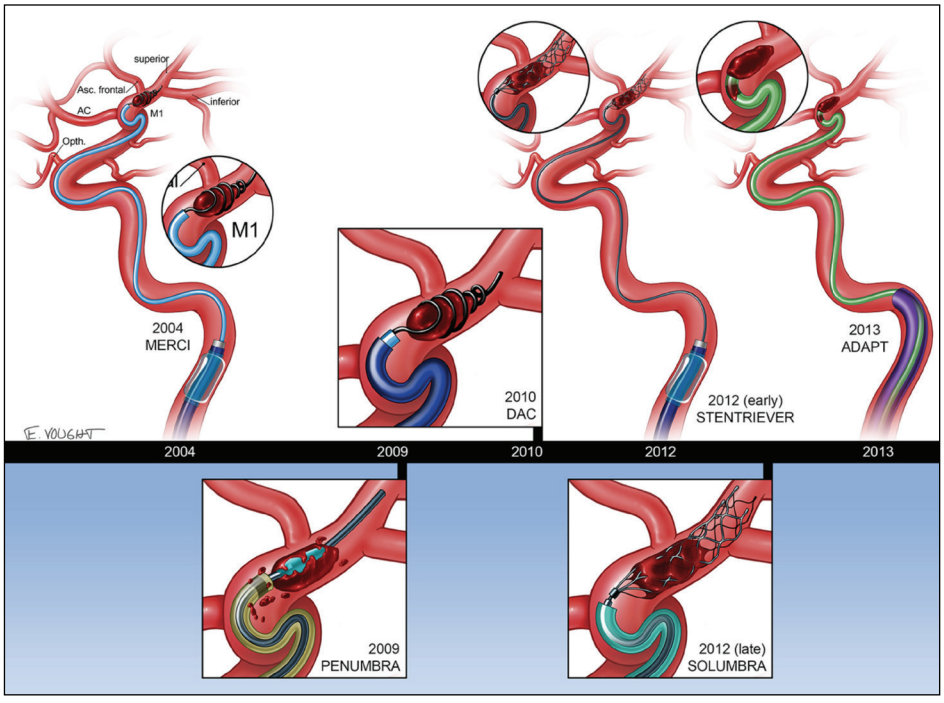
The use of aspiration for treating acute ischemic stroke is best exemplified with ADAPT (A Direct Aspiration first Pass Technique). This technique utilizes aspiration as the first approach to revascularize the occluded vessel, and if this strategy fails, then the aspiration catheter is used in conjunction with a stent retriever to obtain revascularization.

ADAPT TECHNIQUE: PRINCIPLES

The simplicity of ADAPT belies the inherent safety of this approach. Navigating the catheter to a lesion is typically the easiest part of a neurovascular procedure. Attaching the aspiration catheter to a syringe or aspiration pump is then all that is required to perform the thrombectomy. Once attached to the suction system, the catheter is advanced into the proximal end of the thrombus, and suction is initiated. Forward pressure is provided to ensure adequate apposition. The catheter's engagement with the thrombus

is confirmed when there is no backflow through the suction tubing. The thrombus is then either aspirated through the catheter, or it becomes stuck at the catheter tip, and the catheter may be withdrawn back into the guide catheter.

This technique does not require manipulation of the clot or the passage of a catheter blindly through thrombus into nonvisualized distal vasculature. As such, the risk of downstream emboli is reduced, and the potential risks associated with blindly accessing distal vasculature, which could potentially harbor a dangerous lesion such as an aneurysm, is mitigated.[13] It should be emphasized that this aspiration step may require two or three attempts and is successful at removing the clot 75% of the time in this fashion.[14]



(Courtesy of the Medical University of South Carolina.)

Figure 1. Timeline depicting strategies and techniques employed over time to achieve recanalization of an ELVO in the setting of acute ischemic stroke.

ADAPT: PROCEDURAL DETAILS

Access to the cerebral vasculature is typically obtained with a dedicated 6-F sheath. The guide is advanced distally, as far as safely possible, into the internal carotid artery (ICA), usually to the skull base or petrous segment of the ICA. For posterior circulation thrombi, an intracranial access system (eg, Neuron Max 088 [Penumbra, Inc.]) is navigated into the largest-caliber vertebral artery and positioned into the distal V2 segment. The largest-caliber aspiration catheter that the occluded vessel can accommodate is selected for each case, which in our practice is most commonly an ACE 064 reperfusion catheter (Penumbra, Inc.) for M1 or carotid terminus occlusions. The aspiration catheter is advanced to the level of the thrombus over any microcatheter and microwire the operator chooses; at our institution, we most commonly use a Velocity microcatheter (Penumbra, Inc.) or a 3Max reperfusion catheter (Penumbra, Inc.) over a 0.016-inch Fathom wire (Boston Scientific Corporation). In our experience, this triaxial system is able to negotiate the ophthalmic bend at the carotid siphon and any siphon tortuousity.

Under road map guidance, the wire and microcatheter are navigated to or past the thrombus, most commonly into a middle cerebral artery postbifurcation branch. Over this platform, the larger aspiration catheter is delivered and positioned immediately adjacent to the site of occlusion. The microcatheter and wire are removed, and aspiration is applied via either a 20- or 60-mL syringe, or use of the aspiration pump that is part of the Penumbra separator system.[15]

Inability to draw back on aspiration confirms optimal position of the aspiration catheter abutting the thrombus. At this point, the catheter is slightly advanced to ensure firm engagement with the thrombus. The aspiration catheter is then slowly withdrawn while maintaining aspiration. Simultaneous aspiration is also applied to the sideport of the Neuron 088 Max to prevent dislodging the thrombus from the aspiration catheter's aperture as it is withdrawn into the sheath. If aspiration fails, the aspiration catheter can be rapidly advanced to the thrombus, at which point a repeat aspiration can be attempted, or the addition of a stent retriever with local aspiration can be performed. In smaller-caliber vessels, the technique can similarly be employed with either a 4Max or 3Max reperfusion catheter (Penumbra, Inc.).

POTENTIAL BENEFITS

Improvements in catheter technology have resulted in decreasing procedure times of 30 to 40 minutes on average,[14] nearly half of that required with stent retrievers.[16] Our most recent recanalization times are now down to 21 minutes on average, in large part due to the use of larger-bore

aspiration catheters (unpublished data). The ability to complete the case with a single aspiration catheter without additional retrieval devices also markedly reduces the cost.[17,18]

SAFETY AND EFFICACY

The ADAPT technique has been shown to be effective in opening cerebral vessel occlusions with aspiration alone in approximately 75% of cases.[14] In the cases in which aspiration was unable to open the vessel, the adjunctive use of a stent retriever improved the success to at least 95% successful revascularization to TICI 2b or 3 level.[11,12,15] The success of aspiration alone is dependent on using the largest-caliber aspiration catheter that the vessel can accommodate. This allows the greatest amount of aspiration with a catheter approximating the diameter of the thrombus. If aspiration does not remove the thrombus, then the large aspiration catheter can be used in conjunction with a stent retriever to recanalize the vessel. This creates a safer procedure because the stent retriever is pulled into the aspiration catheter in the occluded vessel, reducing the risk of distal emboli to new territories and minimizing traction on the cerebral vessels. Further, this strategy eliminates the need to backtrack through the carotid siphon if the retrievable stent fails to achieve revascularization on the first pass and additional passes are needed.

CONCLUSION

The ADAPT technique is based on aspiration as the primary method for vessel recanalization, and then the addition of a stent retriever in the cases in which aspiration alone is not successful for treatment of acute ischemic stroke. In our experience, this method is at least as safe and effective as using a stent retriever, while proving to be faster and more cost-effective. The success and maturation of this technique relies on continued development of large and trackable aspiration catheters that can safely and easily track into the tortuous cerebral vasculature. The ability to start simply with aspiration and add complexity with adjunctive devices, such as stent retrievers in the cases where aspiration does not work, is the crux of the success of the ADAPT technique. ■

Alejandro M. Spiotta, MD, is Co-Director of the Neurointensive Care Unit and Associate Professor, Department of Neurosurgery and Neuroendovascular Surgery, Medical University of South Carolina in Charleston, South Carolina. He has disclosed he is a consultant for and receives nonfinancial research support from Penumbra, Inc. and MicroVention, Inc. Dr. Spiotta may be reached at spiotta@musc.edu.

Kyle M. Fargen, MD, MPH, is an Assistant Professor, Department of Neurosurgery and Neuroendovascular Surgery, Medical University of South Carolina in Charleston, South Carolina. He has stated that he has no financial interests related to this article. Dr. Fargen may be reached at fargen@musc.edu.

Imran Chaudry, MD, is Associate Professor, Department of Radiology and Neuroendovascular Surgery, Medical University of South Carolina in Charleston, South Carolina. He has disclosed that he is a consultant for and receives nonfinancial research support from Penumbra, Inc., Medtronic, Inc., and MicroVention, Inc. Dr. Chaudry may be reached at chaudry@musc.edu.

Raymond D. Turner, MD, is Professor, Department of Neurosurgery and Neuroendovascular Surgery, Medical University of South Carolina in Charleston, South Carolina. He has disclosed that he is a consultant for and receives nonfinancial research support from Penumbra, Inc., Medtronic, Inc., Codman Neuro, and MicroVention, Inc. Dr. Turner may be reached at turnerrd@musc.edu.

Aquilla S. Turk, DO, is Professor, Department of Radiology and Neuroendovascular Surgery, Medical University of South Carolina in Charleston, South Carolina. He has disclosed that he is a consultant for and receives nonfinancial research support from Penumbra, Inc., Stryker Corporation, Medtronic, Inc., MicroVention, Inc., and Codman Neuro. Dr. Turk may be reached at turk@musc.edu.

1. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med. 2015;372:1019-1030.
2. Saver JL, Goyal M, Bonafe A, et al. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. N Engl J Med. 2015;372:2285-2295.
3. Campbell BC, Mitchell PJ, Kleinig TJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med. 2015;372:1009-1018.
4. Berkhemer OA, Fransen PS, Beumer D, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med. 2015;372:11-20.
5. Jovin TG, Chamorro A, Cobo E, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. N Engl J Med. 2015;372:2296-2306.
6. Mocco J, Fiorella D, Fargen KM, et al. Endovascular therapy for acute ischemic stroke is indicated and evidence based: a position statement. J Neurointerv Surg. 2015;7:79-81.
7. Powers WJ, Derdeyn CP, Biller J, et al. 2015 American Heart Association/American Stroke Association focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2015;46:3020-3035.
8. Penumbra Pivotal Stroke Trial Investigators. The penumbra pivotal stroke trial: safety and effectiveness of a new generation of mechanical devices for clot removal in intracranial large vessel occlusive disease. Stroke. 2009;40:2761-2768.
9. Tarr R, Hsu D, Kulcsar Z, et al. The POST trial: initial post-market experience of the Penumbra system: revascularization of large vessel occlusion in acute ischemic stroke in the United States and Europe. J Neurointerv Surg. 2010;2:341-344.
10. Kasirajan K, Haskal ZJ, Ouriel K. The use of mechanical thrombectomy devices in the management of acute peripheral arterial occlusive disease. J Vasc Interv Radiol. 2001;12:405-411.
11. Wagner H, Starck EE, Reuter P. Long-term results of percutaneous aspiration embolectomy. Cardiovasc Intervent Radiol. 1994;17:241-246.
12. Benenati J, Saxon R, Teigen C. Revascularization of acute ischemia and thrombo-embolic complications in below-the-knee and visceral arterial circulation using a novel mechanical thrombo-aspiration device: initial findings of the PRISM multicenter study. J Vasc Interv Radiol. 2015;26:S53-S54.
13. Asai K, Nakamura H, Sakaguchi M, et al. Direct aspiration first pass technique for a middle cerebral artery occlusion with a hidden aneurysm. Interv Neuroradiol. 2015;21:700-702.
14. Turk AS, Frei D, Fiorella D, et al. ADAPT FAST study: a direct aspiration first pass technique for acute stroke thrombectomy. J Neurointerv Surg. 2014;6:260-264.
15. Yoo AJ, Frei D, Tateshima S, et al. The Penumbra Stroke System: a technical review. J Neurointerv Surg. 2012;4:199-205.
16. Turk AS, Turner R, Spiotta A, et al. Comparison of endovascular treatment approaches for acute ischemic stroke: cost effectiveness, technical success, and clinical outcomes. J Neurointerv Surg. 2015;7:666-670.
17. Comai A, Haglmuller T, Ferro F, et al. Sequential endovascular thrombectomy approach (SETA) to acute ischemic stroke: preliminary single-centre results and cost analysis. Radiol Med. 2015;120:655-661.
18. Turk AS, Spiotta A, Frei D, et al. Initial clinical experience with the ADAPT technique: a direct aspiration first pass technique for stroke thrombectomy. J Neurointerv Surg. 2014;6:231-237.