Neuroradiology (2012) 54:1261–1265
DOI 10.1007/s00234-012-1039-3

INTERVENTIONAL NEURORADIOLOGY

Manual aspiration thrombectomy through balloon-tipped guide catheter for rapid clot burden reduction in endovascular therapy for ICA L/T occlusion

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Received: 16 January 2012 / Accepted: 4 April 2012 / Published online: 28 April 2012

Abstract
Introduction Timely recanalization during endovascular procedures for acute ischemic stroke can be challenging in cases with large clot burden, such as those encountered in the terminal internal carotid T- or L-type occlusion.
Methods A novel but simple technique to achieve fast reduction in clot burden in stroke patients with occlusion of the internal carotid artery termination is described where manual suction using a 60-ml syringe applied through an 8-F balloon guide catheter positioned in the cervical carotid vasculature with proximal flow arrest allows subsequent revascularization of the residual middle cerebral artery clot.
Results The use of manual suction through a balloon-tipped guide catheter in internal carotid artery L- or T-type occlusion is illustrated. This resulted in a significant reduction of the clot burden and facilitated further interventions leading to full recanalization.
Conclusion Manual suction using a 60-ml syringe through a ballon guide catheter is a useful and feasible technique that facilitates thrombectomy of large burden cerebral clots.

Keywords Aspiration · Embolectomy · Stroke

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Introduction

Intravenous thrombolytic therapy is the standard of care in ischemic stroke patients presenting acutely. There are, however, limitations in treating all patients with a shotgun approach as intravenous therapy alone is not sufficient in many patients with large proximal occlusions [1]. Endovascular therapy for stroke has been brought to the forefront with the results of the PROACT data [2] and, more recently, through data on mechanical thrombectomy devices [3–5]. Patients with proximal vessel occlusions can be recanalized with a good safety profile and in a fast manner [6]. The necessity for rapid recanalization in acute ischemic stroke to restore flow through the occluded vessel and salvage ischemic penumbra is well established [7, 8].

However, patients with extensive clot burden such as terminal carotid T- and L-type occlusions still may have a poor outcome from slower recanalization, higher complication rate [9], and non-target embolization [10]. We describe a simple method to address this problem by allowing for rapid reduction in clot burden by manual aspiration through a balloon guide catheter carefully placed into the cervical carotid vasculature to allow for subsequent mechanical thrombectomy of the residual occluded middle cerebral artery in a quick and safe manner.

Technique

Patients who presented with acute ischemic stroke related to a proximal vessel occlusion with a large clot burden on CT angiography and where a decision had been made to pursue an endovascular revascularization strategy were rapidly shifted to the angiography suite. Using a modified Seldinger technique, femoral arterial access was obtained and an 8-F intravascular sheath was placed over a suitable 0.035-in. guide wire and attached to a continuous pressurized heparinized saline drip. Based on available information from the pre-procedure CT angiogram of the aortic arch and neck vessels, either a Headhunter (H1) curve or a Simmons 2 curve 125-cm-long catheter (5.5-F Slip-cath, Cook Medical, Bloomington, IN) was co-axially introduced through an 8-F balloon-tipped guiding catheter (Concentric Medical, Inc, Mountain View, CA). The balloon port of the guide catheter was prepped using a standard technique and the assembly introduced through the 8-F sheath over a 0.035-in. angled-tip guide wire (Terumo Medical Corporation, Somerset, NJ). The coaxial system was maneuvered under fluoroscopy guidance and advanced into the ipsilateral common carotid artery. Based on information from the CT angiogram of the neck, the guide catheter was either placed in the common carotid artery or advanced carefully into the internal carotid artery depending on the degree of stenosis of the carotid bifurcation. The inner diagnostic catheter is then removed, and after carefully double flushing the guide catheter lumen, a small test injection was performed to ensure no immediate complications from the placement of the guide catheter. The hub of the catheter was then attached to a rotating hemostatic valve. The balloon was then inflated to the recommended volume to ensure flow arrest and a 60-cc syringe attached to the rotating hemostatic valve; manual aspiration was performed for approximately 5–10 s (Fig. 1). Usually, only a single attempt is performed. In successful cases, fragmented thrombus was seen in the syringe. No complications were seen from the aspiration alone. A control angiogram was performed to assess the extent of residual clot burden and to serve as a target for subsequent revascularization using a device of choice at the discretion of the neurointerventional practitioner in a standard manner. Figures 2 and 3 demonstrate the angiograms in two separate patients.

Discussion

Time to treatment plays a very important role when it comes to having meaningful outcome from any therapeutic strategy for patients presenting with acute ischemic stroke. This has been shown in various publications in the literature as it pertains to intravenous thrombolysis [11]. There are various components to this from a temporal perspective. This includes time factors related to patients not only before they present to the hospital but also while in the hospital [12].

The presence of large clot burdens has been shown to be a poor predictor of outcomes due to decreased overall recanalization rates. Tan et al. [13], in their paper, showed that patients with a large clot burden showed lower rates of recanalization and poorer clinical outcomes. Bhatia et al. [1] showed that in patients receiving intravenous tPA for proximal vessel occlusions, the rate of recanalization for those with distal internal carotid artery (ICA) occlusions with or without ICA neck occlusion or stenotic disease was 4.4 %.

With increasing experience and newer available devices, good results are being shown with endovascular therapy and with impact on clinical outcomes. Even with various available devices, there is still room for improvement in achieving faster

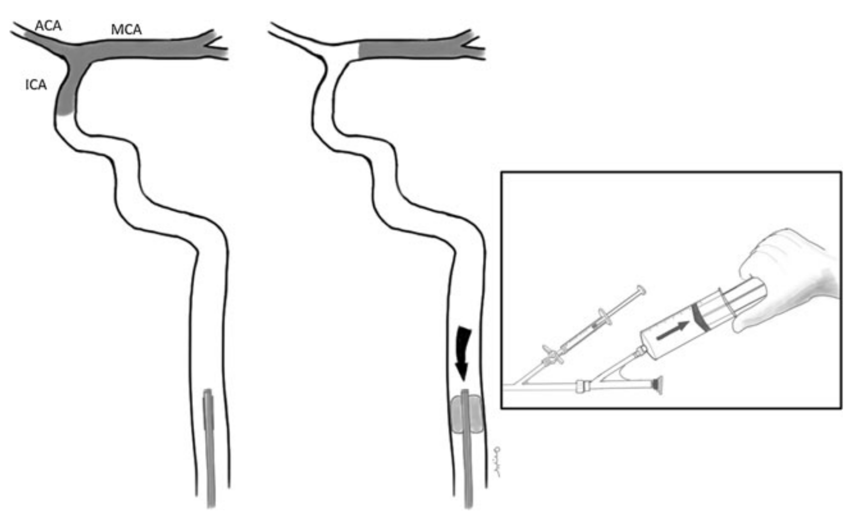

Fig. 1 Schematic line diagram showing a carotid T-type occlusion (*gray*, *left*). The balloon guide catheter is placed within the proximal internal carotid artery and inflated (*right*). Manual aspiration is performed through the proximal aspect of the balloon guide catheter while the balloon port is inflated (*inset*)

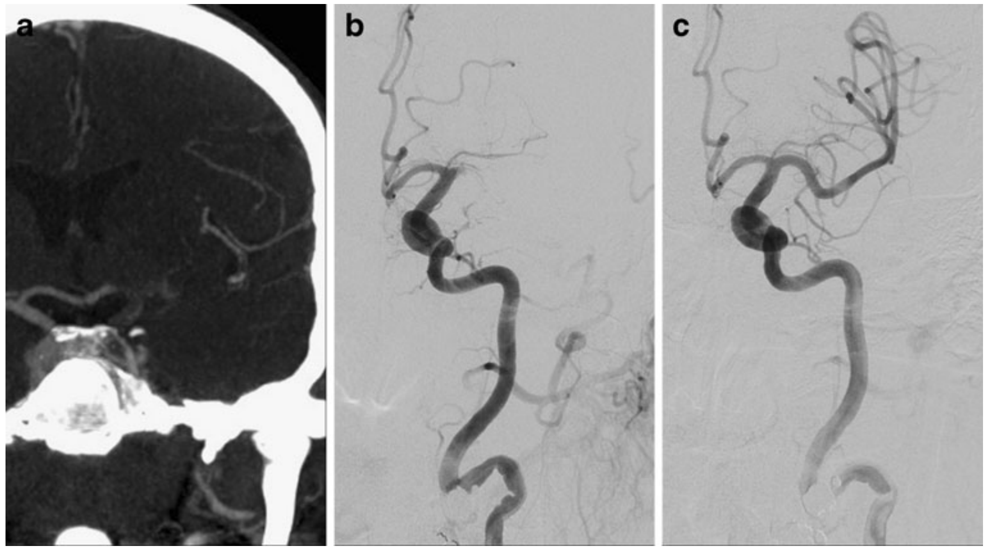

Fig. 2 **a** Coronal reformatted image of CT angiogram at presentation shows a left carotid T-type occlusion. **b** Control angiogram performed after manual aspiration shows debulking of the thrombus burden from the ACA and terminal ICA. **c** The MCA was subsequently revascularized to TIMI 3 flow with a Solitaire FR device

recanalization times. In a recent study with the Penumbra device, the mean time to recanalization was 97±37 min [14]. Brekenfeld et al. [15] showed that this time could be shortened to approximately 52.5 min (median time) with retrievable stent devices. This was also similar to recent data on the Penumbra 054 system [6].

It is also well known that the presence of a large clot burden may have a deleterious effect due to the potential for non-target embolization of uninvolved territories. King et al. [10] showed that in patients with ICA T-type occlusions, 32 % of patients showed anterior cerebral artery (ACA) infarcts on a 24-h scan following intervention. Those with ACA infarcts did not show a favorable outcome (zero out of ten patients had a modified Rankin score of 0–2).

The technique that we described using manual aspiration using a 60-cc syringe through the balloon-tipped guide catheter is useful in allowing for rapid reduction in large portions of the ICA clot. This then allows the reestablishment of some collateral flow through leptomeningeal flow from the ACA territory and medial lenticulostriate vessels and potentiates the presence of penumbra, thereby buying some more time for recanalizing the residual clot in the middle cerebral artery (MCA). This technique may not always be successful depending on numerous factors such as clot consistency, tortuous anatomy, and anatomical variants such as prominent posterior communicating artery preventing adequate flow arrest. When it does work, partial clot reduction can be achieved in a few minutes. We also feel that it is a relatively safe technique in that the guiding catheter can be safely placed into the internal carotid artery using a standard technique for neurointerventional access, provided that there is no significant athereosclerotic disease of the bulb. The placement of the

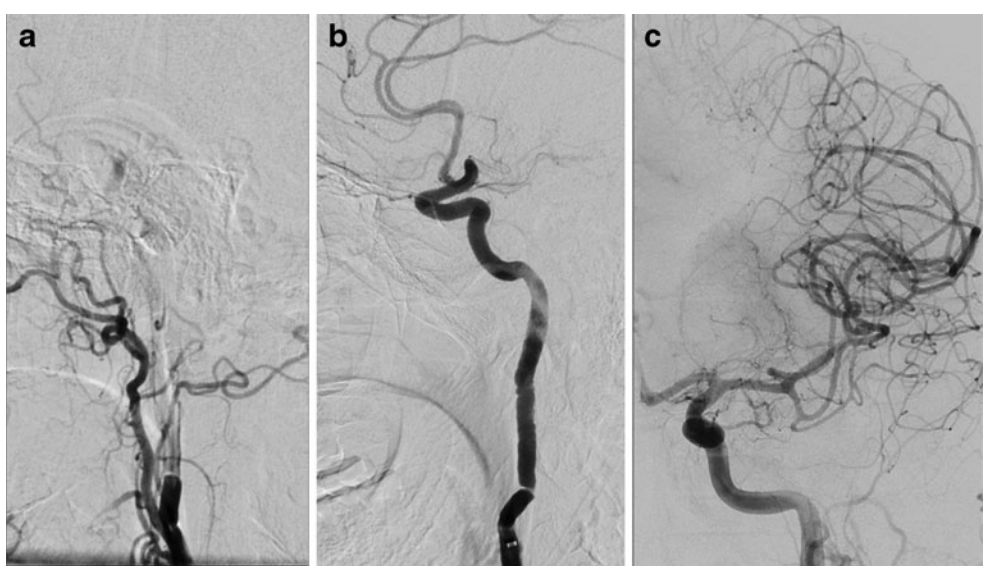

Fig. 3 **a** Lateral view of left common carotid artery injection shows slow flow in the left internal carotid artery from a carotid T-type occlusion known from the CT angiogram (not shown). **b** Manual aspiration was performed, which allowed for partial recanalization of the distal ICA. Note the restored flow within the anterior cerebral artery. **c** Frontal view showing complete recanalization performed subsequently with a mechanical device

guiding catheter in the ICA is not associated with complications such as intracranial wire perforation or vascular injury and, if successful, allows for better visualization of the intracranial vessels for a relatively safe navigation. Placement in the common carotid, however, may not be as efficient due to the presence of competing flow from the external carotid artery; however, the larger inner lumen of the 8-F catheter may be advantageous in this specific situation.

Prior reports have described similar techniques for aspiration thrombectomy in the setting of acute ischemic stroke [16–19]. The first two reports used manual suction through a large bore, non-balloon-tipped guiding catheter to clear clots from the cervical internal carotid artery where the catheter was placed at the thrombus interface, allowing for direct aspiration of the clot into the catheter. In the study by Imai et al. [18], a technique using a proximal balloon-tipped guiding catheter to cause flow arrest was described, but using a combination of a 10-cc syringe and a microsnare for clot disruption. Our technique is different in that it emphasizes the use of proximal flow arrest with the balloon guide catheter in the cervical carotid vasculature, in conjunction with manual aspiration with a 60-cc syringe in an attempt to clear portions of the intracranial carotid terminus clot to pave the way for subsequent therapy to the residual MCA clot using an appropriate mechanical thrombectomy device. Fesl et al. [19], in their series of ICA occlusions, mention the use of manual aspiration in three patients. However, it does not specify the type of syringe used and the catheter through which the aspiration was performed.

There are certain limitations to this report in that it is based on observational data and needs validation in a larger patient cohort. Since we started adopting this technique, we have not had consistent results due to the various factors mentioned above. However, the technique is relatively safe and, if it works, may help achieve faster recanalization in cases with a large clot burden.

Conflict of interest Dr. Goyal has received honoraria from Penumbra Inc. for speaking engagements and from ev3/Covidien as a consultant for education and trial design. The rest of the authors have no conflict of interest.

References

1. Bhatia R, Hill MD, Shobha N, Menon B, Bal S, Kochar P, Watson T, Goyal M, Demchuk AM (2010) Low rates of acute recanalization with intravenous recombinant tissue plasminogen activator in ischemic stroke: real-world experience and a call for action. Stroke 41(10):2254–2258
2. Furlan A, Higashida R, Wechsler L, Gent M, Rowley H, Kase C, Pessin M, Ahuja A, Callahan F, Clark WM, Silver F, Rivera F (1999) Intra-arterial prourokinase for acute ischemic stroke. The PROACT II Study: a randomized controlled trial. Prolyse in Acute Cerebral Thromboembolism. JAMA 282 (21):2003–2011
3. Smith WS, Sung G, Starkman S, Saver JL, Kidwell CS, Gobin YP, Lutsep HL, Nesbit GM, Grobelny T, Rymer MM, Silverman IE, Higashida RT, Budzik RF, Marks MP (2005) Safety and efficacy of mechanical embolectomy in acute ischemic stroke: results of the MERCI trial. Stroke 36 (7):1432–1438
4. Bose A, Henkes H, Alfke K, Reith W, Mayer TE, Berlis A, Branca V, Sit SP (2008) The Penumbra system: a mechanical device for the treatment of acute stroke due to thromboembolism. AJNR Am J Neuroradiol 29(7):1409–1413
5. Machi P, Costalat V, Lobotesis K, Lima Maldonado I, Vendrell JF, Riquelme C, Bonafe A (2012) Solitaire FR thrombectomy system: immediate results in 56 consecutive acute ischemic stroke patients. J Neurointerv Surg 4(1):62–66
6. Frei D, Turk A, Heck D, Hui F, Joseph G, Jahan R, Carpenter J, Grobelny T, Goddard J, Leader B, Bose A, Sit S (2011) The SPEED trial: a study of the Penumbra early evacuation device. Paper presented at the International Stroke Conference Los Angeles, 01 Mar 2011
7. Hesselmann V, Niederstadt T, Dziewas R, Ritter M, Kemmling A, Maintz D, Koehler M, Seifarth H, Jacobs AH, Ringelstein EB, Heindel W (2012) Reperfusion by combined thrombolysis and mechanical thrombectomy in acute stroke: effect of collateralization, mismatch, and time to and grade of recanalization on clinical and tissue outcome. AJNR Am J Neuroradiol 33:336–342
8. Goyal M, Menon BK, Coutts SB, Hill MD, Demchuk AM (2011) Effect of baseline CT scan appearance and time to recanalization on clinical outcomes in endovascular thrombectomy of acute ischemic strokes. Stroke 42(1):93–97
9. Gralla J, Burkhardt M, Schroth G, El-Koussy M, Reinert M, Nedeltchev K, Slotboom J, Brekenfeld C (2008) Occlusion length is a crucial determinant of efficiency and complication rate in thrombectomy for acute ischemic stroke. AJNR Am J Neuroradiol 29(2):247–252
10. King S, Khatri P, Carrozella J, Spilker J, Broderick J, Hill M, Tomsick T (2007) Anterior cerebral artery emboli in combined intravenous and intra-arterial rtPA treatment of acute ischemic stroke in the IMS I and II trials. AJNR Am J Neuroradiol 28 (10):1890–1894
11. Hacke W, Donnan G, Fieschi C, Kaste M, von Kummer R, Broderick JP, Brott T, Frankel M, Grotta JC, Haley EC Jr, Kwiatkowski T, Levine SR, Lewandowski C, Lu M, Lyden P, Marler JR, Patel S, Tilley BC, Albers G, Bluhmki E, Wilhelm M, Hamilton S (2004) Association of outcome with early stroke treatment: pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials. Lancet 363(9411):768–774
12. Wester P, Radberg J, Lundgren B, Peltonen M (1999) Factors associated with delayed admission to hospital and in-hospital delays in acute stroke and TIA: a prospective, multicenter study. Seek-Medical-Attention-in-Time Study Group. Stroke 30(1):40–48
13. Tan IY, Demchuk AM, Hopyan J, Zhang L, Gladstone D, Wong K, Martin M, Symons SP, Fox AJ, Aviv RI (2009) CT angiography clot burden score and collateral score: correlation with clinical and radiologic outcomes in acute middle cerebral artery infarct. AJNR Am J Neuroradiol 30(3):525–531
14. Kulcsar Z, Bonvin C, Pereira VM, Altrichter S, Yilmaz H, Lovblad KO, Sztajzel R, Rufenacht DA (2010) Penumbra system: a novel mechanical thrombectomy device for large-vessel occlusions in acute stroke. AJNR Am J Neuroradiol 31 (4):628–633
15. Brekenfeld C, Schroth G, Mordasini P, Fischer U, Mono ML, Weck A, Arnold M, El-Koussy M, Gralla J (2011) Impact of

retrievable stents on acute ischemic stroke treatment. AJNR Am J Neuroradiol 32(7):1269–1273
16. Lutsep HL, Clark WM, Nesbit GM, Kuether TA, Barnwell SL (2002) Intraarterial suction thrombectomy in acute stroke. AJNR Am J Neuroradiol 23(5):783–786
17. Xu GF, Suh DC, Choi CG, Kim JK, Kim W, Kim SJ, Kim JS (2005) Aspiration thrombectomy of acute complete carotid bulb occlusion. J Vasc Interv Radiol 16(4):539–542
18. Imai K, Mori T, Izumoto H, Takabatake N, Kunieda T, Shimizu H, Watanabe M (2006) Clot removal therapy by aspiration and extraction for acute embolic carotid occlusion. AJNR Am J Neuroradiol 27(7):1521–1527
19. Fesl G, Wiesmann M, Patzig M, Holtmannspoetter M, Pfefferkorn T, Dichgans M, Brueckmann H (2006) Endovascular mechanical recanalisation of acute carotid-T occlusions: a single-center retrospective analysis. Cardiovasc Intervent Radiol 34(2):280–286