

Stent Deployment as an Emergency Alternative Treatment for Acute Stroke. Case Series

El Despliegue del Stent como Tratamiento en el Tratamiento del ACV Agudo. Una Alternativa en la Emergencia

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ABSTRACT

Introduction. Acute ischemic stroke due to large vessel occlusion refractory to aspiration or mechanical thrombectomy is a therapeutic challenge. **Objective.** A treatment variant is in order. **Methods.** In the last three years, we admitted seven patients with refractory large vessel occlusions, for all of whose aspiration and mechanical thrombectomy had failed. A Solitaire AB stent was deployed as a rescue measure. **Results.** Data was retrospectively analyzed. Six out of seven patients had a good clinical outcome as measured by mTICI and mRS twelve months after the procedure. One patient died after the first follow-up visit, one month after endovascular therapy. **Conclusion.** Results of this small series support the role of stent deployment as a rescue measure for such challenging patients.

Keywords: Stent; Stroke; Mechanical thrombectomy

RESUMEN

Introducción. La oclusión de un vaso cerebral importante causa infarto isquémico agudo y puede ser refractaria a la aspiración y a la trombectomía mecánica. Su terapia es un verdadero desafío. **Objetivo.** Se impone encontrar una variante terapéutica. **Métodos.** En los últimos tres años, ingresamos siete pacientes con oclusiones refractarias de vasos cerebrales importantes. En todos estos casos, tanto la aspiración como la trombectomía mecánica fracasaron. Fue desplegado un stent Solitaire AB en calidad de maniobra de rescate. **Resultados.** Analizamos retrospectivamente sus historias. Seis de los siete pacientes tuvieron una buena evolución clínica, medida por el mTICI y el mRS doce meses después del procedimiento. Un paciente falleció después de la primera visita de seguimiento, un mes después de la terapia endovascular. **Conclusión.** Los resultados de esta breve serie apoyan el uso del despliegue del stent como medida de rescate para estos pacientes tan difíciles.

Palabras clave: Stent; ACV; Trombectomía mecánica

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INTRODUCTION

Stroke, one of the leading causes of morbidity and mortality worldwide, is the primary cause of disability in adults¹⁻³. Large vessel occlusion (LVO), which accounts for 40-50% of acute strokes^{4,5}, often proves refractory to IV thrombolysis⁵.

Standard stroke treatment involves IV thrombolysis when indicated, and then endovascular stroke treatment with either direct aspiration, mechanical thrombectomy, or both. A large body of evidence gives endovascular stroke treatment (EST) class 1a evidence within 6 h of onset, and considerable support for an extended timeframe of up to 24 h in selected patients^{6,7}. Recent studies have also shown that the time window for this treatment is significantly longer than that of EVT.

In case of obstruction being refractory to both EST techniques, the endovascular specialist must find creative alternatives like the deployment of a self-expandable stent to open the occluded vessel. This technique, feasible in most patients with recent strokes, can restore circulation. Posterior anti-platelet therapy is its main disadvantage. Although several small series depicting this procedure exist, no randomized clinical trials with long-term follow-up are available. Our country has the additional advantage of the predominant use of the Solitaire AB stent (ev3 Inc, Plymouth, MN), a device that performs both mechanical thrombectomy and stent deployment.

Our first Y-stenting experiences were published in May 2018⁸. A Solitaire AB stent was placed at the occlusion site in M1, after checking the presence of distal flow and then released the stent. This rather inelegant option did permit vascular rescue and a good outcome.

Stent deployment is not a new technique. We propose its use only if classical techniques have failed and specifically with stent retrievers like the Solitaire AB.

A retrospective patient series from Spain was published in 2016 with patients treated with direct aspiration using the

Penumbra System (Oakland, California, USA). Their further standard treatment was mechanical thrombectomy using the Trevo System (Stryker Neurovascular, Kalamazoo, MI 49002 USA). When recanalization was not achieved after four passes, they tried using the Enterprise stent (Codman Neurovascular, Ratham, Massachusetts, USA). Recanalization rate was 71.4%, with good outcomes for 48.3% of patients with carotid territory strokes and for 15.4% of those with vertebrobasilar strokes⁹.

Furthermore, Baek et al., in 2016, retrospectively evaluated 208 patients with carotid territory strokes who underwent mechanical thrombectomy (Solitaire AB/FR), followed by direct aspiration using a Penumbra System in case of failure. Forty-five patients (21.6%) were refractory to EVT. Other 17 patients were further treated with permanent stenting: Solitaire-AB for 10 patients and Wingspan® (Stryker) for 7 patients. Successful reperfusion (TICI 2b-3) was achieved in 14 members (83.3%) of the stenting group, which had better outcomes than patients deprived of rescue treatment¹⁰.

These findings provide some evidence to support the use of intracranial stents in the acute setting, a necessary measure considering the dire alternative: unsuccessful revascularization, subsequent disabling cerebral infarction.

METHODS

We retrospectively reviewed our prospectively maintained database of stroke patients, identifying 7 patients with anterior circulation strokes attributable to LVO who underwent endovascular stroke therapy in our comprehensive stroke center between March 2015 and January 2017. Indications for EST were a National Institute of Health Stroke Scale score greater than six, presentation within six hours of index event and non-contrast CT exclusion of hemorrhagic stroke. If indicated, IVT was performed with tissue-type

plasminogen activator in the Emergency Department, and the patient was transferred afterwards to the Cath lab independent of results. LVO in the anterior circulation was defined as occlusion of the internal carotid artery, or the M1 and/or M2 segments of the middle cerebral artery.

Our institutional Ethical Committee board waived patient consent for this retrospective study.

Endovascular Stroke Therapy

All procedures were performed by two experienced operators. The procedure was initiated after angiography and 2D perfusion study of the affected vessel, as suggested by the clinical examination and identified by computed tomography. In most patients, mechanical thrombectomy using Solitaire AB (Covidien/ev3, Irvine, CA) was used as a first line treatment. Stent size and diameter were selected by the operator. In case of failure or operator preferences, the Penumbra Aspiration System was used. For refractory patients, and only in those cases where both techniques failed (even when simultaneously used), the same Solitaire AB stent was deployed as a rescue measure. Proper deployment was confirmed with XperCT software (Koninklijke Philips N.V., Amsterdam, Netherlands), and successful recanalization was defined when mTICI 2b-3 recanalization was achieved.

Follow-up

As per our protocol, all patients received, after stent deployment, a loading dose of Clopidogrel (300mg) using a nasogastric tube, followed by Clopidogrel 75 mg/d and aspirin 325 mg/d for three months, and then aspirin for one year, since intravenous platelet inhibition is unavailable at our center. Clinical follow-ups were scheduled at three months, six months, and one year intervals. Angiographic follow-up was scheduled at intervals of six months to one year. Angiographic outcome was evaluated using the modified thrombolysis in cerebral ischemia (mTICI) scale, defining successful reperfusion as mTICI 2b/3 and sustained perfusion in hemodynamic imaging as shown by perfusion angiography. Clinical outcomes were evaluated using the modified ranking (mRS) scale at three months and one year when possible. Good clinical outcomes were defined as per international consensus as mRS equal to 0-2 at three months.

RESULTS

Out of 69 stroke patients treated in our center in the past three years, seven (10.1%) had LVO that required stent deployment to achieve reperfusion. Results are summarized in Table 1. All except one received prior IVT with rtPA; angiography diagnosed unsuccessful recanalization. Angiography was not delayed on account of waiting for IVT results, except for one patient transferred from a different center without prior consultation with our team, arriving six hours after the initial symptoms. This patient had a poor outcome. For the other patients, the “good outcome” scores held beyond 3 months, up to 12 months. One had a score of 0 at 6 months, three had a score of 1 up to 12 months and the remaining 2 had a score of 2 at 12 months. Average door to puncture time (DTP) was 227 min. Six out of seven patients (86%) had successful reperfusion after stent deployment and good clinical outcomes in the latest control. There were no complications. The transfer patient had passed away at the first control due to cerebral edema, making the mortality in our series 14%. No intra-stent thrombosis was observed.

Table 1. Outcomes of patients treated with stent deployment.

Patient	Age	NIHSS	DTP (min)	Occlusion Site	Prior IVT	EVT	mTICI	mRS (months)			
								1	3	6	12
1	Adult	12	160	M1	Yes	IAT after stenting	2b	2	2	2	2
2	Adult	10	144	ICA, M1, A1	Yes	MT, IAT	3	0	0	0	N/A
3	Adult	20	227	M1	No	DA, IAT	1	6	-	-	-
4	Adult	8	101	M1, M2	Yes	MT	2b	2	2	2	2
5	Adult	10	125	M1	Yes	IAT after stenting	2b	1	1	1	1
6	Adult	9	102	ICA, M1	Yes	MT, IAT	2b	2	2	1	1
7	Adult	12	159	M1	Yes	MT, IAT	2b	1	1	1	1

NIHSS, National Institutes of Health Stroke Scale; DTP, Door to Puncture time; IVT, intravenous thrombolysis; EVT, endovascular treatment; IAT, intra-arterial thrombolysis; DA, direct aspiration; MT, mechanical thrombectomy; mTICI, modified treatment in cerebral infarction score; mRS, modified ranking score; N/A, not available.

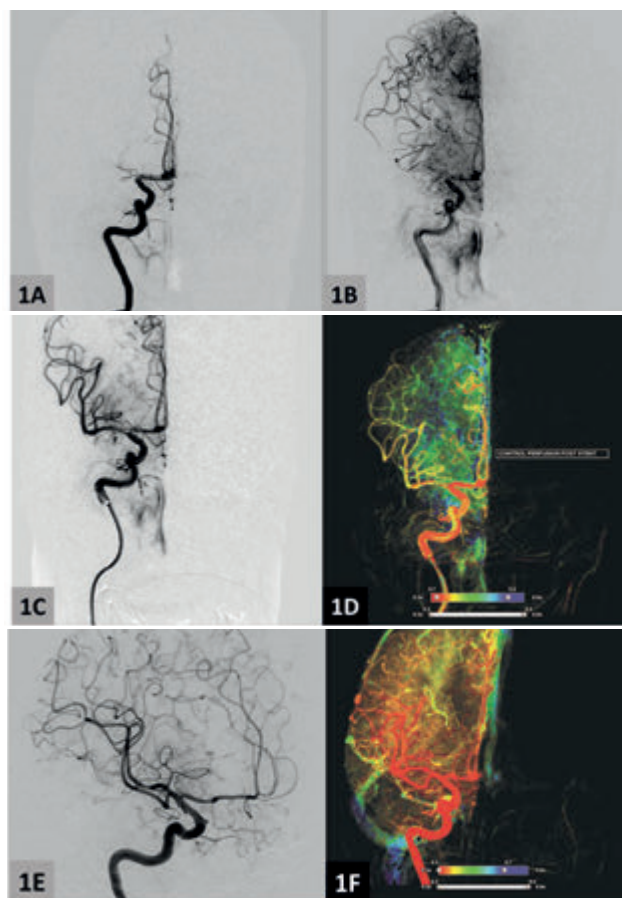


Figure 1. Adult patient, excellent functional status prior to index stroke. Door to puncture time 159 minutes, NIHSS 12. **1A.** Diagnostic angiography shows M1 occlusion. Aspiration and stent thrombectomy were unsuccessful. **1B.** Post stent deployment angiography shows mTICI 2b reperfusion. **1C, 1D.** Post treatment perfusion imaging confirms mTICI score. **1E, 1F.** One year later, follow-up angiographic perfusion shows excellent flow in the whole hemisphere in. At one year, mRS was 1.

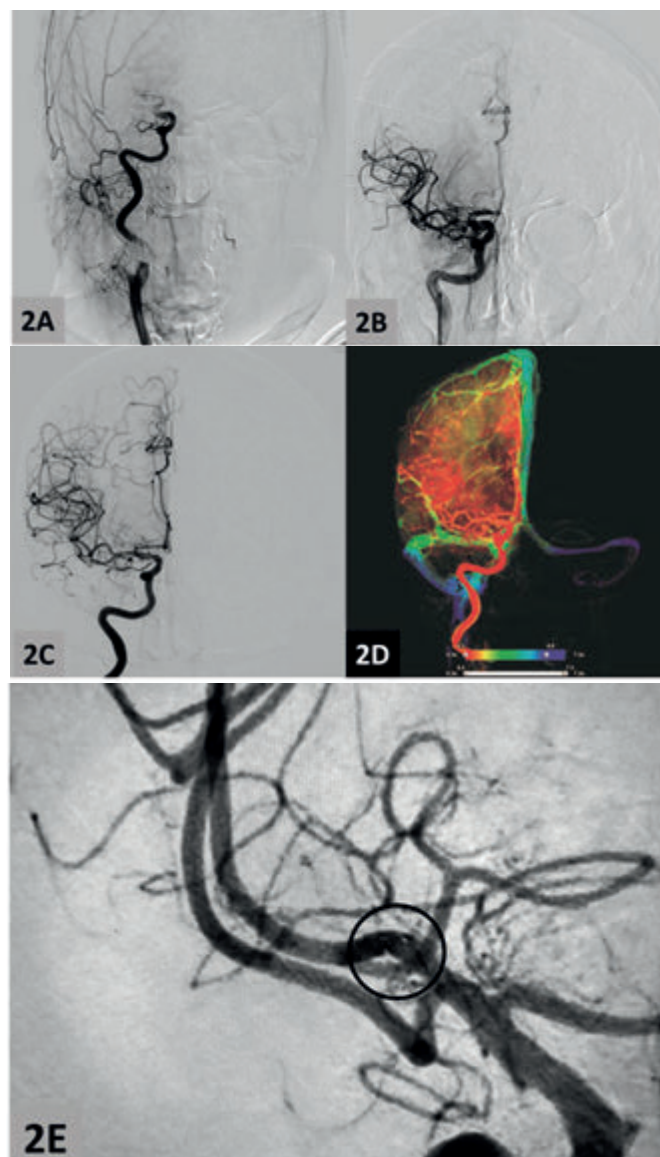


Figure 2. Adult patient. Hypertension, chronic atrial fibrillation, under treatment with Warfarin and Diltiazem, poor adherence to treatment. Door to puncture time 244 min, NIHSS 10. **2A.** Diagnostic angiography at shows tandem occlusion. **2B.** demonstrates mTICI 3 reperfusion after mechanical thrombectomy and stent deployment in the M1 segment. Note previous stenosis at the initial segment of M1. **2C, 2D.** One year later, follow-up conventional angiography and perfusion, respectively. Functional outcome was excellent. **2E.** Distal mark of the stent is evident.

DISCUSSION

The results in this small series of patients support all published data on intracranial stenting as a rescue measure. Even though our percentage of patients with successful reperfusion and good clinical outcomes is higher than previously reported^{9,11}, the small number of patients does not allow us to draw conclusions in this aspect. It must also be noted that patients with excellent outcome (see Figures 1 and 2 corresponding to patients 2 and 7 in Table I) had average or below average door to puncture times. This is in accordance with all current randomized controlled trials, which have shown that cerebral ischemia is time-dependent¹⁰.

CONCLUSION

Given our results and previously published data, we confidently propose rescue stent deployment as an alternative to standard EST. This study was limited in several ways: it was retrospective, patients were few and there were no independent reviewers. We strongly believe that randomized controlled clinical trials assessing stent deployment using modern self-expandable devices and delivery catheters are now necessary to better assess short- and long-term effects and possible complications.

REFERENCES

1. Feigin VL, Krishnamurthi RV, Parmar P, Norrving B, Mensah GA, Bennett DA, et al. Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. *Neuroepidemiology*. 2015;45(3):161-76. doi: 10.1159/000441085.
2. Feigin VL, Roth GA, Naghavi M, Parmar P, Krishnamurthi R, Chugh S, et al. Global burden of stroke and risk factors in 188 countries, during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet Neurol*. 2016 Aug;15(9):913-924. doi: 10.1016/S1474-4422(16)30073-4.
3. Hansen CP, Overvad K, Kyrø C, Olsen A, Tjønneland A, Johnsen SP, et al. Adherence to a Healthy Nordic Diet and Risk of Stroke: A Danish Cohort Study. *Stroke*. 2017;48(2):259-264. doi: 10.1161/STROKEAHA.116.015019.
4. Smith WS, Lev MH, English JD, Camargo EC, Chou M, Johnston SC, et al. Significance of large vessel intracranial occlusion causing acute ischemic stroke and TIA. *Stroke*. 2009 Dec;40(12):3834-40. doi: 10.1161/STROKEAHA.109.561787.
5. Skagen K, Skjelland M, Russell D, Jacobsen EA. Large-Vessel Occlusion Stroke: Effect of Recanalization on Outcome Depends on the National Institutes of Health Stroke Scale Score. *J Stroke Cerebrovasc Dis*. 2015;24(7):1532-1539. doi:10.1016/j.jstrokecerebrovasdis.2015.03.020.
6. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2018;49(3):e46-e110. doi: 10.1161/STR.0000000000000158.
7. Thrift AG, Cadilhac DA, Thayabaranathan T, Howard G, Howard VJ, Rothwell PM, et al. Global stroke statistics. *Int J Stroke*. 2014 Jan;9(1):6-18. doi: 10.1111/ijss.12245.
8. Crosa R, Spiotta AM, Negrotto M, Jaume A, Casagrande W. "Y-stent retriever": a new rescue technique for refractory large-vessel occlusions?. *J Neurosurg*. 2018;128(5):1349-1353. doi:10.3171/2016.12.JNS161233.
9. Delgado Acosta F, Jiménez Gómez E, Bravo Rey I, Bravo Rodríguez FA, Ochoa Sepúlveda JJ, Oteros Fernández R. Intracranial stents in the endovascular treatment of acute ischemic stroke. *Radiologia*. 2017;59(3):218-225. doi:10.1016/j.rx.2017.01.003.
10. Baek JH, Kim BM, Kim DJ, Heo JH, Nam HS, Yoo J. Stenting as a Rescue Treatment After Failure of Mechanical Thrombectomy for Anterior Circulation Large Artery Occlusion. *Stroke*. 2016;47(9):2360-2363. doi:10.1161/STROKEAHA.116.014073.

11. Brekenfeld C, Schroth G, Mattle HP, Do DD, Remonda L, Mordasini P, Arnold M, Nedeltchev K, Meier N, Gralla J. Stent placement in acute cerebral artery occlusion: use of a self-expandable intracranial stent for acute stroke treatment. *Stroke*. 2009;40(3):847-52. doi: 10.1161/STROKEAHA.108.533810.

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No conflicts of interest were declared.

This study was done at CEN, Médica Uruguaya, Montevideo, Uruguay.

This study was approved by the Institutional Ethical Committee at Médica Uruguaya.