Novel Use of Stenting for Temporary Endovascular Bypass and Thrombectomy in Major Ischemic Stroke

José E. Cohen MD,1,2, Ronen R. Leker MD, Shlomtsion Kahana MD, Alex Lossos MD and Eyal Itshayek MD

Departments of 1Neurosurgery, 2Neurology and 3Radiology, Hadassah-Hebrew University Medical Center, Jerusalem, Israel

KEY WORDS: bypass, stroke, stent, thrombectomy, thrombolysis

IMAJ 2010; 12: 764–766

For Editorial see page 762

Stenting is a promising treatment option for acute cerebral ischemia secondary to large-vessel arterial occlusion. The main advantage of stenting in this setting is rapid recanalization, which has high technical success rates. In order to avoid long-term complications of stenting, the “temporary endovascular bypass” technique was recently described [1,2]. A stent is deployed and then recaptured after successful vessel recanalization has been achieved.

We report a case of successful recanalization of large-artery occlusion after using a stent first to achieve temporary endovascular bypass and then as a thrombectomy device.

PATIENT DESCRIPTION

A 71 year old woman was transferred to our center with a National Institutes of Health Stroke Scale (NIHSS) score of 21, three hours after stroke onset. She had a history of multiple partially controlled vascular risk factors and had suffered a mild myocardial infarction 2 days before. Upon examination she was in a stupor and presented clear signs of left dense hemiplegia and hemihypesthesia. Head computed tomography, followed by CT angiogram, showed mild signs of right hemispheric ischemia and occlusion of the proximal right middle cerebral artery.

The patient was intubated and brought to the interventional neuroradiology suite. Diagnostic angiogram confirmed proximal right MCA occlusion [Figure A]. After access was obtained and intravenous heparin administered (activated clotting time 280 seconds), an 8F 90 cm Concentric Merci Balloon Guide Catheter (Concentric Medical, Mountain View, CA, USA) was placed at the right internal carotid artery. The occlusion was crossed with a Synchro 0.014 inch microguide-wire (Boston Scientific, Natick, MA, USA) and a Rebar 18 microcatheter (ev3, Irvine, CA). A long 4 x 20 mm Solitaire AB stent (ev3, Irvine, CA) was fully deployed, extending across the entire occluded segment of the MCA [Figure B]. Repeat angiogram showed reconstituted flow through the MCA trunk (transient endovascular bypass step) [Figure C].

After 10 minutes, the proximal third of the stent was resheathed. The balloon of the Guide Catheter was inflated to provide for proximal carotid occlusion. The partially deployed stent was slowly pulled back [Figure D].

MCA = middle cerebral artery

back (mechanical thrombectomy step) under continuous aspiration through the balloon guide catheter. A large clot was removed into the stent and small clot fragments were aspirated from the Guide Catheter.

The total time span between femoral access and arterial recanalization was 28 minutes. The final angiogram revealed complete recanalization of the right MCA and all its branches, with no signs of residual vascular damage or distal occlusion [Figure D]. The patient’s neurological condition improved, reaching an NIHSS score of 5 after one week.

**COMMENT**

Recanalization is associated with improved outcome in acute ischemic stroke, with time-to-recanalization considered a critical factor. Recanalization rates achieved with intravenous recombinant tissue plasminogen activator for proximal, large-vessel arterial occlusion are poor. Intravenous thrombolysis is not as effective for thromboembolic obstruction of these large proximal vessels, compared with more distal smaller vessels. The main concerns with intraarterial and IV pharmacological thrombolysis have been the rate of hemorrhage, the inability to effectively dissolve platelet-rich clots, lengthy times to recanalization, and the inability to prevent abrupt reocclusion at the initial site of obstruction.

Endovascular mechanical therapies yield higher recanalization rates and allow a slightly broader treatment window, leading to better outcomes in this group of patients. The Merci Mechanical Clot Retriever (Concentric Medical) and the Penumbra Device (Penumbra, Inc., Alameda, CA) are mechanical thrombectomy devices that have been approved by the U.S. Food and Drug Administration for patients with stroke symptoms in whom IV rt-PA therapy has failed or surgical management is contraindicated [3,4]. The recanalization rate with the device alone was only 50%, with multiple passes required to reestablish flow in the occluded vessel. Concomitant use of intraarterial fibrinolytics increased the recanalization rate as well as the rate of hemorrhagic complications [3].

The newer generation Merci Mechanical Clot Retriever, used in combination with pharmacological therapy, is successful in about 70% of patients. With the Penumbra Device, despite an 81.6% recanalization rate, only 25% of patients recovered to a modified Rankin Scale score of ≤ 2, with 32.8% mortality and symptomatic intracranial hemorrhage in 11.2% at 3 months. Furthermore, an average of 40 minutes was required to restore flow after delivery of the device to the target vessel [4].

Self-expanding stents specifically designed for neurovascular use are now available, and can be delivered to proximal intracranial vessels with a high success rate. These stents have an increased safety profile in comparison to balloon-expanding stents because they are deployed at significantly lower pressure. Since most cases of acute intracranial vascular occlusion are embolic in nature, high-pressure balloon angioplasty and balloon-expandable stents are not necessary to recanalize the vessel and may only increase the chance of serious complications, such as vessel rupture or dissection. The major benefit of stent-assisted recanalization over other mechanical recanalization strategies is the high rate of immediate, sustained restoration of flow in occluded vessels.

The successful use of self-expanding stents in stroke as a bail-out after failed recanalization with other modalities, and even as the initial mechanical maneuver, was recently reported with high recanalization rates. Complications associated with stent placement include stent thrombosis, restenosis, and the risks associated with aggressive double antiplatelet therapy for at least 3–6 months must be taken into consideration. Current experience with stent-assisted recanalization in acute stroke is very limited, and long-term results have not been reported.

Using a self-expanding stent for recanalization involves leaving a permanent implant in the vessel, and this may not be justifiable as most occlusions in acute ischemic stroke result from embolic occlusion of normal cranial arteries. The advent of closed-cell stents that can be used as a temporary endovascular bypass to achieve immediate high rates of flow restoration, and then resheathed or removed after recanalization is achieved, has obviated the need for dual antiplatelet therapy and eliminated the long-term risk involved in leaving a permanent implant [1,2]. In both case reports, the stent was partially deployed for some time and retrieved, with successful recanalization of the occluded vessel.

The Solitaire AB (ev3, Irvine, CA) is a stent-like device that was originally designed as a remodeling tool to assist with the embolization of wide-necked cerebral aneurysms. This device can be completely deployed and fully retrieved back into the microcatheter if needed; detachment requires the assistance of an electric detachment system. Controlled detachment of this device allowed us to first deploy the stent, achieving an immediate recanalization of the artery. This is a key point in this new technique, because time to recanalization is among the most crucial factors defining the success of any stroke therapy [5]. We then removed the partially resheathed stent, using it as a thrombectomy device. This combined approach allowed us to achieve three important goals: rapid endovascular recanalization (endovascular bypass), clot removal (thrombectomy), and avoiding dependence on a permanent implant.

Our early experience with this technique suggests that stent-based thrombectomy devices, that can be used if necessary, may become a valuable tool in:

**NIHSS = National Institutes of Health Stroke Scale**

**rt-PA = recombinant tissue plasminogen activator**

**CASE COMMUNICATIONS**
the primary therapy for acute ischemic stroke. Larger trials are needed for a more rigorous assessment of this technique.

Corresponding author:
Dr. J.E. Cohen
Dept. of Neurosurgery, Hadassah University Medical Center, P.O. Box 12,000, Jerusalem 91120, Israel
Phone: (972-2) 677-7092, Fax: (972-2) 641-6281
email: jcohenms@yahoo.com

References

Capsule

Antibodies protect against intracellular bacteria by Fc receptor-mediated lysosomal targeting

The protective effect of antibodies (Abs) is generally attributed to neutralization or complement activation. Using Legionella pneumophila and Mycobacterium bovis bacillus Calmette–Guérin as a model, Joller et al. discovered an additional mechanism of Ab-mediated protection effective against intracellular pathogens that normally evade lysosomal fusion. The authors show that Fc receptor (FcR) engagement by Abs, which can be temporally and spatially separated from bacterial infection, renders the host cell non-permissive for bacterial replication and targets the pathogens to lysosomes. This process is strictly dependent on kinases involved in FcR signaling but not on host cell protein synthesis or protease activation. Based on these findings, the researchers propose a mechanism whereby Abs and FcR engagement subverts the strategies by which intracellular bacterial pathogens evade lysosomal degradation.

PNAS 2010; 107: 20441
Eitan Israeli

Capsule

Pictures predict embryos' fate

The likelihood that a human embryo cultured during in vitro fertilization (IVF) will develop successfully to the 5-day mark can be predicted with about 93% sensitivity and specificity from three early developmental events. In IVF, 50–70% of embryos never make it to the blastocyst stage, which begins 5 or 6 days after fertilization. Renee Reijo Pera at Stanford University in California and her group analyzed images of 242 IVF embryos taken with microscopic time-lapse photography. They found that those that would go on to form blastocysts showed specific developmental patterns, such as the first cytokinesis – cleavage that results in two separate cells – lasting less than 33 minutes. The team devised an algorithm to automatically screen embryos for this and two other parameters and found that it could predict which embryos would reach the blastocyst stage.

Nature Biotechnol 2010; 28: 1115
Eitan Israeli

Capsule

Video imaging of walking myosin V by high-speed atomic force microscopy

The dynamic behavior of myosin V molecules translocating along actin filaments has been mainly studied by optical microscopy. The processive hand-over-hand movement coupled with hydrolysis of adenosine triphosphate was thereby demonstrated. However, the protein molecules themselves are invisible in the observations and have therefore been visualized by electron microscopy in the stationary states. The concomitant assessment of structure and dynamics has been unfeasible, a situation prevailing throughout biological research. Kodera and team directly visualized myosin V molecules walking along actin tracks, using high-speed atomic force microscopy. The high-resolution movies not only provide corroborative 'visual evidence' for previously speculated or demonstrated molecular behaviors, including lever-arm swing, but also reveal more detailed behaviors of the molecules, leading to a comprehensive understanding of the motor mechanism. This direct and dynamic high-resolution visualization is a powerful new approach to studying the structure and dynamics of biomolecules in action.

Nature 2010; 468: 72
Eitan Israeli