Endovascular Therapy for Acute Stroke Is a Safe and Efficient Evolving Method: A Single-Center Retrospective Analysis

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ABSTRACT

Purpose: To determine the clinical outcome in patients undergoing endovascular therapy for acute stroke.

Materials and Methods: During the period 2009–2012, 134 patients with acute stroke and normal computed tomography (CT) findings were treated with endovascular therapy at a single center. Based on CT perfusion and CT angiography findings, all patients had large vessel occlusions. Intravenous thrombolysis was used in eligible patients. The recanalization rate, time to recanalization, periprocedural complications, and clinical outcome at discharge from the hospital (National Institutes of Health score, modified Rankin Scale [mRS]) were analyzed.

Results: The recanalization rate during the study interval increased from 70% (2008–2009) to 94% (2011–2012) ($P \leq .01$). The procedure time was reduced from 124 minutes (2009) to 43 minutes (2012) ($P \leq .01$), and the periprocedural complication rate decreased from 21% (2009) to 2% (2012) ($P \leq .01$). Patients in 2009–2010 had a 2.21 times greater probability for an mRS score ≥ 2 after the procedure compared with patients in 2011–2012 (95% confidence interval, 1.0–5.0). If the procedure lasted 15 minutes longer, the prospect for an mRS score ≥ 2 after the procedure was 1.30 times greater ($P = .02$).

Conclusions: High recanalization rates, low procedural complications, and improved clinical outcomes were achieved using endovascular therapy in selected patients with acute stroke during a 4-year period. Endovascular therapy is an evolving safe and effective treatment for intracranial large vessel occlusion.

ABBREVIATIONS

IMS = Interventional Management of Stroke, IVT = intravenous thrombolysis, mRS = modified Rankin Scale, NIHSS = National Institutes of Health Stroke Scale

When performed within the limited time window, endovascular therapy of an occluded artery allows for tissue reperfusion and can improve outcomes and functions in patients with acute ischemic stroke (1). In institutions with endovascular experts, this therapy is being used to treat patients with occlusions of large intracranial arteries (2). In addition, a combined approach of intravenous thrombolysis (IVT) followed by endovascular therapy results in faster response times and higher recanalization rates (3). Because the main goal of treatment of acute stroke is reperfusion, it is intriguing that the Interventional Management of Stroke (IMS) III trial and other reports comparing IVT and combined treatment for patients with acute stroke failed to show a significant advantage in favor of combined treatment (4,5). To recruit a significant number of patients, these randomized studies averaged the results of both treatments over 4 years. During the course of the IMS III trial, the protocols and the device technology for managing strokes changed significantly. Additional analyses of the results could show an improvement of clinical outcomes after endovascular therapy from 2009 to 2012 and possibly aid in better patient and device selection.

The initial results from our tertiary academic institution proved the safety and effectiveness of endovascular therapy (6). In the present study, the yearly results from endovascular therapy for the same 4 years as the IMS III

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trial were retrospectively analyzed. The outcome for each separate year was compared with our overall results and the results of similar studies. The objective of our study was to test the improved clinical outcome by analyzing the outcomes of patients who underwent endovascular therapy from 2009 to 2012 from the University Medical Centre. How the therapy changed over those 4 years (the evolution of the therapy) was also studied.

MATERIALS AND METHODS

Because this was a retrospective analysis, the approval of the National Medical Ethics Committee was not needed. Each of the patients with acute stroke had normal noncontrast brain computed tomography (CT) scans, which were immediately followed by a more detailed stroke imaging protocol. In addition to CT of the brain, the protocol included CT perfusion imaging and CT angiography of the intracranial and extracranial neck arteries.

A vascular neurologist and interventional neuroradiologist decided the optimal treatment for every patient. The inclusion criteria for endovascular therapy were as follows: patients with a major vessel stroke based on a National Institutes of Health Stroke Scale (NIHSS) score $\geq$ 10, which indicates a large vessel occlusion, who had a contraindication for IVT (eg, $>$ 4.5 h from the onset of the symptoms, anticoagulant therapy, or recent surgery) and with repeated symptom fluctuation (NIHSS score $\geq$ 10) or no improvement within 1 hour after IVT. The presence of any demarcated ischemic lesion on brain CT scan and no ischemic penumbra on CT perfusion imaging were the imaging exclusion criteria. The time from the onset of the stroke symptoms to the final decision for intervention (admission to the protocol) was variable but was $\leq$ 5.5 hours (in patients who received IVT after a maximum 4.5 h, the endovascular treatment was started after a maximum 5.5 h).

All patients admitted to the endovascular treatment protocol underwent conventional cerebral angiography using the femoral artery approach under general anesthesia. When an extracranial carotid artery stenosis was the cause of stroke, the carotid artery was treated first, followed by intracranial mechanical revascularization. A wide variety of devices were used, as follows: clot retrievers, including Catch device (Balt Extrusion, Montmorency, France), MERCI Retriever (Concentric Medical, Mountain View, California), and Phenox Clot Retriever (phenox GmbH, Bochum, Germany); an aspiration device (Penumbra; Penumbra, Inc, Alameda, California); and stent retriever devices, including Solitaire (ev3 Neurovascular, Irvine, California) and Trevo (Concentric Medical). Intracranial stent implantation was a common method for endovascular therapy in the earlier years of the trial and was later used only in cases in which stable flow restoration was not achieved with the aforementioned devices. The following intracranial stents that were used: Pharos (Micrus Endovascular, San Jose, California), Neuroform (Boston Scientific, Fremont, California), Wingspan (Boston Scientific), Enterprise (Cordis Corporation, Miami Lakes, Florida), LEO (Balt Extrusion), and Solitaire (ev3 Neurovascular). The technique and the device used in each individual case were at the discretion of the interventional neuroradiologist. The decision was based on a device that was currently being successfully used and on the operator's personal preferences and experience. The stents were implanted in the anterior and posterior cerebral circulation only in cases in which no flow restoration was achieved with the thrombectomy devices. A standard double antiplatelet loading dose was used when the stents were implanted (6).

The time to IVT, time to groin puncture, and duration of the procedure were retrospectively analyzed. A thrombolysis in cerebral infarction classification grade 2b or 3 was considered to be a successful recanalization (7). Any procedure-related complication was reported and analyzed. Clinically significant procedure-related adverse events were defined as a decline of the NIHSS score $\geq$ 4 or death related to the procedure (8). Complications were also stratified according to Society of Interventional Radiology (SIR) standards (9). At discharge from the hospital, the clinical outcome was assessed using NIHSS scores after the procedure and a modified Rankin Scale score (mRS) after the procedure. A favorable outcome was defined as an mRS score $\leq$ 2 after the procedure (8). The overall mortality rate during hospitalization after the procedure was recorded.

Statistical Analysis

The time to IVT, time to groin puncture, duration of the procedure, recanalization rate, and adverse events rate for each year were compared using analysis of variance. We dichotomized the clinical outcome after the endovascular therapy into favorable (mRS score $\leq$ 2 after the procedure) and nonfavorable (mRS score $>$ 2 after the procedure) and used a χ^2 test to compare the overall clinical outcomes with the clinical outcomes of the specific years. We also compared NIHSS score improvement (NIHSS score before the procedure minus NIHSS score after the procedure) and used analysis of variance to compare the overall NIHSS score improvement with the NIHSS score improvement of the specific years. We created a new binary variable, interval period, that enabled the comparison of the first 2 years (2009–2010) and second 2 years (2011–2012). A logistic regression was used to analyze the relationship between clinical outcome and interval period. A multivariate logistic regression analysis was used to discriminate between the influence of the interval period, age, use of IVT, and duration of the procedure on the clinical outcome. IBM SPSS Statistics for Windows version 20.0 (IBM Corp, Armonk, New York) was used for the statistical analyses.