Outcome Evaluation of Acute Ischemic Stroke Patients Treated with Endovascular Thrombectomy: A Single-Institution Experience in the Era of Randomized Controlled Trials

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BACKGROUND: **Endovascular thrombectomy is an effective procedure to treat selected ischemic strokes, as shown in recent randomized controlled trials (RCTs). The generalizability of these trial data to real-world settings, however, is unknown. The aim of this study was to examine our single-center experience with endovascular thrombectomy for acute ischemic strokes and perform a comparative outcome analysis to the most recent RCTs.**

METHODS: **We performed a 5-year retrospective analysis, from April 2011 to March 2016, on 66 consecutive patients with acute ischemic stroke who received endovascular thrombectomy at our institution. The Alberta Stroke Program Early CT Score (ASPECTS) and the National Institutes of Health Stroke Scale were used to assess preoperative status. Our primary outcomes were the modified Rankin Score (mRS) at 90 days and recanalization grade measured by the 6-point thrombolysis in cerebral infarction (TICI) grading system.**

RESULTS: **Sixty-six patients received endovascular treatment during the study period. Among the patients examined, 35 (53%) had a favorable outcome (mRS 0–2 at 90 days), 23 (35%) a poor outcome (mRS 3–5), and 8 (12%) died. Successful recanalization (TICI score 3–5) was achieved in 68% of cases. In univariate analysis, patients with good outcome at 90 days had significantly greater ASPECTS, lower National Institutes of Health Stroke Scale, and higher TICI scores. In a multiple logistic regression model, higher ASPECTS and TICI scores were significantly and independently associated with favorable outcome.**

CONCLUSIONS: **Excellent outcomes, as demonstrated by the recent RCTs, can be achieved in clinical practice and reproduced in dedicated tertiary centers.**

INTRODUCTION

Ischemic stroke is one of the leading causes of death and disability in Canada.[1] Intravenous (IV) medical thrombolysis had been the only effective treatment, but only for about 8% of patients.[2] In the last few years, endovascular thrombectomy has emerged as another effective procedure for the treatment of acute stroke caused by large vessel occlusion (LVO), promptly restoring blood flow and significantly improving clinical outcomes. Multiple recent randomized controlled trials (RCTs) confirmed this effect in acute anterior circulation ischemic strokes.[3-7] Furthermore, post-hoc studies of

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- Endovascular
- Stroke
- Thrombectomy

Abbreviations and Acronyms
ASPECTS: Alberta Stroke Program Early CT Score
CI: Confidence interval
CT: Computed tomography
ESCAPE: Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times
IV: Intravenous
LVO: Large vessel occlusion
MR CLEAN: Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands
mRS: Modified Rankin Scale
NIHSS: National Institutes of Health Stroke Scale
OR: Odds ratio
RCT: Randomized controlled trial
TICI: Thrombolysis in Cerebral Infarction
tPA: Tissue plasminogen activator

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these RCTs identified several independent predictors of outcome that included imaging-to-reperfusion time and preoperative neurologic status.[8,9]

One of the main limitations reported by the RCT investigators is that their results might not be generalizable to all tertiary stroke centers.[5,7] This disparity is due partly to recruiting centers with high levels of neurointerventional experience and differences in practical workflow and imaging processes. Therefore, the aim of this study was to examine our institutional experience with endovascular thrombectomy for acute ischemic strokes and study the reproducibility of RCT results. Furthermore, we investigated the predictors of outcomes among our patients.

METHODS

Study and Patient Selection

We retrospectively analyzed all consecutive patients who underwent endovascular thrombectomy at our tertiary stroke center (Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada), from April 2011 to March 2016. The eligibility criteria for endovascular thrombectomy at our center are 1) sudden, severe neurologic symptoms and signs at presentation; 2) normal or near-normal plain computed tomography (CT) brain scan; and 3) definite proximal LVO in the anterior or posterior circulation on plain CT or CT angiography. CT perfusion was used to exclude patients from thrombectomy if it showed signs of irreversible ischemia. IV thrombolysis with tissue plasminogen activator (tPA) was also given, if not contraindicated. Written consent for treatment was obtained from all patients or from their next of kin. This study received research ethics board approval from our institution.

Clinical and Radiologic Assessments

Baseline clinical assessment for all patients included clinical examination and National Institutes of Health Stroke Scale (NIHSS) score and Glasgow Coma Scale score calculation by a stroke neurologist. Alberta Stroke Program Early CT Score (ASPECTS)[10] from the CT images for anterior circulation strokes or the analogous pc-ASPECTS[11] for basilar artery occlusions were assessed at time of presentation in most patients. Missing data relating to radiologic assessments were evaluated retrospectively by a neuroradiologist, blinded to this study, from the original CT images.

Endovascular Thrombectomy

Four neurointerventionalists at our institution performed endovascular thrombectomy for all patients included in this study. Patients underwent endovascular thrombectomy if feasible and deemed to be clinically appropriate by the treating neurointerventionalist. Most patients (80%) had retrievable stent devices as the primary treatment, either the Trevo stent (Stryker; Kalamazoo, Michigan, USA) or Solitaire AB device (ev3; Irvine, California, USA). The remaining minority of patients were treated with aspiration, the Penumbra separator (Penumbra Inc., Alameda, California, USA), or intra-arterial tPA. All patients underwent CT brain within 24 hours after the procedure.

Primary and Secondary Outcomes

Our primary outcomes were the modified Rankin Score (mRS)[12] at 90 days and recanalization grade measured by the Thrombolysis in Cerebral Infarction (TICI) grading system. We dichotomized clinical outcomes into favorable (mRS 0–2) and unfavorable (mRS 3–5). mRS scores were documented mostly in our stroke clinic notes by a neurologist. TICI grade was evaluated retrospectively by 2 independent neuroradiologists blindly, according to the new 6-points scale (0–5) where 5 indicates complete reperfusion, 4 recanalization over 67%, 3 between 50% and 67%, and 2 less than 50%.[13]

Secondary outcomes included symptomatic hemorrhage (defined as clinical deterioration of $\geq$4 points on the NIHSS or 1-point decrease in Glasgow Coma Scale, in the presence of a space-occupying hematoma on imaging), malignant edema (large ischemic infarction with mass effect/midline shift on CT), and complications related to the thrombectomy procedure, such as reocclusion, dissection, or emboli.

Comparative Analysis

To allow for a meaningful analysis and assess the reproducibility of RCTs results, our data and results are presented in combination with results of Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands (MR CLEAN),[3] which had the greatest number of patients, and the Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times (ESCAPE),[7] which was performed on 22 centers worldwide (including Canada) and was stopped early because of significant treatment efficacy. For outcome comparison, we considered separately patients with basilar artery occlusions, because these trials did not include posterior circulation strokes, and these are known to be associated with poor prognosis.[14]

Statistical Analyses

Univariate analyses were performed by the use of independent-samples t tests or χ^2/Fisher exact tests, for continuous and categorical covariates, respectively. Independent predictors of the primary outcome were identified with the use of a multiple logistic regression model. Potential interactions between continuous covariates were checked, and dropped from the final model if nonsignificant. Model diagnostics were performed to assess for colinearity and overly influential observations. All statistical analyses were performed with SPSS v.24.0 (IBM Inc., Armonk, New York, USA), and R, an open-source statistical computing and graphics platform developed by the R Foundation for Statistical Computing (www.r-project.org).

RESULTS

Patient Demographics and Characteristics

Sixty-six patients received endovascular treatment during the study period. **Table 1** shows the baseline characteristics in comparison with the ESCAPE and MR CLEAN trials. Overall, our patients were younger than those in the ESCAPE trial and comparable in age with those in MR CLEAN, but their clinical presentation was worse according to both ASPECTS and NIHSS scores. The most common site of LVOs in our patients involved the middle cerebral artery, which is similar to the patients in the other