The Addition of Endovascular Intervention for Dural Venous Sinus Thrombosis: Single-Center Experience and Review of Literature

Eric M. Nyberg, MD,* David Case, MD,† Lidia M. Nagae, MD,* Justin M. Honce, MD,* William Reyenga, MD,* Joshua Seinfeld, MD,† Sharon Poisson, MD, MAS,‡ and Michelle H. Leppert, MD, MBA‡

Background: Dural venous sinus thrombosis (DVST) is a cause of infarction and intracranial hemorrhage (ICH) that can lead to significant morbidity. Endovascular therapy has emerged as an adjunctive therapy in select cases but has been associated with increased hemorrhagic complications. We present our experience with a large single-center cohort of DVST cases treated with current-generation thrombectomy devices. *Materials and Methods:* In this retrospective cohort study, a chart review was performed to compare presentations and outcomes of patients treated with anticoagulation alone with those treated with additional interventional therapy, using the modified Rankin Scale (mRS) score at discharge and at 90 days' follow-up. *Results:* A total of 66 patients were included; 37 were treated with anticoagulation alone, and 29 underwent additional interventional therapy. Patients presenting with ICH or infarction had a significantly greater likelihood of disability at the time of discharge (odds ratio [OR] of 64.5 and 45.8, respectively; $P < .0001$) and at 90 days (OR of 28.4 and 22.8, respectively; $P < .0001$). Patients presenting with ICH or infarction were more likely to be selected for endovascular therapy ($P < .05$). Endovascular therapy was typically performed within 24 hours of admission; 9 patients (31%) had post-treatment hemorrhage, with 2 being (6.9%) symptomatic. There were fewer patients with slight disability (mRS score ≤1) in the endovascular group compared with the anticoagulation group at discharge ($P = .05$), but outcomes were not significantly different at 90 days ($P = .19$). *Conclusions:* Despite a higher rate of ICH or infarction at presentation in the endovascular group and an increased risk of postprocedural ICH, both treatment groups had similarly good functional outcomes at 90 days. **Key Words:** Cerebral venous thrombosis—thrombectomy—thrombolysis—stroke.

From the *Department of Radiology, University of Colorado, Aurora, Colorado; †Department of Neurosurgery, University of Colorado, Aurora, Colorado; and ‡Department of Neurology, University of Colorado, Aurora, Colorado.

Received February 6, 2017; revision received March 23, 2017; accepted May 5, 2017.

Contributorship statement: E.N. conceived and designed the study, designed the data collection tools, cleaned and analyzed the data, drafted and revised the paper, and was also a guarantor. L.N. drafted and revised the paper. J.H. drafted and revised the paper. W.R. chart reviewed and collected the data and revised the draft paper. D.C. drafted and revised the paper. J.S. drafted and revised the paper. S.P. drafted and revised the paper. M.L. analyzed and interpreted the data, and drafted and revised the paper.

Address correspondence to Michelle H. Leppert, MD, MBA, Department of Neurology, University of Colorado, Mail Stop L950, 12401 E. 17th Ave., Aurora, CO 80045. E-mail: michelle.leppert@ucdenver.edu.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2017.05.006

Introduction

Dural venous sinus thrombosis (DVST) is a well-known yet uncommon cause of acute infarction and intracranial hemorrhage (ICH) and carries the risk of permanent neurological deficits. Outcome data regarding DVST treatment are limited to case series and reviews.

The mainstay of treatment for DVST is systemic anticoagulation with heparin or low–molecular-weight heparin, which has supporting evidence in the setting of ICH regardless of intracerebral hemorrhage.[1-4] Despite medical therapy, the death and long-term dependency rate is 15.1% based on data from prospective studies with long-term follow-up.[1] Among the predictors of poor outcome are coma or altered mental status, ICH on admission, thrombosis of the deep cerebral venous system, central nervous system infection, and cancer.[1]

These high morbidity and mortality rates spurred the use of endovascular therapy with intrasinus thrombolysis and mechanical thrombectomy, which has generally been reserved for patients with clinical deterioration on anticoagulation, based on the current American Heart Association (AHA) guidelines on the management of DVST.[5,6] However, in patients with predictors of poor outcome, earlier endovascular intervention may be justified. Prior case series and reviews have suggested that endovascular treatment is effective for reducing clot burden but is associated with an increased risk of hemorrhagic complications.[7-10] Data describing the safety and effectiveness of the current generation of endovascular devices, including retrievable stents and flexible aspiration catheters capable of distal intracranial placement, are limited.

We sought to compare patients treated for DVST with current-generation endovascular thrombectomy devices and those treated with conservative therapies. The present study was performed in the setting of a comprehensive stroke center with a dedicated neurosurgical intensive care unit (ICU), where intervention may be considered sooner than would be expected given current AHA guidelines. We also compared our results with those found in the literature.

Materials and Methods

Institutional review board approval was obtained for this retrospective cohort study. The electronic medical record was queried using International Classification of Disease, Ninth Revision, code 325 followed by a chart review to identify patients treated for DVST at our institution from January 2011 to December 2015. Reasons for exclusion included occlusion of a dural venous sinus by a mass, chronic DVST, or significant comorbidities such as end-stage malignancy or life-threatening traumatic injuries. All radiological studies were reviewed by a neuroradiologist for the present study.

Patients were stratified into those presenting with nonspecific neurological complaints, for example, headache, and those with objective neurological findings including focal weakness or numbness, aphasia, slurred speech, or seizures. Patients were also stratified into groups that presented with acute findings on their initial noncontrast computed tomography (NCCT) or magnetic resonance imaging, including infarction and ICH, and those without acute parenchymal changes. Patients were classified into 2 treatment groups: those undergoing systemic anticoagulation therapy alone versus those also undergoing endovascular therapy.

In the endovascular therapy group, charts were reviewed to determine whether there had been a symptomatic progression before intervention, including new or worsening focal symptoms, worsening mental status, new seizures, or progression to status epilepticus. The duration of therapeutic anticoagulation before intervention and the hospital day of intervention was also recorded. The angiography reports for the endovascular group were reviewed for technique and to note any procedure-related complications. All patient charts were reviewed to assess for post-treatment complications including new or enlarged ICHs during the admission after initiating anticoagulation or endovascular therapy. Chi-squared test, 2-tailed *t*-test and the Fisher exact test were used to assess for statistical significance between the 2 groups.

Treatment Methods

The increased likelihood of endovascular therapy in the presence of objective clinical or imaging findings was assessed using a chi-squared test. Treatment decisions were made by an interdisciplinary team consisting of neurointerventionists, neurointensivists, and stroke neurologists.

All endovascular patients included in this analysis underwent intrasinus thrombolysis consisting of thrombolytic infusion via microcatheters positioned in the dural venous sinuses, occasionally directly within the DVST clot, for a duration of 24-72 hours. Twenty-two of the 29 endovascular patients also underwent mechanical thrombectomy. Thrombectomy patients were treated with Solitaire FR (Covidien, Irvine, CA), Penumbra (Penumbra Inc., Alameda, CA), AngioJet (Boston Scientific, Marlborough, MA), or any combination therein. All endovascular patients were closely monitored in the neurological ICU while continuing heparin infusion, in many cases at a lower set infusion rate to reduce the risk of hemorrhage while on continuous thrombolytic infusion. Patients receiving continuous thrombolytic infusion had serial fibrinogen levels checked every 6 hours for titration.

Clinical outcomes were compared using the modified Rankin Scale (mRS) score at discharge and at 90 days after discharge. Favorable outcome was defined by an