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Contrast enhanced magnetic resonance venography in the follow-up evaluation of idiopathic intracranial hypertension patients with cerebral venous sinus stenting

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ABSTRACT

Purpose: Role of contrast-enhanced magnetic resonance venography (CE-MRV) in the follow-up of venous sinus stenting (VSS) among the idiopathic intracranial hypertension (IIH) patients.
Materials and methods: Prospective evaluation of VSS patients with CE-MRV, DRCV and DSA for follow-up of clinically suspected recurrent stenosis. CE-MRV was evaluated against DRCV and DSA.
Results: Ten patients with twelve episodes of recurrent symptoms. Sensitivity, specificity, PPV, NPV and accuracy of the CE-MRV for the detection of recurrent stenosis were: 100%, 33.33%, 81.82%, 100% and 83.3% respectively.
Conclusion: CE-MRV was a reliable first-line investigation for the detection of recurrent stenosis following VSS.

1. Introduction

Cerebral venous sinus stenting (VSS) has become an effective treatment with a favorable risk-to-benefit profile for medically refractory idiopathic intracranial hypertension (IIH) [1]. Stent patency and recurrent stenosis (in-stent stenosis or stent-adjacent stenosis) are the concerns for long-term follow-up of these patients [2,3]. To date, no imaging modality has been validated for follow-up imaging after VSS and imaging modalities vary greatly among reporting centers, including: no follow-up at all in asymptomatic patients, Magnetic resonance venography (MRV), CT venography (CTV), direct retrograde catheter venography (DRCV) or digital subtraction arteriography (DSA) [4–7]. The cumulative risks inherent to repeated arterial or venous puncture, exposure to ionizing radiation, iodinated contrast media and vascular catheterization procedures from these modalities demand a safe and reliable approach suitable for long-term follow-up of patients with cerebral venous sinus stenting.

Magnetic resonance venography (MRV) is widely accepted as a first line investigation for the diagnosis of venous sinus stenosis in patient with idiopathic intracranial hypertension (IIH) [8–10]. Contrast enhanced magnetic resonance angiography (CE-MRA) is a time tested and validated technique in the follow-up evaluation of intracranial aneurysms with or without stent-assisted embolization [11,12] as well as with flow diversion [13–15]. CE-MRA remains a reliable technique in the long-term follow-up of carotid stent [16] and intracranial arteriovenous fistula [17] patients. Despite its non-invasive nature, no patient exposure to ionizing radiation and iodinated contrast media and simultaneous offering of multi-planar reconstructions, CE-MRV in the follow-up of venous sinus stent has not been validated. Ogungbo et al. [18] reported use of CE-MRV in one patient at 3-month follow-up of VSS and used DSA for subsequent follow-up at 1-year. Authors have not commented on reasons for change in the follow-up imaging modality and their experience on using CE-MRV for the venous sinus stent follow-up has not been reported.

At our institute, CE-MRV is used as primary imaging modality for the initial diagnosis of venous sinus stenosis as well as post-stenting follow-up of IIH patients. The purpose of this study was to prospectively evaluate the role of contrast-enhanced magnetic resonance venography (CE-MRV) in the follow-up evaluation of the VSS in IIH patient population by comparing it with direct retrograde catheter venography

Abbreviations: VSS, venous sinus stenting; IIH, idiopathic intracranial hypertension; DRCV, direct retrograde catheter venography; CE, contrast enhanced; BMI, body-mass index

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(DRCV) and digital subtraction arteriography (DSA).

2. Materials and methods

2.1. Patient selection

This is a prospectively collected data of all the patients who underwent venous sinus stenting (VSS) at our institution. The patients are enrolled either as a part of ongoing FDA approved clinical trial "Venous Sinus Stenting for Idiopathic Intracranial Hypertension Refractory to Medical Therapy" (ClinicalTrials.gov Identifier: NCT01407809) or in a prospective patient registry, both approved by our Institutional Review Board. All data were collected prospectively. A written informed consent approved by the Weill Cornell institutional review board was signed by the study participants. Seventy-two consecutive patients treated with venous sinus stenting (VSS) were prospectively evaluated. A written informed consent approved by the Weill Cornell institutional review board was signed by the study participants. Patient demographics including age, gender, weight and body-mass index (BMI) were collected from the database.

2.2. Inclusion & exclusion criteria

Patients with recurrent clinical symptoms or findings concerning for stent thrombosis or recurrent stenosis on CE-MRV, who were further evaluated with both direct retrograde catheter venography (DRCV) and digital subtraction arteriography (DSA) constituted the study population. Patients with recurrent symptoms lacking CE-MRV, DRCV or DSA were excluded.

2.3. Post-VSS follow-up

Following VSS, all patients were routinely evaluated with time-of-flight (TOF), phase contrast (PC) and contrast enhanced MRV sequences at 3, 12 and 24-months and cerebrospinal fluid opening pressure measurements at 3 months as a part of study protocol. Patients with recurrent clinical symptoms were initially evaluated with CE-MRV followed by direct retrograde catheter venography (DRCV) and manometry and by digital subtraction arteriography (DSA).

2.4. Study parameters

All patients were evaluated for stent patency, in-stent stenosis, stent adjacent stenosis and patency of vein of Labbe on CE-MRV. Stent patency was defined as visualization of the entire stent lumen on the axial CE-MRV (Fig. 1). A reduction of ≥50% sinus lumen with in the stent or adjacent to the stent was defined as stenosis (Fig. 2). Patency of the vein of Labbe was evaluated based on its visualization on the CE-MRV source and 3D-reformatted images (Fig. 3).

2.5. Contrast enhanced MRV (CE-MRV)

Contrast enhanced (CE) MRV was performed on 1.5 Tesla scanner using 3D T1-fast spoiled gradient-echo pulse sequence with TR/TE = 11/2.3 ms, flip angle = 25°, FOV = 25 cm, 256 × 256 sampling matrix, 120-axial acquisitions with slice thickness: 1.5 mm and space: 1.5 mm following 7–10 ml of intravenous gadolinium contrast dose. Post-processing of the source images in coronal and sagittal reformats was performed using retrograde 50% overlap resulting in a 0.8 mm slice thickness. Post-processing of the DICOM source images was performed using three-dimensional multi-planar curved reformats on advanced workstation (ADW: 4.7) with optimal luminal opacification. Sinus evaluation was performed on the axial source images with subsequent confirmation on 3D reconstructions.

2.6. Direct retrograde catheter venography (DRCV)

Procedures were performed in an angiographic suite (GE Innova 2100). A 5 French Envoy (Codman Neurovascular, Raynham, MA, USA) guide catheter was advanced over 0.035″ Terumo guide wire (Terumo Medical Corporation, Somerset, NJ, USA) via common femoral venous access in to proximal jugular vein on the side of target stenosis. Then, a 2.7 French Headway-27 (MicroVention Inc., Tustin, CA, USA) microcatheter was advanced over the Synchro-14 standard (Stryker Neurovascular, Fremont, CA, USA) microwire via the Envoy guide catheter in to the superior sagittal sinus. The microwire was then removed. Catheter venography was performed in the biplane projections to evaluate for stent patency, recurrent stenosis and sinus morphology. Venous manometry was performed via the microcatheter across the venous stent/recurrent stenosis.

2.7. Digital subtraction arteriography (DSA)

Performed in the angiographic suite (GE Innova 2100) using a 4 French Terumo diagnostic glide catheter (Terumo Medical Corporation, Somerset, NJ, USA) via femoral arterial access. The diagnostic catheter was advanced in to the common carotid artery ipsilateral to the side of venous sinus stent. Frontal, lateral and oblique projections were obtained to evaluate for stent patency, recurrent stenosis, sinus morphology and vein of Labbe.

2.8. Statistical analysis

Statistical analysis was performed with SPSS version 21 (SPSS Inc., Chicago, IL, USA). Age, BMI, weight and time duration between the MRV and DRCV and DSA are considered continuous variables. Continuous variables were described with mean, range and SD. The sensitivity, specificity, positive and negative predictive value as well as accuracy of the CE-MRV was evaluated against DRCV and DSA.

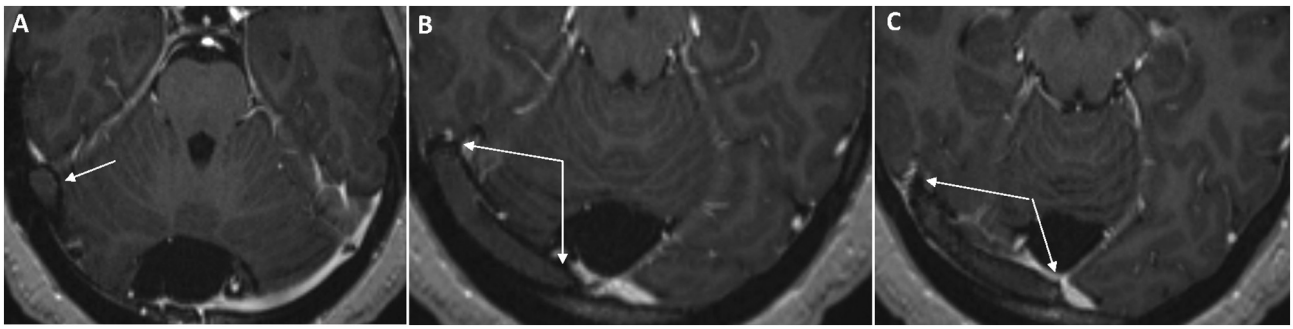

Fig. 1. A–C: Shows normal endoluminal opacification of the right transverse dural venous stent. The relatively low signal intensity in the patent right transverse sinus (TS) compared to the left TS is attributed to the stent related magnetic susceptibility. Focal step on the anterior of the sinus (B) is from overlapping of the adjacent stents.