Transarterial treatment of cerebral vascular disease has undergone significant improvement in the last 2 decades. It has been greatly supported and enhanced by the new developments in imaging technology. Flat-panel detector radiographic systems have enabled acquisition of in-room CT-like data sets with adequate contrast and exceptionally high spatial resolution. These improvements have allowed for improved morphological assessment of the intracranial vessel anatomy in 3 dimensions as well as for evaluation of periprocedural bleedings. Real-time fusion of 2D fluoroscopic images and the corresponding 3D vessel reconstructions has helped us better understand the anatomical relationship of a given vascular lesion; there has also been advancement in the endovascular material used during interventional treatment. Image guidance is considered crucial during endovascular treatment as it improves safety and increases the procedural success rate. It is frequently performed with multiple intravascular injections that carry multiple risks of allergic reactions and possible renal toxicity. Contrast medium–induced nephropathy has been reported to occur in approximately 10%–30% of patients with preexisting renal insufficiency.1,2,5,9 Hence, a coregistered fluoroscopic image and corresponding MR angiogram, requiring no additional contrast utilization, may become tremendously helpful. In the present report, we detail the technique of image fusion used for endovascular treatment of a giant cerebral aneurysm.

Case Report

This 55-year-old woman presented with headache and ophthalmoplegia. Magnetic resonance imaging revealed a left internal carotid artery cavernous aneurysm (Fig. 1). The patient also suffered from chronic renal fail-

Abbreviations used in this paper: FDCT = flat detector CT; MRA = MR angiography.
Fused MR angiography and 2D fluoroscopy

ure, which made us decide to treat her using coregistered fluoroscopy-MRA guidance to limit the contrast material to an absolute minimum. A novel MRI system, the Dynamic 3D Roadmap (Philips Healthcare), allowed for a periprocedural coregistration of the previously acquired MRA data set with the intraoperatively acquired fluoroscopic images.

To coregister the diagnostic MRA data set with the C-arm acquisition space, a peri-interventional FDCT vessel reconstruction (XperCT, Philips Healthcare) is created without injecting any contrast medium. This FDCT reconstruction is coregistered with the previously acquired MR images, using the mutual information criterion as a similarity measure. Because the FDCT image is acquired with the same equipment as the fluoroscopic images, this procedure allows overlaying of the fluoroscopic image and the MR-imaged vasculature in a single fused image. Placement of a guiding catheter in the left common carotid artery was achieved using a couple of milliliters of contrast media. After verification of the aneurysm location with injection of 6 ml of 50% diluted contrast medium, the intracranial endovascular navigation was completely performed using the Roadmap MRI system, with no additional contrast medium administrated. Misalignments that were created when the patient moved were corrected during the course of the procedure by the XtraVision workstation within 2–4 sec (automatic motion compensation software). The rotation and angulation incidences of the C-arm angles were tracked automatically, as were the source-to-detector distance and table movements. The MRI data set was corrected for the parallax distortion of the radiographic bundle. After having coregistered the data sets for navigation (Figs. 1 and 2), the microcatheter (Marksman, ev3) and guidewire (Terumo 16, Terumo Interventional Systems), present in the live fluoroscopic image, were properly aligned with the vascular lumen from the MRI data set. Small deviations may occur as a result of limited deformation of the vessels, caused by the insertion of the catheter. The MRI data set is updated for any change of the C-arm viewing incidence (angulation, rotation, source-to-detector distance, and image magnification rate) and table panning. These updates were processed in real time. Furthermore, patient motion was tracked by comparing the fluoroscopic image to a virtual projection of the FDCT data as a background process. Any patient motion introduced during the intervention was compensated for within 2–4 sec. The guidewire intracranial navigation was entirely based on the described hybrid data set, and the stent (Pipeline Embolization Device, ev3) was positioned and deployed without additional contrast injections. The final stent deployment was verified by acquiring a high-resolution FDCT data set (Fig. 3). The stent was fully deployed and covered the aneurysm neck as intended. Conventional biplane digital subtraction angiography was repeated with another 6 ml of 50% diluted contrast medium for confirmation.

Discussion

It proved to be feasible to perform safely an endovascular embolization of a large aneurysm and a subsequent stent deployment while using a minimum amount of iodinated contrast medium under hybrid image guidance. The procedure is performed by coregistering the fluoroscopic images on a previously acquired MRA data set. Although the accuracy of the coregistration was not measured, it was sufficient to perform the procedure. The accuracy of the overlay of both image data sources was deemed to be of good quality during the entire intervention.

Disclosure

Dr. Islak reports a nonfinancial relationship with Philips Healthcare. Drs. Babic and Ruijters are employed by Philips Healthcare. Author contributions to the study and manuscript preparation include the following. Acquisition of data: Kocer, Ruijters, Kizilkilic, Islak. Analysis and interpretation of data: Kocer, Ruijters. Drafting the article: Kizilkilic. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Kocer. Administrative/technical/material support: Babic, Kizilkilic.

References


Fig. 1. The previously acquired MR image (purple) is fused with the live fluoroscopic images (gray).

Fig. 2. The previously acquired MR image (purple) is fused with the live fluoroscopic images (gray).

Fig. 3. The stent deployment is checked by acquiring a high-resolution FDCT reconstruction.

Fig. 2. The MRI overlay is updated in real time to capture any change in C-arm viewing incidence and table movement.

Fig. 3. The stent deployment is checked by acquiring a high-resolution FDCT reconstruction.

Manuscript submitted August 12, 2011. Accepted November 12, 2012. Please include this information when citing this paper: published online December 14, 2012; DOI: 10.3171/2012.11.JNS111355. Address correspondence to: Naci Kocer, M.D., Department of Radiology, Division of Neuroradiology, Cerrahpasa Medical School, University of Istanbul, Kocamustafapasa, Istanbul 34098, Turkey. email: nkocer@istanbul.edu.tr.