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I read with interest the recent article by Nederkoorn and coworkers (1) regarding the occurrence of flow voids in 3D time-of-flight MR angiography (TOF-MRA) of the carotid bifurcation, although I was disappointed that they had not discovered a smaller series analyzing 2D TOF-MRA published by our group (2). In fact, the lower limit of percent stenosis associated with a flow void is similar between the two studies, probably primarily due to the relatively long echo time (TE = 6.9 ms) used in Nederkoorn's 3D-TOF series. It is important to note that flow voids would be even more likely to represent greater than 70% diameter stenosis with a shorter TE, as is commonly employed by many practitioners for this purpose. In 10 of the 14 arteries in which flow voids were observed at less than 70% stenosis as determined by digital substraction angiography (DSA), the authors note that Doppler sonography suggested a more severe stenosis. A trend toward poor DSA image quality with increasing stenosis is suggested as a cause. Since only two or three projections were obtained of each artery at DSA, another possible cause would be underestimation of true stenosis by DSA due to lack of the optimal projection.

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Reply

We agree with the clinical important findings described by Heiserman et al (1). Their study, however, focused on 2D-TOF MRA, where we describe the results of 3D-TOF MRA. We have only used 2D-TOF MRA to confirm flow void artifacts found on the three-dimensional images. In our opinion maximal-intensity-projections of 3D-TOF MRA are actually used in clinical practice to determine the degree of stenosis and therefore flow voids often are recognized with this technique. However, their conclusions certainly are in line with our findings and we apologize for not having cited their article. We agree with their suggestion that DSA in two or three projections might underestimate stenosis. Moreover, we recently studied the same hypothesis (2) and found it confirmed.

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Visualization of Subdural Electrodes

We read with interest the technical note of Schulze-Bonhage et al on the visualization of subdural electrodes by curvilinear reformatting of MR imaging in the March issue of the *AJNR* (1).

We agree with the authors that there are obviously several approaches to localizing subdural electrodes, each of which has its specific advantages and limitations. In their note they also refer to the method used by our group (described in detail by Winkler et al [2]). We fail to understand, however, how they can describe our method as "time-consuming" and estimate that it would require at least "half a day" for data processing as compared with only 30 minutes for their approach. We would like to correct this misrepresentation by giving a more realistic picture of the time frame of our method.

We first use a preimplantation MR imaging study to render a 3D reconstruction of the cortical surface anatomy. Image registration is then performed with a postoperative CT scan to localize the implanted subdural electrodes. Preoperative MR imaging is an integral part of the routine diagnostic evaluation in all patients being considered for epilepsy surgery. After electrode implantation, we use a CT scan to superimpose the electrodes onto the reformatted 3D MR image. By contrast, Schulze-Bonhage et al use postoperative MR imaging. Two advantages of the postoperative CT scan are that it is more readily available in most institutions and clearly less time consuming than postoperative MR imaging. In addition, the CT scan is less prone to movement artifacts, and the localization of electrodes is more precise, because fewer artifacts and no image distortion interfere with the data processing.

The data processing of preoperative MR imaging and postoperative CT in our approach consists of the following steps:

1. Interactive coregistration of MR imaging and CT (5 minutes).
2. Creation of a new combined data set from both studies (2 minutes).
3. Interactive segmentation of the skull in the region of interest (5–15 minutes).
4. Volume rendering of the desired view (>1 minute per view).

Thus, the entire procedure for our data processing lasts less than half an hour, by no means the "half a day" estimated by Schulze-Bonhage et al (1).Our protocol has proved itself highly reliable for electrode localization and has been routinely used since 1998 in all invasive epilepsy surgery candidates in the University of Munich Epilepsy Program.

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