**Wada-validated clinical fMRI reveals typical and atypical speech activation patterns in individual patients with epilepsy**

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**Introduction**

The Wada-test, or intracarotid amobarbital procedure is used to determine the laterality of language dominance to avoid postoperative aphasia in patients undergoing surgery for seizures. The Wada-test is a combination of a cerebral angiography with the application of sodium amytal into one internal carotid artery at a time, thus effectively anesthetizing one hemisphere to test the function of the other. It is invasive.

Before functional magnetic resonance imaging can be utilized for the clinical lateralization of language function and potentially replace the invasive Wada-test, it is necessary to show that it meets certain minimal criteria (Hammeke, 1999): fMRI can be used in the majority of patients otherwise undergoing the Wada-test; the assessment of fMRI-results is easy and reproducible; fMRI provides typical and atypical results in individual cases in concordance with a "gold standard" (i.e. Wada-test or postoperative outcome).

The aim of our study was to determine the potential role of fMRI in a sequence of diagnostic tests used in the presurgical assessment of patients with focal epilepsy.

**Methods**

Patients

Forty patients with symptomatic focal epilepsy (22 men, 30 right-handed, mean age 31.8 years (SD 12.3), range 12 - 60 years) had a Wada-Test during their presurgical workup. Twenty-three patients had left-sided temporal lobe epilepsy (TLE), 9 right-sided TLE, 5 left-sided extratemporal epilepsy, and 3 patients right extratemporal epilepsy. The protocol of the Wada test is described elsewhere (Jokeit, 1997).

Twenty-six patients had language represented in the left hemisphere (typical lateralization) and 14 had an atypical representation of language function.

**FMRI acquisition and assessment**

In each patient, fMRI were acquired twice using a 1.5 T Siemens Symphony scanner. Two different activation paradigms (phonematic and semantic verbal fluency) were applied in a blocked design consisting of 10 epochs of activation and 10 epochs of resting condition with 10 acquisitions per epoch. An EPI sequence (TR 1600 msec, TE 50 msec, 16 axial 4mm thick slices, FOV 192 mm, 64x64 matrix) was used. On-line statistical image-processing software provided with the commercially available scanner (Siemens, Erlangen, Germany) produced statistical maps thresholded at 3SD and overlaying one individual set of EPI images. The statistical maps were visually assessed and rated either typical, atypical, or artefactual by two independent raters "blinded" to clinical information.

**Results**

Between the visual assessment of two raters, there was a high measure of agreement (kappa = 0.94). FMRI results in 3 patients were rated artefactual. The cross table summarizes the remaining results comparing 37 fMRI- with Wada-test-results. Figure 1 shows an example of images rated as atypical activation pattern overlying axial EPI images (in a patient with left-sided TLE due to an early gliotic lesion in the left posterior temporal lobe [note the bilateral activation pattern with right predominance!])

**Discussion**

In our study, there was concordance between fMRI- and Wada-based lateralization of language function in 81% of the cases. Numerous cross-validation fMRI studies have shown typical left hemispheral language lateralization in concordance with the Wada-test, although with inconsistent distribution of activated brain areas between studies (most probably due to different activation tasks during scanning) (Desmond, 1995; Binder, 1996; Hertz-Pannier, 1997; Lehericy, 2000).

In all studies comparing Wada-test and fMRI, there were only few patients with atypical cerebral dominance for language. The overall number of patients measured with both methods seemed to be so low that no discrepant results between Wada-test and fMRI were published to date.

In our study, it was not possible to categorize language lateralization according to fMRI-results in three patients. Seven patients were falsely categorized using visual assessment of fMRI. Assuming that in a sequence of presurgical tests only an atypical fMRI-language-lateralization would lead to a Wada-test, two patients with falsely typical fMRI-language-lateralization (and in fact atypical Wada-test-lateralization) would have been missed by this filter.

How this compares to the risks and problems of the Wada-test can only be answered with an even larger study of unselected presurgical patients.

**References**


