Estelle Rikir[1,2,3]
Laurent Koessler[4,5]
Georgia Ramantani[4,6,7]
Louis G. Maillard[1,4,5]
l.maillard@chu-nancy.fr
[1]*Neurology Department, University Hospital of Nancy, Nancy, France;*
[2]*Neurology Department, University Hospital of Sart-Tilman, Liège, Belgium;*
[3]*Faculty of Medecine, University of Liège, Liège, Belgium;*
[4]*CRAN, UMR 7039, Lorraine University, Vandœuvre-lès-Nancy Cedex, France;*
[5]*CNRS, CRAN, UMR 7039, Vandœuvre-lès-Nancy Cedex, France;*
[6]*Division of Child Neurology, University Children's Hospital, Zürich, Switzerland; and*
[7]*Swiss Epilepsy Center, Zürich, Switzerland*

References

1. Russo A, Jayakar P, Lallas M, et al. The diagnostic utility of 3D electroencephalography source imaging in pediatric epilepsy surgery. *Epilepsia* 2016;57:24–31.
2. Russo A, Lallas M, Jayakar P, et al. The diagnostic utility of 3D-ESI rotating and moving dipole methodology in the pre-surgical evaluation of MRI-negative childhood epilepsy due to focal cortical dysplasia. *Epilepsia* 2016;57:1450–1457.
3. Rikir E, Koessler L, Gavaret M, et al. Electrical source imaging in cortical malformation–related epilepsy: a prospective EEG-SEEG concordance study. *Epilepsia* 2014;55:918–932.
4. Lantz G, Grave de Peralta R, Spinelli L, et al. Epileptic source localization with high density EEG: how many electrodes are needed? *Clin Neurophysiol* 2003;114:63–69.
5. Hauptman JS, Mathern GW. Surgical treatment of epilepsy associated with cortical dysplasia: 2012 update. *Epilepsia* 2012;53(Suppl. 4):98–104.

Response: Added value and limitations of electrical source localization

To the Editors:

In their commentary on our two articles[1,2] Rikir et al. offer several insightful observations and pose a series of questions regarding the reliability of electrical source imaging (ESI). The respondents suggest that a negative outcome in patients whose three-dimensional electroencephalographic source imaging localizes within the surgical resection cavity (SRC) implies mis-localization, We believe this conclusion could also logically apply to every localizing tool utilized in the epilepsy presurgical evaluation including ictal single-photon emission computed tomography (SPECT), interictal fluorodeoxyglucose–positron emission tomography (FDG-PET), subtraction ictal SPECT co-registered to magnetic resonance imaging (MRI) (SISCOM), and magnetoencephalography (MEG). It is now well accepted that no single methodology is perfectly localizing and that a concordance of different data is required before offering epilepsy surgery to patients.

Rikir et al. underline their previous prospective study,[3] in the adult population demonstrating concordance of ESI with stereo electroencephalography (SEEG) in the epilepsy surgical evaluation. In particular they showed a better concordance with the SEEG-defined ictal-onset zone in MRI-negative than in MRI-positive cases (respectively, 64% in MRI-negative subjects versus 18% in MRI-positive cases, considering the fully concordant data). However, the authors do not provide sufficient postsurgical data to allow a comparison of their results with ours. In fact, of their 28 subjects reported, 10 did not undergo resection, many for functional reasons, and 4 remaining subjects had a poor outcome (Engel class III or IV). We previously pointed out in our first publication that not all the operated patients were significantly improved (Engel class I or II).

Furthermore, although delineation of the EZ and mapping are listed in their study, all of their patients with malformations of cortical development (MCDs) underwent SEEG, although the indication for SEEG was not well defined. We typically do not implant electrodes in MRI-positive patients unless there is a need to map nearby eloquent cortex or there are discordant data. We believe that this protocol is fully consistent with the recent International League Against Epilepsy (ILAE) guidelines for invasive EEG.[4]

Rikir et al. also commented on our finding of improved localization in the temporal versus extratemporal dipoles with low-resolution three-dimensional (3D)-ESI. We typically place electrodes beyond standard channels only after reviewing all patient data, including semiology, EEG, and MRI data. Nonuniform electrode placement has been evaluated in simulated dipoles[5] and provides local high-resolution recording. This technique likely eliminates many of the known difficulties associated with localizing temporal sources. Prior to monitoring, we add sub temporal electrodes bilaterally in cases that do not have a well-documented semiology or EEG abnormalities. This strategy overcomes many of the limitations of the standard 10-20 placement for sampling the basal temporal regions.

With regard to our definition of specificity, we agree that it is difficult to determine the best definition in complex cases. In both studies in which the Rotating Dipole (RD) solution was considered outside the SRC, it was found to be fully outside. Given that the RD should represent the starting point of the ictal discharge, it is insufficient to focus on incomplete resection of the epileptic zone (EZ) rather than the specificity of the 3D-ESI. Furthermore, in our second study we analyzed the moving dipole

solution to minimize poor outcome due to partial resection of the EZ with excellent results, and surprisingly the moving dipole was useful only when the RD was inside the SRC.

Disclosure

None of the authors has any conflict of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Angelo Russo[1]
Matt Lallas[2,3]
Prasanna Jayakar[4]
Ian Miller[4]
Ann Hyslop[4]
Brandon Korman[5]
Catalina Dunoyer[4]
Trevor Resnick[4,6]
Michael Duchowny[4,6]
michael.duchowny@mch.com
[1]*Child Neurology Unit, Institute of Neurological Sciences of Bologna, IRCCS, Bologna, Italy;*
[2]*Department of Neurology, Children's Hospital Los Angeles, Los Angeles, California, U.S.A.;*
[3]*Department of Neurology, University of Southern California, Los Angeles, California, U.S.A.;*
[4]*Department of Neurology and Comprehensive Epilepsy Program, Brain Institute, Nicklaus Children's Hospital, Miami, Florida, U.S.A.;*
[5]*Neuropsychology Section, Brain Institute, Nicklaus Children's Hospital, Miami, Florida, U.S.A.; and*
[6]*Department of Neurology, University of Miami Miller School of Medicine, Miami, Florida, U.S.A*

References

1. Russo A, Jayakar P, Lallas M, et al. The diagnostic utility of 3D electroencephalography source imaging in pediatric epilepsy surgery. *Epilepsia* 2016;57:24–31.
2. Russo A, Lallas M, Jayakar P, et al. The diagnostic utility of 3D-ESI rotating and moving dipole methodology in the pre-surgical evaluation of MRI-negative childhood epilepsy due to focal cortical dysplasia. *Epilepsia* 2016;57:1450–1457.
3. Rikir E, Koessler L, Gavaret M, et al. Electrical source imaging in cortical malformation-related epilepsy: a prospective EEG-SEEG concordance study. *Epilepsia* 2014;55:918–932.
4. Jayakar P, Gotman J, Harvey AS, et al. Diagnostic utility of invasive EEG for epilepsy surgery: indications, modalities, and techniques. *Epilepsia* 2016;57:1735–1747.
5. Benar CG, Gotman J. Non-uniform spatial sampling in EEG source analysis. In: *2001 Conference Proceedings of the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. Vol 1. IEEE:903–905.

Electroconvulsive therapy and epilepsy

To the Editors:

Recently, Bryson et al.[1] published a paper entitled "Temporal lobe epilepsy following maintenance electroconvulsive therapy—Electrical kindling in the human brain?" In their manuscript, they described five patients who received electroconvulsive therapy (ECT) and developed temporal epileptiform discharges on electroencephalography (EEG) despite no previous history of epilepsy. They reported that three patients had epileptic seizures. After cessation of ECT their EEG findings normalized and no further clinical seizures occurred. These authors concluded that maintenance ECT is potentially hazardous. They recommended that EEG should be performed regularly for patients receiving long-term ECT.[1]

Herein, I would like to argue that their study has a major limitation: they did not reintroduce ECT after they stopped it and when the patients' EEG findings normalized to verify the existence of any cause and effect relationship between ECT and epilepsy that they have hypothesized in their manuscript. Of course, one may argue that it was not ethically feasible to do so, but this does not eliminate that major limitation in order to establish a cause and effect relationship between ECT and epilepsy. Ironically, ECT has been employed as a treatment for refractory epilepsy and status epilepticus in a few anecdotal reports, sometimes successfully.[2–4] In addition, ECT has not been found to cause epilepsy in two large studies.[5,6] In one study of 166 patients who had received ECT, the prevalence of epilepsy did not differ significantly from that in the general population.[5] In another study of 619 patients, there was no report of spontaneous seizures.[6] I should also mention that there are some other studies that suggested otherwise and are consistent with the Bryson's observation.[7] It is probably fair to say that epidemiologic data do not suggest that ECT causes epilepsy. However, when a patient who is receiving ECT develops spontaneous epileptic seizures, one is challenged with the question as to whether ECT caused it. To answer to this question, we should bear in mind the possibility of coexistent epilepsy and psychiatric disorders, the chance of seizures happening as adverse effects of psychiatric drugs, and other potentially confounding factors (e.g., family history of epilepsy).

In brief, this is too premature to suggest that ECT is potentially hazardous and that routine EEG should be performed for patients receiving this therapy based on this observation. Well-designed studies are required to establish any potential relationship between ECT and epilepsy.