Seizure 23 (2014) 475–479

Contents lists available at ScienceDirect

Seizure

journal homepage: www.elsevier.com/locate/yseiz

Short communication

Lesion focused stereotactic thermo-coagulation of focal cortical dysplasia IIB: A new approach to epilepsy surgery?

Jörg Wellmer [a,*], Klaus Kopitzki [b], Jürgen Voges [b]

[a] Ruhr-Epileptology, Department of Neurology, University Hospital Knappschaftskrankenhaus, In der Schornau 23-25, 44892 Bochum, Germany
[b] Department of Stereotactic Neurosurgery, Otto-von-Guericke University, and Leibniz Institute for Neurobiology, Leipziger Str. 44, 39120 Magdeburg, Germany

ARTICLE INFO

Article history:
Received 15 October 2013
Received in revised form 26 January 2014
Accepted 29 January 2014

Keywords:
Epileptogenic zone
Epileptogenic lesion
Stereotactic radio-frequency thermo-coagulation
Focal cortical dysplasia
Magnetic resonance imaging

ABSTRACT

Purpose: Over the last few decades, preferred epilepsy surgical approaches have developed from standard lobectomies to individually tailored resections. Yet, it remains uncertain how small surgical interventions can be without compromising the success of the surgery. Particularly in patients with epileptogenic lesions identified by magnetic resonance imaging (MRI), it is unresolved whether resection or destruction of the lesion suffices to eliminate the epileptogenic zone. We present a minimally invasive surgical approach that may provide insight into this issue.
Methods: Two patients with pharmacoresistant epilepsy due to focal cortical dysplasia type IIB demonstrated by 3 Tesla MRI were treated with lesion-focused stereotactic radio-frequency thermo-coagulation. In both patients, pathognomonic epileptic discharges were recorded from the lesion via a stimulation device prior to coagulation. In one patient, the suspected proximity of the lesion to the pyramidal tract was verified by eliciting motor evoked potentials from the depths of the lesion.
Results: Following complete and near complete lesion destruction, seizures (several per day or per week, respectively) ceased in patients A and B, with no seizures for 12 months and 5 months, respectively, at the time of this publication. Neither patient acquired persistent postoperative neurological deficits.
Conclusion: The fact that seizure activity stopped after destruction of small bottom-of-sulcus dysplasias implies that in these cases, the epileptogenic zone and the epileptogenic lesion may overlap. If future studies can replicate this finding, focused lesion destruction could be a further development of individually tailored epilepsy surgery. The technique described here is especially suited for high-precision surgery close to eloquent brain structures.

1. Introduction

Over the last few decades, tailored epilepsy surgery has successively replaced standard lobectomies. This development was enabled by the availability of 1.5- and 3-Tesla magnetic resonance imaging (MRI), which enables the detection of epileptogenic lesions and their demarcation against non-lesional tissue. The significance of epileptogenic lesions is indicated by the fact that incomplete resection is usually associated with poor outcome.[1] It is less clear, however, in which cases epileptogenic lesions as visualised by MRI, and the epileptogenic zone (EZ) as defined by Lüders,[2] overlap completely, and when circumscribed lesionectomy or destruction is sufficient for seizure control. The study of small bottom-of-sulcus focal-cortical dysplasias (FCD) type IIB could help elucidate this.[3] According to intralesional electroencephalography (EEG), these are intrinsically epileptogenic,[4] and limited resections concentrating on the cortical aspect of the lesions suffice for seizure freedom.[5]

We report two cases of lesion-focused stereotactic radio-frequency thermo-coagulation (RFTC) in patients with epilepsy due to circumscribed FCD IIB. Using MRI to guide coagulation distinguishes our approach from primarily stereo-EEG guided RFTC, which only rarely leads to seizure freedom.[6] Postoperative seizure control in both cases supports the idea that for some lesion entities, the EZ may be restricted to the morphological anomaly.

Abbreviations: EEG, electroencephalography; EZ, epileptogenic zone; FCD IIB, focal cortical dysplasia type IIB; RFTC, radio-frequency thermo-coagulation; MRI, magnetic resonance imaging; 3D-FLAIR, three dimensionally acquired fluid attenuated inversion recovery MRI sequence.

* Corresponding author. Tel.: +49 234 299 3705; fax: +49 234 299 3739.
E-mail address: j.wellmer@gmx.de (J. Wellmer).

1059-1311/$ – see front matter © 2014 British Epilepsy Association. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.seizure.2014.01.024

Table 1
Biographical data of the two patients.

	Age at onset of epilepsy	Age at surgery	Seizure type and semiology	Number of lifetime AED	AED at surgery and at last visit	Persistent neurological deficit
Patient A	9	39	SPS, CPS, sGTCS initiation by jerks in left face	19	Phenytoin 450 mg/day down to 125 mg/day	None
Patient B	18	46	Hypermotor SPS, CPS and sGTCS	3	Lamotrigin 450 mg/day down to 400 mg/day	None

SPS, single partial seizures; CPS, complex-partial seizures; sGTCS, secondary generalised tonic–clonic seizures; AED, antiepileptic drugs.

2. Patients and methods

A 39-year-old (patient A) and a 46-year-old patient (patient B) suffered from epilepsy with several seizures per day (patient A) and per week (patient B) despite pharmacological treatment for 30 and 28 years. In both patients, 3 Tesla MRI including a three dimensional 1 mm × 1 mm × 1 mm fluid-attenuated inversion recovery (3D-FLAIR) sequence showed the typical signs of singular, circumscribed FCD IIB. Both lesions were identified as being epileptogenic lesions by non-invasive presurgical workup. For clinical details see Table 1.

An *extended* lesionectomy was offered to each patient with an estimated chance for long term seizure freedom of 80% but a significant risk of permanent neurological morbidity. In patient A, the lesion was located in the right pre-central gyrus close to the neocortical face representation. More importantly, the deep parts of the lesion reached the pyramidal tract (Fig. 1(A1)); therefore, the risk of paresis following resection was estimated at 50%. In patient B, the left fronto-orbital lesion did not immediately neighbour eloquent cortex or fibre tracts (Fig. 1(B1)), but complications during an open sub-frontal surgical approach could have resulted in aphasic disturbance.

The patients were informed about alternative local lesion destruction via stereotactic RFTC. Based on clinical and in vivo data relating the dimensions of tissue defects to the applied electrode type, temperature and heating time,[7,8] together with the large clinical experience from the application of this technology for functional stereotactic neurosurgery (thalamotomy, pallidotomy), the procedural risk was estimated to be lower than that of conventional surgery. Experience regarding the chances for seizure freedom following lesion-oriented RFTC was lacking. However, for the case of complete lesion destruction, a similar chance for seizure freedom as for the case of lesionectomy was projected. Both patients opted for the RFTC.

RFTC was planned based on the lesion extent recognisable on 3 Tesla 3D-FLAIR, coregistered to a contrast enhanced 3D-T1 to prevent penetration of blood vessels by the electrode. For the definition of coagulation points and trajectories, we used

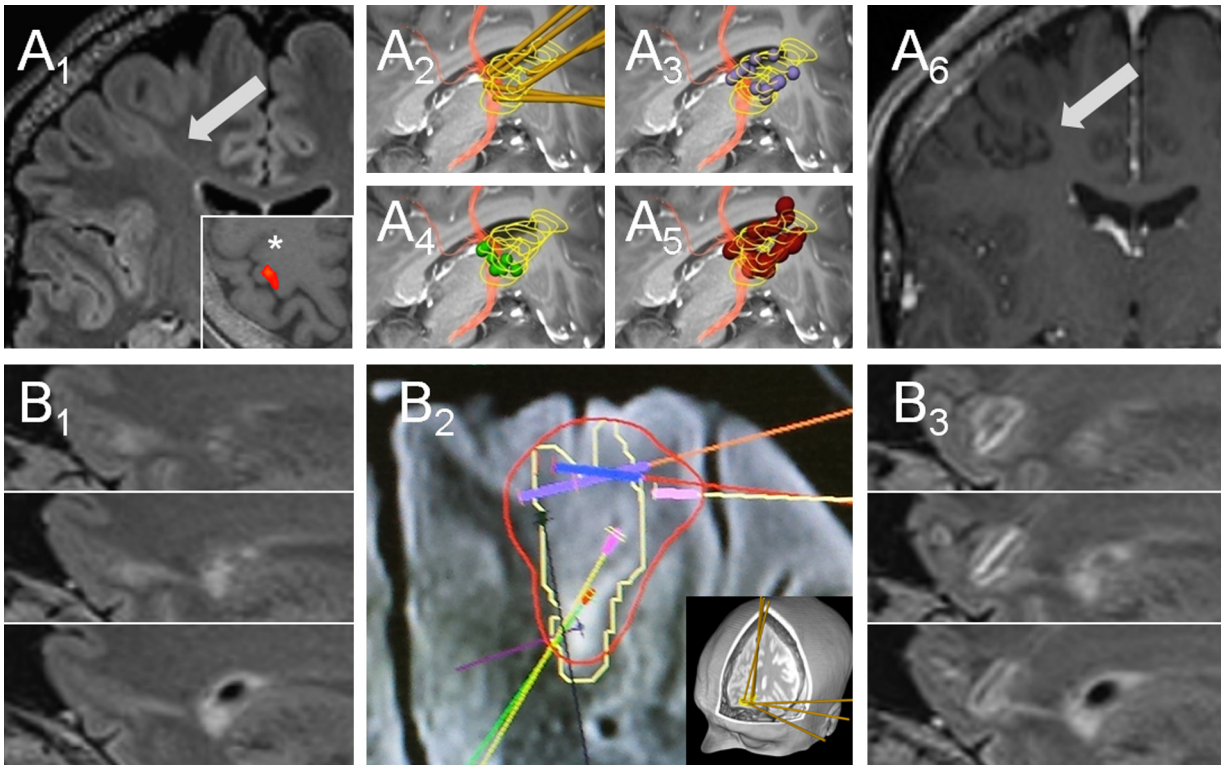

Fig. 1. (A1) 3 Tesla MRI (1 mm × 1 mm × 1 mm FLAIR) clearly indicates the existence of a FCD type IIB of Palmini and Lüders (arrow) with a funnel-like signal extension from a thickened cortex to the ventricle wall. Insert A1: the lesion (*) is located close to the hand-representation of the precentral gyrus according to functional magnetic resonance imaging. (A2) In patient A, six trajectories where chosen to impale the lesion (yellow outline), which is located close to the pyramidal tract according to diffusion weighted imaging-based fibre tracking (light red). (A3–5) Blue spheres indicate the sites within the lesion at which a bipolar EEG was recorded via the RFTC device; green spheres indicate the sites of stimulation for motor evoked potentials; and red spheres indicate the final coagulation sites. (A6) MRI of patient A one year after RFTC documents the extinction of the previous lesion. (B1) Also in patient B, the high resolution 3D-FLAIR indicates a FCD IIB with trans mantle sign towards the ventricle. (B2) In patient B, seven trajectories were chosen to allow coagulation of the lesion (screenshot of the coagulation plan). (B3) The 3D-FLAIR of patient B two months after intervention indicates only a minimal amount of oedema around the coagulation sites, which is equivalent to the amount of oedema patient A showed at 3 months post-op (not shown).